THE COMING OF THE WAR AT THE KIANGNAN ARSENAL 1885-1895

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INTRODUCTION

The growth of local military forces in China during the Self-Strengthening Movement, 1860-1895, was accompanied by the pioneering development of modern machine industries to produce arms and ammunition locally. By 1895, there were nineteen arsenals scattered along the China coast and dotting the inland waterways. More than 25,000,000 taels of government revenues had been invested in the three largest arsenals at Shanghai, Nanking. and Tientsin. Incalculable sums had been poured into the establishment and operation of smaller plants. The Kiangnan Arsenal in Shanghai had consumed the lion's share of this investment, some 17,000,000 taels. It was the showpiece of modern industry for the empire, the Krupp of China. Still when the war with Japan ended in humiliating defeat for China in 1895, concerned officials of the imperial and provincial governments were prompt to acknowledge that the development of modern military industrial potential at Kiangnan had fallen far short of China's needs. (1)

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(1) This article prepared especially for the special issue of the *Bulletin of the Institute of Modern History* commemorating the fiftieth anniversary of the Academia Sinica draws from materials in my forthcoming study, *The Arms of Kiangnan: Modernization in the Chinese Ordnance Industry* 1860-1895.

Throughout the notes I have used the following abbreviations:

CCKT I	*Chung-kuo chin-tai kung-yeh-shih tzu-liao* (Materials on the history of modern Chinese industry), Vol. I (1840-95), ed. Sun Yu-t'ang (Peking, 1957).
CCKT III	*Ibid.*, Vol. III, ed. Ch'en Chen (Peking, 1961).
CS	*Ch'ing-shih* (History of the Ch'ing Dynasty), ed. Ch'ing-shih pien-tsuan wei-yüan-wei (Ch'ing History Editorial Committee), 8 vols. (Taipei).
KNCTCC	*Chiang-nan chih-tsao-chü chi* (The record of the Kiangnan Arsenal), Wei Yun-kung ed., 10 chüan (Shanghai, 1905).
LWCK	Li Hung-chang, *Li Wen-chung kung ch'üan-chi* (The complete works of Li Hung-chang) (Taipei, 1965) including:
	LWCKTK memorials, 80 chüan;
	LWCKPLHK letters to fellow officials, 20 chüan;
	LWCKHCHK letters to the Navy Yamen, 4 chüan.
NCH	*The North China Herald and Supreme Court and Consular Gazette* (Shanghai, 1872-1941).
YWYT	*Yang-wu yun-tung wen-hsien hui-pien* (Collected documents on the foreign matters movement), Yang Chia-lo, ed., 8 vols. (Taipei, 1963).

Established at Shanghai in 1865, Kiangnan had augured well for the development of a modern munitions making capability in China. Through the initiative of its founders, Li Hung-chang and Tseng Kuo-fan, the arsenal was staffed with a cadre of highly paid foreign technicians, and equipped with a costly plant of foreign machinery for the construction of steamships and production of foreign-style small arms and ammunition. In 1867, the imperial government allocated to Kiangnan an annual income of twenty percent of the Shanghai Maritime Customs proceeds taken from the forty percent regularly forwarded to the Board of Revenue in Peking. A foreign language school and technical training program for Chinese youths were established at the arsenal and a translation bureau employed Chinese and foreign personnel to translate western books on science and technology. During the first few years after establishment, the arsenal concentrated on production of small arms and ammunition for supply of the government forces battling the Nien rebels. After the pacification of the Nien in 1868, the primary mission changed from rebellion suppression to foreign defense. Shipbuilding then took over the most important place in Kiangnan's operations. (2)

Like all weapons manufactories in imperial China, Kiangnan was entirely owned and operated by the government. In practice, the power to control production and finance rested with the governor general of the Liangkiang Provinces who served concurrently as commissioner of southern ports in charge of maritime defense of the southern coast, an area known as Nanyang. Depending on who was incumbent in the southern post, Li Hung-chang, the governor general of Chihli Province and commissioner of northern ports in charge of maritime defense of the northern coast, or Peiyang, from 1870 to 1895, also had a decisive voice in the arsenal's affairs. After the death of Southern Commissioner Tseng Kuo-fan in early 1872, officials who held the southern commissioner's post from then until 1879 were disposed to heed Li's counsel regarding Kiangnan's operations. Li was dissatisfied with the high cost of foreign materials and manpower required for naval construction and the inferiority of Kiangnan-built vessels compared to those of foreign construction.

(2) *LWCKTK* 9:31-5. Yung Wing, *My Fife in China and America stalicize* (New York: Henry Holt, 1909), 160-64. Tseng Kuo-fan, *Tseng Wen-chung kung ch'üan-chi* (The complete works of Tseng Kuo-fan) (Taipei, 1964), 5 vols., 808-9. *Shang-hai hsien-chih* (History of the Shanghai District), Yü Yüeh, ed., 32 chüan (1871), 2:28-9. Knight Biggerstaff, *The Earliest Modern Government Schools in China* (Ithaca, 1961), 165-76. *YWYT* IV, 28-34, 37-41.

After Tseng's death he slowed down shipbuilding operations, suspending them entirely after 1875. In 1876, guided by a new British ordnance engineer, Kiangnan converted from a shipyard to an ordnance plant devoted chiefly to the production of muzzle-loading Armstrong coastal defense guns and ammunition. The production of breech-loading Remington single-shot rifles and black powder cartridges, begun in the early 1870's, was also continued. (3)

In the late 1870's, Southern Commissioner Shen Pao-chen, concerned over the inadequacy of naval vessels for defense of the mouth of the Yangtze, resolved to resume construction of medium-sized military steamers at Kiangnan. But Shen died in 1879, before plans for the resumption of construction materialized. His successor in the post of southern commissioner, Liu K'un-i, responding to the pressure for improved naval defense in the south resulting from the 1880 crisis with Japan over the Ryukyus, moved ahead with the plans for shipbuilding at Kiangnan. Tso Tsung-t'ang, who, in 1881, succeeded Liu in the post of southern commissioner, was an earnest advocate of southern naval development. During his incumbency, shipbuilding was resumed at Kiangnan, employing southern maritime defense appropriations. (4)

Only one vessel had been completed by late 1885 when naval reorganization subsequent to the Sino-French War again put an end to shipbuilding at Kiangnan. The Navy Yamen was established in September 1885 and charged with the organization of a national navy with first priority emphasis on the development of a northern fleet. It was given general authority to supervise and coordinate the modernization of equipment in all arsenals and shipyards and control of all maritime defense appropriations. Northern Commissioner Li Hung-chang was named associate controller of the new yamen. Li quickly made it clear that maritime defense appropriations would not be available for the finance of shipbuilding at Kiangnan. From that time until 1905, the shipyard at Kiangnan was devoted entirely to maintenance and repair. (5)

During the late 1870's and the early 1880's, the income from the Shang-

(3) Thomas L. Kennedy, "Industrial Metamorphosis in the Self-Strengthening Movement: Li Hung-chang and the Kiangnan Shipbulding Program." *Journal of the Institute of Chinese Studies* (Hongkong 1971). Kan Tso-lin, "Chiang-nan chih-tsao-chü chih chien-shih," *Tung-fang tsa-chih* (Eastern miscellany), XI (1914), 5:46-48; 6:21-25. Demetrius Boulger, *The Life of Sir Halliday Macartney* (London, 1908) 188-243. *KNCTCC* 3:7, 17.

(4) *YWYT* II, 378-80, 508-9, 535-6. *YWYT* IV, 51-2, 62. *Liu K'un-i i-chi* (A posthumous collection of Liu K'un-i's writings) (Peking, 1959), shu-tu (letters) 8:1.

(5) *YWYT* III, 1. *LWCKHCHK*, 1:10. *YWYT* II, 567.

hai maritime customs, the mainstay of Kiangnan's annual budget, was devoted almost entirely to the production of small arms ammunition, Remington rifles, gun ammunition, mines and Armstrong coastal defense guns—with the last occupying the most important place in production. During these years, Kiangnan was the only plant in China attempting to produce modern ordnance. Its production was, for the most part, disappointing. The Remington was obsolete by the early 1880's. A modified version was introduced in 1884. Several thousand of these weapons were produced and placed in storage each year until 1890 when they were tested and found to be unsafe to operate. The Armstrong coastal defense gun was adopted by Kiangnan largely because of the preference expressed by Northern Commissioner Li. Li favored the Armstrong because it was the strongest and therefore the safest to operate of the several models then employed in the West; but it was also the heaviest, the most cumbersome, and the most difficult to operate. Rationalization of heavy gun production, in the late 1880's and 1890's, required that the Armstrong be replaced by more easily operated breech-loading models and eventually by lighter quick-firing models suitable for shipboard use as well as employment in coastal defense forts. Experience in the Sino-French War showed another serious deficiency in Kiangnan's ordnance production: the arsenal lacked the capability to produce a modern light artillery piece suitable for employment by ground forces. (6)

At the time of the Sino-French War, the most critical deficiencies in Kiangnan's production were in modern field artillery and small arms. Large-scale modernized production of these ordnance items would have required new technicians and new equipment. The latter, at prevailing rates in the 1880's, would have cost over 380,000 taels. Despite its vast financial resources, Kiangnan was unable to meet this expense. In fact, after 1880 although income increased sharply, production stagnated. The continuing costs of steamship maintenance and the notion, which died slowly on the part of the southern commissioners, that the arsenal would be used for the construction of steamships weakened the arsenal financially during the transition to ordnance production. Furthermore, in the decade prior to the war, resources which could have been used for the acquisition of urgently needed ordnance machin-

(6) *YWYT* IV, 44, 47, 50, 54, 57, 61-2. *LWCKPLHK*, 20:4-5. *KNCTCC*, 3:1, 7:10, 3:13, 14, 16, 63-7.

ery were swallowed up by the costs of current production. The cost of materials most of which came from abroad consumed the greatest portion of Kiangnan's resources, about forty-one percent. The root problem here was the underdevelopment of the domestic coal, iron and steel industries. Material costs were also driven upward by purchasing malpractices among lower officials.

Another thirty-four percent of expenditures was devoted to personnel costs. Though high personnel costs have been observed in the early modern munitions industries in other countries such as Japan and the United States, in these countries high costs were accompanied by high productivity.(7) At Kiangnan, this was not the case. Gunnery trainees increased by more than three hundred during these years. There was also a sharp increase in official personnel though it is entirely unclear what they were doing. Official salaries almost doubled from 38,000 taels to over 70,000 taels per year during the decade. Foreign personnel were another important expense factor. Kiangnan still had to rely on new foreign technicians to update production, and such well-established areas as powder making remained under foreign supervision. Though the arsenal paid dearly for foreign technicians (twenty to thirty thousand taels annually), they did not bring the excellence in production which its supervisors sought.

The cost of current production and personnel consumed seventy-five percent of Kiangnan's resources. The remainder was devoted to building, purchases of equipment, purchase of munitions, and translation. The arsenal had been unable to concentrate its huge fluctuating income from the maritime customs to solve the technological problems involved in the production of field artillery and rifles. If every tael spent for the acquisition of new equipment during this decade (about 310,000 taels) had been used for the purchase of the rifle and field artillery machinery needed to remedy production deficiencies, the amount still would have fallen far short of the estimated cost of 380,000 taels. In addition to this, more funds would have been needed for new technicians, materials, and buildings. The high cost of operating a modern machine industry in an underdeveloped economic setting had sapped Kiangnan of financial strength and prevented the capital investments necessary to moder-

(7) Felicia Johnson Deyrup, *Arms Makers of the Connecticut Valley, a Regional Study of the Economic Development of the Small Arms Industry* (Northampton, Mass., 1948), pp. 206-208; Sanshi Hakumon, *Gendai nihon bunmei shi*, XIV, *Gijutsushi* (1940), p. 200.

nize production for maritime defense.[8]

THE COMING OF THE WAR 1885-1895

The inadequacy of China's military preparations became obvious during the Sino-French War giving rise to a spate of reform proposals. In the provinces, jarred by the inability of China's arsenals to meet logistic needs during the war and exhorted by imperial decree, the officials in charge of the arsenals introduced modernization measures calculated to stimulate production and reduce dependency on costly imported materials. At Kiangnan, the production problems inherited from the previous decade, rifles, coastal defense guns and field artillery, stemmed from the arsenal's inability to modernize and expand its production facilities. The lingering expense of the steamship program, the high cost of imported materials and the support of a large staff of Chinese personnel and some highly paid foreign technicians had prevented this. In addition to these developmental difficulties, there was the latent problem of strategic vulnerability. The most convenient route to and from Kiangnan could be imperiled by hostile naval vessels in the lower Yangtze. Furthermore, defense of the arsenal itself, in its exposed maritime location in Shanghai, became a constant source of concern to defense planners after the French bombardment of the Foochow Dockyard in 1884.[9]

In the decade from 1885 to 1895, the officials who supervised and directed the Kiangnan Arsenal attempted to solve two of the three major production problems; most of the activity at the arsenal was centered on the modernization of coastal defense guns and rifle production. The third production problem, guns for employment by ground forces, never figured in the planning at Kiangnan. This challenge was taken up elsewhere by Governor-General Chang Chih-tung who in this decade established China's second modern ordnance plant at the Hanyang Arsenal where guns were first produced in the summer of 1895. The authorities who controlled Kiangnan attempted to deal with one of the arsenal's major financial problems, dependence on imported materials. China's first steel refinery was established at Kiangnan in a move designed to eliminate the need for costly imported steel for ordnance and ammunition production.

(8) Thomas L. Kennedy, *The Establishment and Development of the Kiangnan Arsenal* 1860-1895 (Ph. D. Dissertation, Columbia University, 1968), pp. 143-185.
(9) *CCKT*, I, 508-509.

But the same authorities seemed to close their eyes to the serious financial problem caused by the high cost for domestic and foreign personnel serving at the arsenal. Though there was increased awareness of the strategic weakness of the arsenal's site in Shanghai, nothing was done about this either. During the war with Japan, Kiangnan's vulnerability was a keen source of worry to the southern commissioner and, from that time on, it became an actual rather than a potential problem affecting all future plans for the arsenal. (10)

Before discussing the development of production, it is appropriate to consider briefly the arsenal's financial basis, some of the internal factors affecting production costs, and the overall control of operations. Income from the 20 percent of Shanghai maritime customs proceeds remained the largest component of Kiangnan's overall income during the decade. Year to year fluctuation continued to be great but a general increase was noticeable after 1889. Prior to that time, the customs allotment varied between 400,000 and 600,000 taels annually. Thereafter, the variation was generally between 600,000 and 800,000 taels. Miscellaneous income also showed a marked increase from 1889 on, totaling 526,082 taels. The result was an overall income of over 800,000 taels in 1890, 1894, and 1895. An investigation of the arsenal's financial status conducted by the southern commissioner after the war revealed that some of this miscellaneous income was from loans which were later paid back and some was received from other parties for the arsenal to use in making purchases of machinery or materials. A record of receipt and expenditure of these funds was kept separately from the customs income and no irregularities were noted. But it was noted that, over the years, sale of scrap from the arsenal had resulted in a total income of 34,000 taels that should have been reported as regular income but was not. (11)

The great amount of miscellaneous income and the fact that it was not reported to the imperial government is a positive indication of the high degree of autonomy which Kiangnan enjoyed under the supervision of the southern commissioner. Arsenal authorities began to abuse this autonomy by malpractices in purchasing and laxity in personnel policies in the 1870's and early

(10) Thomas L. Kennedy, "Chang Chih-tung and the Struggle for Strategic Industrialization: The Establishment of the Hanyang Arsenal, 1884-1885," *Harvard Journal of Asiatic Studies*, 33:174 (1973). On plans for the removal of Kiangnan from the Shanghai site, which first came up after 1895, see Thomas L. Kennedy, "The Kiangnan Arsenal in the Era of Reform," *Chung-yang yen-chiuyüan chin-tai li-shih-so chi-k'an*, 3.1:269-346.

(11) Liu K'un-i, *Liu K'un-i i-chi* (Taipei, 1966), tsou-shu, 25:32-35.

1880's; there appears to have been an intensification of these problems during the decade from 1885 to 1895. An examination of the office of director of the Kiangnan Arsenal and the background of the two individuals who directed operations and administration during most of this decade sheds some light on these problems. The office of director was customarily held by the Taotai who supervised the Shanghai Customs House. Li Chung-chio, a proctor at the arsenal just after the turn of the century, suggested that there was another informal qualification: "In the past," Li observed, "directors were usually from Hunan Province; therefore, the officials at the arsenal also were mostly Hunanese."(12) During the period from 1879 through 1895, the southern commissioners who recommended the directors for appointment all were Hunanese. Furthermore, on the arsenal grounds, there was a temple dedicated to the Hunanese founder, Tseng Kuo-fan. Here Tseng's tablet was hung and incense was burned continually. Each year on the anniversary of Tseng's death, the officials of the arsenal, from the director right on down, gathered at the temple for memorial services. Such evidence together with Li's statement suggests that favoritism was shown to officials from Hunan for the post of director and for other posts at the arsenal. It was also reported that even the workmen and military personnel were predominantly Hunanese.(13)

One of the important directors of Kiangnan during this decade was Nieh Ch'i-kuei. Nieh, a native of Heng-shan in Hunan and a son-in-law of Tseng Kuo-fan, entered official life without ever passing a civil service examination. In 1882 at age twenty seven, he held a minor post in Nanking when a distinguised son of Hunan and an old comrade-in-arms of Tseng Kuo-fan, Tso Tsung-t'ang, was named southern commissioner. In his initial interview with Tso, Nieh impressed the senior statesman with his ability to correct Tso's mistakes as the latter recited passages from the *Huang-ch'ao ching-shih wen-pien* (Collected Documents on Statecraft) memorized more than twenty years before. Subsequently, Tso appointed Nieh to his military staff office where the two frequently dined together—the quick-witted Nieh humoring the aging commissioner while finessing Tso's efforts to share his dogmeat lunches with his new

(12) Tang T'o-ching, ed., *Ch'ieh-wan lao-jen ch'i-shih-sui tzu-hsu* (held by the Institute of Modern History, Academia Sinica, Taiwan), pp. 272-275.

(13) Hummel, *Eminent Chinese of the Ch'ing Period* (Washington, D.C. 1943-44), pp. 523, 749, 762, *NCH*, November 12, 1902; Shen Yün-lung, ed., *Hsien-tai cheng-chih jen-wu shu-p'ing* (Taipei, 1966), hsia, p. 51.

staff officer. It was not long before Nieh was named assistant director of Kiangnan but this was only after his wife had dropped a hint to Tso's daughter-in-law regarding the Nieh family's straitened finances. During the Sino-French War, Nieh supervised the production of traditional style ordnance at Kiangnan for Tso and effectively covered up a scandal at the arsenal involving Director Li Hsing-jui. Li subsequently retired to mourn the death of a parent and was replaced by P'an Ching-ju who left office in 1884 when Tso was succeeded as southern commissioner by Tseng Kuo-ch'üan (1884-1890), a younger brother of Tseng Kuo-fan. After the brief and unsuccessful tenure of Chung Yün-ku as Director, Tseng appointed his nephew by marriage, Nieh Ch'i-kuei to the directorship of Kiangnan at an unprecedented monthly salary of two hundred taels. (14)

The Nieh household was known to stick to a strict budget and, during his term as director, Nieh was also successful in putting Kiangnan on a sound financial footing. However his concern with frugality seems to have been carried to extreme, resulting ultimately in irrational and wasteful personnel practices at the arsenal. Specific instances of inept personnel administration were first reported sometime in the late 1880's. By that time, a technical training program had been in operation at the arsenal for more than ten years. Students in this program as well as those in the language institute had no fixed graduation dates, no fixed stipends and there were no definite positions for them to go to after they left the school. One who was accomplished in both mathematics and mechanical drawing was assigned to the machine shop to keep work accounts. A recommendation was made that another student who had been studying for over ten years and had shown technical competence should be taken off his student's stipend, put on a more generous salary of ten to twenty taels per month and sent into the arsenal to work. The penny-wise Nieh had seen this man riding in a horse drawn carriage and deplored his extravagance. He disapproved the change of status for the student observing sarcastically that, even if he were put on salary, it would not be enough to pay his carriage fares. Subsequently, this student was reported to have accepted a position with a foreign mining engineer where he earned one hundred taels per month and gained a reputation for the highest competence in mathematics and mechanical drawing. It was also reported that there were many

(14) Shen Yün-lung, *Hsien-tai cheng-chih jen-wu shu-p'ing*, pp. 38-48. *KNCTCC*, 6:42 does not specify this appointment.

such cases of disillusioned students going with foreign firms. (15)

Liu Ch'i-hsiang who followed Nieh as director from March 1890 until September 1895 was also of Hunanese origin and a relative of Li Hung-chang. His father Liu Jung was a distinguished Hunanese warrior from the same town in Hunan as Tseng Kuo-fan. They had studied together as boys and fought together during the Taiping and Nien rebellions. But Liu brought more than family connections and a notable Hunanese lineage to Kiangnan. His background included experience in negotiations with Western nations that provided him with a realistic appreciation of the sophistication and power of Western military forces. In 1880, he had served as secretary of the legation which Tseng Chi-tse (who was married to Liu's sister) brought to Saint Petersburg to renegotiate the dispute over Ili. Included in this group were several foreigners with long experience in Chinese military industry, Halliday Macartney and Prosper Giquel formerly of the Foochow Dockyard. In 1883, he served as second secretary of Tseng's legation in Paris. The following year, he was appointed to assist Tseng Kuo-ch'üan in the Liangkiang Provinces; subsequently, at the request of Tso Tsung-t'ang, he was transferred to Fukien. (16)

During Liu's administration Nieh's parsimonious personnel policies were reversed and carried to the opposite extreme. Official personnel increased in number from eighty or ninety to one hundred seventy or eighty; two-thirds of these, critics charged, did nothing more than draw their pay. The lowest officials had previously received twenty to thirty taels each month and clerical personnel, six to eight. Some of these were raised to as high as eighty taels per month and the lowest received at least twenty. Overstaffing was not a problem that developed suddenly during Liu's administration though it appears to have intensified at this time. It was reported that the number of menial laborers, guards and porters employed at the arsenal had tripled since the time of its establishment. An official investigation of personnel practices conducted after the war revealed that, each time there was a change of directors, it was customary for the new one to bring in thirty to forty of his personal friends as officials and deputies without making any reduction in the existing staff. By the end of Liu's tenure, the number of officials was close to two hundred.

(15) Shen Yün-lung, *Hsien-tai cheng-chih jen-wu shu-p'ing*, pp. 48-51; *CCKT*, III, 75, 79.

(16) Liu K'un-i, *Liu K'un-i i-chi*, tsou-shu, 25: 33; Hummel, *Eminent Chinese of the Ch'ing Period*, p. 855; *CS* VI, 4843-4844; Li En-han, *Tseng Chi-tse te wai-chiao* (Taipei, 1966), pp. 6, 118-119, 226.

The work force was reported to consist of a few highly skilled artisans; the rest were old workers unable to work but drawing high wages. The artillery battalion had increased to six hundred. The total cost of salaries and wages each month was set at about 30,000 taels or 360,000 taels each year, approximately fortyfive to sixty percent of the customs allotment.(17) Personnel practices during the administration of Nieh and Liu seem to have resulted in a waste of the meager technical manpower resources which the arsenal had and a depletion of its financial resources due to overstaffing with highly paid personal favorites and coprovincials of the director.

Wages for foreign technicians tapered off a bit between 1886 and 1889 totaling 61,622 taels over the four year period. Figures for the years after 1889 are not available. If there was any change, it is likely that it was an increase for several new products were introduced after 1889 and new technicians were hired to introduce the production processes. In 1889, for example, Nieh agreed to a wage of three hundred taels per month for one technician, one hundred taels per month more than the director himself received.(18)

The deterioration of purchasing procedures which began in the previous decade became noticeably worse during the administrations of Nieh and Liu. During Nieh's tenure the arsenal was reportedly victimized by fraudulent deliveries from merchant houses. When Kiangnan ordered and paid for iron of stipulated quality required for production, it received instead ordinary British iron valued at only three-eighths of the price paid. The ordinary iron was of no use at the arsenal and was known to have remained unused until at least 1902. This type of leakage of funds was reported to have been very widespread. The orders on which fraudulent deliveries were made were initiated by the director's office rather than the bargaining office, the regular purchasing agency.(19)

Under Liu Ch'i-hsiang, the function of the bargaining office was further reduced; it did no more than make occasional puchases of miscellaneous materials. All the coal, iron, copper, lead and other regularly required materials were purchased by the director through the comprador of a certain foreign firm with whom he was very close. Competitive bidding was abandoned. It was

(17) *CCKT*, III, 77-78; Chang Chih-tung, *Chang Wen-hsiang kung ch'üan-chi* (Taipei, 1963), tien-tu, 28: 12.
(18) *YWYT*, IV, 65, 71; *KNCTCC*, 2: 34.
(19) *CCKT*, III, 77.

also charged that Liu bought up materials required by the arsenal at a low price and had a third party resell them to the arsenal at a high price. After the director's offiice took over the functions of the bargaining office anyone who wanted to do business with the arsenal had to prepare the way through servants and officials before they could reach Liu. Personal fees were discussed first and then the actual price. Prices were inflated to cover the fees and the amount of the arsenal's expenditure that was actually applied to the cost of the goods purchased was very small.(20) Though some of these charges may be exaggerated, there can be little doubt that laxity and malpractices in purchasing during Liu's administration made the high costs of foreign materials even higher and sapped Kiangnan's financial strength.

The potential problems stemming from the need for strong centralized leadership in the industry materialized during this decade as the Navy Yamen proved ineffective in coordinating Kiangnan's production with that of other arsenals. Li, while serving as associate controller, approved plans for the simultaneous development of production of two rifles of different bore diame ters. In May 1889, he wired Liangkwang Governor General Chang Chih-tung assuring him that the Navy Yamen would secure imperial approval for Chang's proposal to purchase machinery to make the 11 mm. caliber Mauser rifle. Then, in the fall of 1890, Li introduced the 7.9 mm. caliber Mauser and the Austrian Mannlicher rifle to Kiangnan as models for improvement of small arms production. Chang Chih-tung subsequently changed his order to 7.9 mm. caliber rifle machinery but Kiangnan developed its own model of 8.8 mm. caliber which it began producing about 1891. As a result of this failure to coordinate production, in 1895 when Chang Chih-tung's new Hanyang Arsenal began production, China had two rifle plants producing two different caliber rifles requiring different sizes of ammunition. Contrastively, Japan had adopted the Murata rifle produced at the Tokyo arsenal as the standard weapon for all ground forces beginning in 1886.(21)

Despite these serious problems in the management and supervision of Kiangnan, the arsenal experienced a decade of furious activity both in production and modernization of facilities. Operations included the maintenance and

(20) *CCKT*, III, 75, 77.

(21) Chang Chih-tung, *Chang Wen-hsiang kung ch'üan-chi*, tien-kao, 11:9-10; Kennedy, "Chang Chih-tung and the Struggle for Strategic Industrialization," 172; *LWCKTK*, 77:1-3; *CCKT*, III, 265; Tsugai Giyū, *Nihon sangyō kigyoshi gaisetsu* (Tokyo, 1969), p. 85.

operation of steamships, construction of new production facilities, and the production of machinery, arms and ammunition. Although the maintenance and operation of steamships continued to consume a noteworthy portion of the arsenal's customs allotment, 135,900 taels from 1886 through 1889, it did not constitute an important area of activity during this decade. New operations were confined to the repair of provincial steamers and use of the drydock gradually declined. (22)

Work at the arsenal was predominantly concerned with the production of new types of arms, ammunition and machinery and the construction of new plants to house the new production. Materials employed continued to come largely from abroad. The initial stimulation to improve production was provided by an edict of June 1885 which directed Southern Commissioner Tseng Kuo-ch'üan to take extraordinary measures to improve the production of ordnance and to thoroughly reorganize the arsenals under his command. Changes began the following year after Ambassador to Germany Hsü Ching-ch'eng reported to the throne on recent developments in the European ordnance industry. Hsü noted that the Armstrong process of building up the steel inner barrel with wrought-iron bands employed by Kiangnan was already outmoded in Europe. Since steel and wrought iron reacted differently to overheating and cooling, after the gun had been used extensively, the barrel became loose. Krupp had developed a gun with steel barrel and steel reinforcing bands. Armstrong had also recently converted to using steel reinforcing bands and, like Krupp, Armstrong was now making breech-loaders rather than muzzle-loaders. Hsü recommended that the Kiangnan Arsenal convert to the production of all-steel breech-loaders. In 1886, Kiangnan engaged a new ordnance technician, Mr. Cornish, who was skilled in making the latest models of Armstrong ordnance. (23)

By the middle of 1887, Nanyang had purchased eight new 800-pounder coastal defense guns and installed them at forts at Chiang-yin and Wu-sung. In 1890, Kiangnan completed its first all-steel breech-loading gun, an 800-pounder based on an Armstrong model. The ammunition for this ordnance

(22) *YWYT*, IV, 66, 72; *KNCTCC*, 3:1; *CCKT*, III, 90.
(23) *YWYT*, IV, 64, 70, 197-199; Liu Chin-tsao, ed., *Ch'ing-ch'ao-hsu wen-hsien t'ung-k'ao* (Taipei, 1965), 238:9833; *NCH*, June 9, 1893.

required a new type of propellant, cocoa brown prismatic powder.[24] The Tientsin Arsenal had already begun to produce this but output was inadequate for the supply of Nanyang. In 1889, Director Nieh Ch'i-kuei proposed that Kiangnan also establish production. By 1891, the Navy Yamen had given its approval to purchase the necessary equipment and Kiangnan artisans had been selected to go to Tientsin for production training. Production of brown powder began in 1893 in a new plant at Lung-hua. The powder machinery purchased from Krupp was powered by a plant built at Kiangnan. Comparative tests with brown powder produced at Tientsin, in 1893, showed the Kiangnan product somewhat inferior.[25]

In 1890, when Diector Liu Ch'i-hsiang reported to the two commissioners that Kiangnan had completed its first all steel breechloader, he announced plans for the production of four more all-steel breech-loading coastal defense guns: two weighing forty-seven tons each and two weighing fifty-two tons each. When these were completed, he planned to make ten all-steel one hundred-pounder quick-firing guns, a model which he had observed while serving in Europe.[26] This gun had four to five times the fire power of the single shot coastal defense gun and was suitable for shipboard installation as well as coastal defense forts. Liu had already purchased the foreign steel required for the big coastal defense guns. After hearing of the plans for the quick-firing guns, Northern Commissioner Li authorized the arsenal to make the additional purchases of steel required for production and to take other necessary preparatory measures. New shops were built, and new furnaces, shrinking pots, huge boring and turning lathes, and rifling equipment were purchased from abroad for the production of the new ordnance. Both the coastal defense guns and the quick-firing model were completed and successfully

(24) In 1880 in the West, a further advance in the controlled burning of gun powder was made through the employment of unburnt charcoal rather than black charcoal in powder production. The resulting brown or cocoa powder burned more slowly than the black and wholly replaced it as a propellant in large guns. Ormond M. Lissak, *Ordnance and Gunnery* (New York, 1915), pp. 1-15.

(25) *YWYT*, IV, 55-56; *KNCTCC*, 2:1, 33-35; 3:1, 63-64, 69-70, 72; *NCH*, September 8, 1893.

(26) Even after the breech-loading gun was perfected, there was still the problem of returning the gun to firing position after recoil. As gun size increased, the amount of human effort required to reposition and reaim was correspondingly greater. During the 1880's Armstrong and Krupp both developed devices which accumulated the force of recoil without transmitting it to the gun mount and then employed it to return the barrel to its original firing position. As soon as the gun could be reloaded it was ready to fire again. This was the quick firing gun. *Encyclopedia Britannica*, 1910-1911, II, 866-873; 1967, I, 801-804.

test fired in early June 1893. The former was thirtyfive feet long with a bore diameter of twelve inches. The quick-firing gun was about sixteen feet long with a bore diameter of 4.7 inches; it could fire twelve rounds per minute. Both had been produced by Chinese artisans under the direction of Mr. Cornish. (27)

Production of quick-firing gun ammunition began in 1891. By 1893, specialized equipment had been installed for the production of the eight hundred pound projectiles fired by the huge coastal defense guns, Gun ammunition produced at Kiangnan then included the various sizes required for the Armstrong guns made at the arsenal as well as Krupp and Woolwich ammunition for imported ordnance. (28)

Small arms production commanded Director Liu Ch'i-hsiang's attention almost to the extent which heavy ordnance did. In 1890, he developed a plan to salvage the defective rifles which the arsenal had been producing since 1884. But Liu recognized that these weapons were already obsolete by Western standards and, even if he was able to salvage them, they would be suitable only for peacetime training. Therefore, at the same time, he had foreign technicians and Chinese artisans working on plans for regular production of a new and improved rifle. Though Kiangnan lacked the equipment necessary for production of the most recent types of Western small arms, the small arms shop was successful in turning out several models of a slightly modified version of the British Lee rifle. Tests conducted at the arsenal showed that these rifles, when fired with smokeless powder cartridges, were half again as powerful as the Mauser or Hotchkiss then popular in the West and twice as powerful as the Remington. Liu sent the models to Southern Commissioner Tseng Kuo-ch'üan for testing and announced that he hoped to begin production by adapting the machinery which the arsenal already had and employing hand labor to make some parts. The additional required machinery would be purchased gradually as funds became available. The tests conducted by the southern commissioner revealed that the superior performance of this rifle was dependent on the employment of smokeless powder ammunition. He instructed Kiangnan to investigate the production of this new propellant. (29)

Less than two thousand of these modified Lee rifles had been produced by

(27) *KNCTCC*, 3:63-64; *NCH*, June 9, 1893.
(28) *KNCTCC*, 3:18-39; *NCH*, June 9, 1893.
(29) *KNCTCC*, 3:65-67, 71.

1892 when it was replaced by a magazine rifle.(30) The introduction of this weapon was promoted by Northern Commissioner Li Hung-chang and carried through by Director Liu. In 1890, Li ascertained that the modified Lee which Kiangnan had produced was less than satisfactory. In the fall of that year, he directed the arsenal to study the new Mauser and the Austrian Mannlicher rifles as a basis for improving their production. Chinese and foreign personnel set to work on the problem. During 1891, Kiangnan began test production of an 8.8 mm. caliber magazine rifle based on the Austrian Mannlicher but with considerable modification. The most significant advancement was the increasd fire power which could be achieved by firing a five-round clip without pausing to reload after each shot as required with the Remington. Tests conducted at the arsenal showed that the striking force of the bullet was far greater when smokeless powder rather than black powder cartridges were employed. It was also observed that the rifle overheated and required cooling after two clips, or ten rounds, of black powder cartridges had been fired while three clips, or fifteen rounds, of the smokeless powder cartridges could be fired before overheating occurred. New Southern Commissioner Liu K'un-i (1891-1894) suggested that this difficulty could be overcome through the employment of a higher grade steel for production. Because Kiangnan lacked the required specialized machinery, this rifle, like its forerunner based on the British Lee, was made partly by hand.(31)

Northern Commissioner Li was greatly impressed with the new rifle. Tests conducted at Tientsin in the fall of 1892 by troop commanders and foreign instructors on Li's staff showed that the Kiangnan weapon was the equal of the new German Mauser in accuracy, ease of operation, fire power, striking force and velocity. The following year, when General Kawakami of the Imperial

(30) In the late 19th century in the West, development of the magazine or repeating rifle brought greatly increased fire power to the individual rifleman. During the 1870's and early 1880's, American and European arms companies developed mechanisms in the rifle butt which could rapidly supply cartridges to the chamber. These proved unsafe and subject to malfunction. In the late 1880's and 1890's, these were replaced by magazines located below the bolt. Cartridges were loaded in the magazine under spring pressure from below. When the bolt was drawn to the rear, it would extract the spent cartridge case from the round just fired and the spring pressure would elevate a new cartridge into the void created by the rearward motion of the bolt. When the bolt was moved forward again, it would deliver the new cartridge into the chamber. Reloading could thus be accomplished in a fraction of the time required for manusal insertion of the cartridge. H. Ommundsen and E. H. Robinson, *Rifles and Ammunition* (New York, 1915), pp. 91-102.

(31) *LWCKTK*, 77:1-3; *KNCTCC*, 3:68-70.

Japanese Army visited Li in Tientsin, he was favorably impressed with the Kiangnan rifle and said that the Murata rifle which the Japanese regarded as superior to contemporary German and French models could not compare with it. He brought two back to Japan with him to serve as models. These appraisals did not stand the test of time and closer comparisons. As new weapons were produced in China the reputation of the Kiangnan rifle began to fade. In 1897, foreign technicians conducted comparative tests with this rifle and the German Mauser model 1888 produced by the new Hanyang Arsenal. The technicians' evaluation found the Kiangnan rifle inferior in ten different major respects. Production was finally halted in 1901 in order to achieve standardization in domestically produced small arms and ammunition. The next year existing stocks were declared scrap because of firing defects which appeared after prelonged use. (32)

Production of the cartridges required for the new magazine rifle added one more type to Kiangnan's variegated output of small arms ammunition. During this decade, the employment of several new types of small arms resulted in Kiangnan producing a total of six different types of cartridges as well as percussion caps though all types were not produced each year. (33)

Subsequent to the southern commissioner's directions given in 1891, Liu set to work on the problem of smokeless powder production to supply the ammunition requirements of the new magazine rifles and quick-firing guns. (34) In January 1893, he signed a contract with Buchheister and Company for a complete set of Krupp machinery capable of producing guncotton, nitric acid and one thousand pounds of smokeless powder per day. The contract also provided for a technician to instruct in the production process. The total cost

(32) *LWCKTK*, 77:1-3; Tsugai Giyū, *Nihon Sangyō kigyōshi gaisetsu*, p. 85; Chang Chih-tung, *Chang Wen-hsiang kung ch'üan-chi*, kung-tu, 15:29-34; *KNCTCC*, 3:76-77.

(33) *KNCTCC*, 3:19-39.

(34) In 1886, smokeless powder was first produced in France. This was made by a chemical rather than a mechanical process. The base was nitrocellulose or guncotton produced by treating cotton in a solution of nitric and sulphuric acids. This was mechanically mixed with metallic salts and nitroglycerine to form a colloidal jelly which was then dried and granulated. The advantage of smokeless powder was that it was almost entirely converted into gas whereas gas evolved by charcoal powder was only about 43% of its original weight and part of the energy of this gas was used up in expelling the powder residue from the bore. Because of this complete combustion of smokeless powder, a smaller charge could produce greater force and impart greater velocity to the projectile. There was practically no residue left to foul the bore. Smokeless powder was particularly well suited for use with quick-firing guns and magazine rifles for the absence of smoke permitted rapid resighting and refiring. Ormond M. Lissak, *Ordnance and Gunnery*, pp. 1-15.

was over one hundred thousand taels. The machinery was expected to arrive in eight or nine months; meanwhile, the foreign plans for the required plant building were sent in advance so that construction could begin promptly. At that time, the production process for smokeless powder was a secret carefully guarded by the nations which held it. After the plant was established, time wore on and the foreign technicians had no success in reproducing the process for making the powder. It was the Chinese official in charge of the new works, Wang Shih-shou, who finally struck upon the proper method but this was not until April 1895 when the war with Japan had already been decided. Output was reported at sixty thousand pounds per year but quality was lacking. In 1897 Mr. Cornish stated that smokeless powder made at Kiangnan was little more than guncotton slightly diluted with vaseline and dissolved by ether. The objection to guncotton was that it was too easily detonated.(35)

In late 1890, Director Liu reported to the two commissioners that, although Kiangnan's equipment for producing all-steel guns and breech-loading rifles was not complete, it was adequate to maintain production. However, the arsenal was entirely dependent on costly foreign imports of steel for production of big guns, steel shells and rifle barrels. To reduce costs and provide a secure domestic source of supply, Liu recommended that Kiangnan establish its own refinery. Both commissioners approved the proposal and Liu proceeded with the purchase of a small refining furnace and equipment to roll rifle barrels. The cost was only twelve thousand taels and the expected output was three tons of steel and one hundred rifle barrels per day. The following year, steel refined at Kiangnan from imported ore was sent to the Nanking and Tientsin Arsenals for tests. Both plants reported that the Kiangnan product was the equal of high grade foreign gun steel. By 1892, the arsenal had begun production of steel gun shells employing ore from Hunan Province.(36)

The operation of a single furnace made the refining of steel an inefficient and costly process. It took two weeks to heat the furnace to the temperature required for smelting. Then, the ore could be inserted. After the pig iron was removed from the furnace, a two week cooling period was required after

(35) *KNCTCC*, 2:37; 3:70, 76; *NCH*, April 26, 1895, July 16, 1897.

(36) *KNCTCC*, 2:35-37; 3:70-72; *YWYT*, IV, 62-63. With the employment of heavier types of armor, harder types of metal were required for shells. By the 1880's, the widespread use of steel in naval armor and fortifications had greatly diminished the usefulness of cast iron shells. Armor piercing shells of forged steel were in common use in the West prior to 1890. *Encyclopedia Britannica*, 1910-1911, II, 866-873; 1967, I, 801-804.

which the interior had to be inspected and repaired if necessary. Finally, the pig iron could be refined. Well over a month was required to produce three tons of steel and, during the cooling period, workers sat idle at full pay. Nevertheless, in 1893 the domestic production of rifle and gun barrels was inaugurated at Kiangnan and, in that year, an extension of the refinery was completed and new British equipment installed. (37)

During this period of rapid modernization of production and construction of new facilities, the production and acquisition of new machinery created a substantial drain on the arsenal's financial resources. Expense figures show a sharp incsease in the amount spent for new machinery during 1893 and 1894. Production figures also give some inkling of the position which machine building occupied in the arsenal's operations. The output of heavy machines, some of which were to provide power for newly purchased production equipment, rose from fourteen pieces in 1890 to twenty-eight in 1894. The following year, Southern Commissioner Liu K'un-i commented that machine building was the chief activity at the arsenal. (38)

During this decade, the largest portion of the arms and ammunition produced at Kiangnan continued to go to ships, units and forts in Nanyang. Distribution to Peiyang units was limited and no ships of the Peiyang squadron were supplied from Kiangnan. As in the early 1880's, the only important supply to Peiyang units was heavy ordnance and gun ammunition. From 1886 through 1895, eleven of Kiangnan's big guns and twenty to thirty thousand pounds of ammunition were sent to units and depots subordinate to Northern Commissioner Li. Other than this, the only distribution was two hundred of the new magazine rifles and a total of sixty-one thousand cartridges sent between 1892 and 1894. Kiangnan's contribution to the Chinese forces opposing Japan was made by equipping Nanyang units which were transferred into the war zone. During 1894 and 1895, large quantities of black powder cartridges, rifles, guns and gun shells were distributed to units of the Hsiang Army which were transferred to Shan-hai-kuan. Shipments to areas other than Nanyang and Peiyang reached significant quantities only in 1893, 1894, and 1895. These war materials were sent to units in the Hupeh, Hunan, Taiwan and provinces along the southeastern coast. (39)

(37) *CCKT*, III, 78; *LWCKTK*, 77:1-3; *NCH*, May 19, 1893.
(38) Liu K'un-i, *Liu K'un-i i-chi*, tien-tu, 11:5.
(39) *KNCTCC*, 5:29-57.

Thanks to an agreement reached between Japan and Great Britain in the summer of 1894, placing the city of Shanghai outside the zone of hostilities, shipments of munitions from the Kiangnan Arsenal continued uninterrupted during the war. However, the arsenal was in constant jeopardy. In the fall of 1894, the Japanese government showed a decided inclination to renege on its promise not to attack Shanghai. At this point, powers with interests in Shanghai, the United States, Great Britain and France, intervened. On December 13, 1884, Arsenal Director Liu Ch'i-hsiang wired acting Southern Commissioner Chang Chih-tung that there was a persistent rumor among the consuls and merchants in Shanghai that Japan again planned to violate the agreement. They were expected to attack the arsenal first and then move up the Yangtze. Local defense authorities had recommended that the households of Kiangnan's two thousand artisans be moved from the arsenal to a more secure location; that the moat surrounding the plant should be made wider and deeper; and that the perimeter wall should be built higher. Noting that these measures would require time and financial resources, neither of which were at his disposal, Liu recommended an additional deployment of troops to defend the arsenal. Japan, however, did not attack probably because of the announcement by Great Britain in early January that it would take whatever steps necessary to insure the proper observance of the neutrality agreement. (40)

After the war, acting Southern Commissioner Chang Chih-tung memorialized that this experience had demonstrated clearly that Shanghai was strategically unsuitable as a site for China's most important arsenal. He pointed out that shipments of munitions from Kiangnan had been possible only because of the international agreement. The ease with which production materials could be supplied in Shanghai had determined the arsenal's location in that city decades before. Strategic considerations had been overlooked. Now, as a result, Chang observed, a dangerous situation had come about and it could no longer be tolerated. (41)

Despite the fact that Kiangnan was not attacked and its supply function was not interrupted, munitions from the arsenal were not an important factor during the hostilities. The war with Japan was decided largely by naval battles

(40) Hosea Ballou Morse, *The International Relations of the Chinese Empire* (London 1910-1918), III, 31; Chang Chih-tung, *Chang Wen-hsiang kung ch'üanchi*, tien-tu, 19;31; *NCH*, January 11, 1895.

(41) Chang Chih-tung, *Chang Wen-hesiang kung ch'üan-chi*, tsou-i, 38:4,

between Japanese vessels and those of the Peiyang squadron. Kiangnan had not equipped any of the Peiyang ships. With only one unimportant exception, the *Tsao-chiang*, Nanyang vessels built or equipped at the Kiangnan Arsenal offered no assistance to the Peiyang squadron during the war. Peiyang units also bore the brunt of the ground fighting; Kiangnan had not made significant shipments of infantry arms or ammunition to Peiyang for almost fifteen years prior to the war. The largest Nanyang units transferred to the war zone, presumably those equipped by Kiangnan, arrived too late to take part in the fighting.(42) The bulk of the war materials distributed from Kiangnan in the years from 1886 to 1895 went to areas in South China that had no direct involvement in the war. In short, Kiangnan arms were not put to an effective test during the Sino-Japanese War because of the isolation of the Southern ships from the naval battles in the north and the late arrival of the ground forces equipped by Kiangnan.

Under the directorship of Liu Ch'i-hsiang, Kiangnan experienced its most rapid expansion and modernization since the establishment years. However, taking stock of the arsenal's production at the time of the Sino-Japanese War, it is clear that results were at best uneven. The heavy ordnance produced at Kiangnan during the early 1890's was of quality equal to that produced in the West but only one or two of the big coastal defense guns and a maximum of twelve 40-pounder quick-firing guns or six 100-pounders could be produced each year. Kiangnan still did not have the machinery necessary to produce light field artillery. (Contrastively, Japan beginning in 1887 had equipped all field artillery units with a 7 cm. mountain gun produced at the Osaka Arsenal based on an Italian model.) Production of smokeless powder required for quick-firing gun and magazine rifle ammunition did not begin until near the end of the war and then the quality was questionable. Eight hundred pounds of the brown powder used for coastal defense gun ammunition could be produced daily. Output of the obsolescent Kiangnan rifle was limited due to the lack of specialized production machinery; only five or six of these partially handmade weapons could be turned out each day. Guided by the diverse requirements of Chinese armies during the war, the arsenal divided its resources to produce percussion caps and four different types of cartridges including those

(42) Rawlinson, *China's Struggle for Naval Development*, 1839-1895, pp. 167-197; Hummel, *Eminent Chinese of the Ch'ing Period* (Cambridge, Mass., 1967), pp. 686-688.

required for its own magazine rifle. Five thousand of the latter could be turned out daily, employing smokeless powder purchased from abroad. The steel refinery produced rifle barrels from Hunan iron ore but steel for heavy ordnance production required pig iron imported from Sweden. Foreign technicians and supply were required in many other areas of production as well.(43)

The Kiangnan Arsenal was unable to produce uniformly high quality modern arms and ammunition in large quantities at the time of the Sino-Japanese War, primarily because the modernization of production facilities carried on during the past six years had been incomplete, imperfect and tardy. Production expenses during the years when facilities were being modernized were so high that they restricted the acquisition of new equipment and taxed financial resources beyond their limit. In early 1895, Kiangnan Director Liu revealed to acting Southern Commissioner Chang Chih-tung that many of the improvements that had taken place and were taking place were not yet paid for. The arsenal had accepted credit from foreign firms and then found that it was unable to meet its indebtedness. Two hundred fifty thousand taels were owing on the price of new equipment for steel refining, powder and ordnance production. In addition to this, another 150,000 taels had been advanced by foreign firms for purchase of land, building for the steel refinery and the new powder plants, and the purchase of ordnance steel and constituents for powder production.(44)

Examining the arsenal's expenditures during the years when modernization was taking place, it is difficult to escape the conclusion that the costs of personnel and materials were responsible for Kiangnan's financial calamity and the incomplete status of production equipment. The arsenal's total personnel expense increased from 264, 468 taels in 1890 to 349, 531 taels in 1895 accounting for a total of thirty-six percent of all expenditures during the six year period. Another fifty-one percent was consumed by purchases of material. The remaining thirteen percent was devoted to purchase of munitions and machinery, and expenses associated with translation.(45)

Behind these cost factors were the same basic problems which had marred the conversion to ordnance production in the previous decade. Kiangnan was

(43) Chang Chih-tung, *Chang Wen-hsiang kung ch'üan-chi*, tsou-i, 38:4, *CCKT*, I, 296-297; Tsugai Giyū, *Nihon sanyō kigyōshi gaisetsu*, p. 85; *KNC TCC*, 3:34-38.

(44) *CCKT*, I, 296-297, 319; Chang Chih-tung, *Chang Wen-hsiang kung ch'üan-chi*, tsou-i, 37: 12-15.

(45) *KNCTCC*, 4:7-8.

attempting to develop modern industrial capability in an economic environment in which raw materials industries lagged far behind the required state of development. Furthermore, the officials who directed and operated the arsenal emerged from the official class of traditional society. Untrained for their positions as managers of modern industry, they permitted unbusinesslike personnel practices and laxity in financial dealings that resulted in large-scale waste of the arsenal's financial resources. In addition to these developmental weaknesses, experience during the war had shown that China could not defend Kiangnan nor insure uninterrupted distribution of products. Though this problem came to a head in 1895, it had been present for three decades. The investment in permanent facilities at Shanghai while Kiangnan was still primarily a shipyard had created a force of inertia which made removal unlikely. Further, Shanghai was probably the best location in China for the arsenal to obtain the imported materials which it needed for production; more than anything else, this had determined the arsenal's location. In this sense, adapting to deficiencies in the domestic economy had also contributed to positioning Kiangnan in a site difficult for defense and ill-suited to serve as a central distribution point during wartime.

CONCLUSIONS

Although Japan enjoyed an advantage over China in the field of ordnance resulting from the superior accomplishments of its domestic ordnance industry, the outcome of the Sino-Japanese War was not decided by the relative fire power of the two forces. Much larger issues reaching far beyond the scope of this study were involved. However, the uneven progress of modernization at Kiangnan in the decade prior to the war limited the Chinese logistically. In addition, Kiangnan was remote from the northern theater of operations and a cumbersome command structure complicated its support of the Chinese side.

In the decade before the war, the arsenal's directors and supervisors had undertaken major programs of modernization stimulated by experience during the Sino-French War and developments in the European ordnance industry. Kiangnan artisans quickly mastered the production of modern heavy ordnance equal in quality to Western counterparts. The mangement exhibited an uncompromising commitment to the highest standards of excellence in production.

The first steps toward self-sufficiency in raw materials were taken with the establishment of a steel refinery, the first in China. Still the problems were grave and new ones appeared during this decade. Overhead expenses, inflated by the need for imported materials and the persistence of traditional practices in personnel administration and purchasing, paralyzed Kiangnan. Educational changes in China lagged far behind the arsenal's needs for technical personnel. Foreign technicians were still essential for certain types of production. By the close of this decade, another extremely fundamental problem had arisen, the arsenal's location. The relative weakness of China's maritime defense had exposed the Kiangnan Arsenal to foreign attack or the threat of it. Post war strategic industrial planning would have to cope with this new dilemma.

Though progress had been great it was marred by problems of overwhelming magnitude and production fell far short of China's wartime needs. From the standpoint of the strategic industrial development at Kiangnan, this was simply the wrong war at the wrong time. It had forced upon the arsenal a timetable for modernization that, in existing economic and social conditions, it was unable to meet.