

II. Roles and Visions of Foreign Engineers

Introducing a French Technological System *The Origin and Early History of the Yokosuka Dockyard*

Reprinted from *East Asian Science, Technology, and Medicine*, no. 16 (1999): 53–72.

When we discuss the all-important question of technology in the modernization of Japan, reference to the Dutch or the British connection is usually in order.¹ Before Japan opened its doors to the outside world at the end of the Edo period, contact with the West was mainly through the Dutch at Nagasaki. It was primarily via this connection that Western writings, including military and industrial treatises, entered the country. After the Meiji Restoration in 1868, attention shifted from the Dutch to the more “advanced” British. Indeed, the new government relied primarily on British engineering to build a modern infrastructure. Central to this effort was *Kōbushō*, the Ministry of Public Works, which hired several hundred British engineers, some of whom served in the newly established Imperial College of Engineering, the precursor of the present School of Engineering of the University of Tokyo, where they taught—in English—a variety of engineering subjects and supervised senior theses written in English.²

But there was also a French connection in modern Japan, though on a more limited scale. One of the most important engineering links between France and Japan was found at Yokosuka, a city located 60 kilometers south of Tokyo and now well known as the site of a United States Naval Base. Before and during the Pacific War, the Yokosuka

1. On the modernization of Japan, see Tessa Morris-Suzuki, *The Technological Transformation of Japan* (Cambridge: Cambridge University Press, 1994).

2. Some of these senior theses are preserved at the libraries of the engineering departments of the University of Tokyo. The library of the Electrical Engineering Department, for instance, contains a complete set of senior theses, from the beginning to the present.

base housed a large arsenal as well as being the technological center of the Imperial Japanese Navy.³ The origin of the arsenal extends back to the Yokosuka Dockyard, founded at the end of the Tokugawa era and designed and constructed by French naval engineers.

The planning, construction, and early management of the Yokosuka Dockyard were all conducted under the directorship of a young French naval engineer, François-Léonce Verny. What Verny achieved in Japan was not only the construction of a dockyard and related manufacturing facilities but also the establishment of the whole technological complex necessary for the operation of a shipbuilding enterprise—the establishment of supply networks, iron foundries, an engineering school, and so on. In other words, Verny introduced and implemented an entire technological system of naval construction, and he did so, albeit on a small scale compared with the burgeoning development after the Meiji Restoration, several years before British engineers arrived on the scene.

An important feature of the dockyard in its early history was the existence of a school, where prospective engineers were instructed in basic mathematics and science as well as engineering subjects. Graduates from this school went on to form an important group of naval engineers who were instrumental in the development of the Imperial Japanese Navy as it prepared for war against China and Russia at the turn of the twentieth century.

Before turning to the history of the dockyard, a few words should be addressed about the name of this institution. The word *seitetsusho* 製鉄所 as in *Yokosuka Seitetsusho*, the original name of the dockyard, now means an ironworks, but it then had a broader meaning, implying a factory producing machines made of iron and other materials.⁴ Although the *Yokosuka Seitetsusho* had such a factory with machine tools, its obvious and primary purpose was to build and maintain modern ships. In 1871 its name was changed to the more suitable

3. On the technological significance of the Yokosuka Arsenal, see Kōzō Yamamura, “Success Ill-gotten?: The Role of Meiji Militarism in Japan’s Technological Progress,” *Journal of Economic History*, 37 (1977): 113–135.

4. Jun Suzuki, *Meiji no Kikai Kōgyō (The Machine Industry in the Meiji Era)* (Kyoto: Minerva Shobō, 1996), p. 50.

Yokosuka Zōsenjo (Yokosuka Dockyard) and, in 1903, to *Yokosuka Kaigun Kōshō* (Yokosuka Naval Arsenal).⁵ However, throughout this chapter, I will refer to it as the Yokosuka Dockyard.

The Origin of the Yokosuka Dockyard

The introduction of Western technology to Japan mainly revolved around military exigencies. After the news reached Japan of China's defeat at the hands of the British in the Opium War, the Tokugawa government and powerful clans grasped the implications of what had happened, and attempted to introduce advanced Western military technologies and related knowledge and techniques.⁶ The Saga, Satsuma, and Mito clans in particular led the scramble to construct and operate furnaces to cast iron and factories to produce machinery of various kinds.

The appearance of the fleet of United States Commodore Matthew Perry off the coast of Uraga in 1853 accelerated the pace of these modernizing efforts. After Perry's arrival, the Tokugawa government became more serious about Western military-related technology, and in this connection it lifted the two-centuries old ban on building sea-going vessels, and even went so far as to encourage powerful clans like the Satsuma—which were its potential rivals—to build Western-style ships. Two hundred years earlier, the Tokugawa government had forbidden local clans to build sea-going vessels having a deck and more than one mast. For two centuries thereafter, with only a few exceptions, sea-going vessels were not built in Japan.⁷

5. More precisely, the *Yokosuka Zōsenjo* was renamed *Yokosuka Chinjufu Zōsenbu* in 1889 and *Yokosuka Kaigun Zōsenjo* in 1897.

6. A remarkable figure who had studied Western artillery was Takashima Shūhan. Takashima had learned Western artillery from the German-born Philip Franz B. von Siebold, and continued to study it when he heard the news of the Opium War. He urged the government to introduce Western military technology, and was assigned the role of using Western guns. See Seiho Arima, *Takashima Shūhan* (Tokyo: Yoshikawa Kōbunkan, 1858).

7. There are many works on the history of shipbuilding in pre-modern Japan. See, among others, Kanji Ishii, *Wasen (Japanese Ships)* (Tokyo: Hosei University Press, 1995) and

Within a few years after Perry's arrival, several Western-style ships were built by the Satsuma, Mito, and other clans, but all turned out unsuccessful. Their failure, according to the official history of the Yokosuka Dockyard, was partly due to Japan's lack of tools and parts, even those as simple as screw nails.⁸ Unable to produce screw nails, nuts and bolts, Japanese shipwrights constructed Western-style ships with ordinary nails, which caused their wooden structure to work loose and ultimately to leak in rough seas. The Tokugawa government began to negotiate and consult with the Dutch government on this matter. It first purchased two ships from them, and then in 1857 decided to set up a shipbuilding school, staffed by Dutch instructors, and a dockyard in Nagasaki.⁹ Although the school was soon closed down, the dockyard continued to develop into a large factory-dockyard complex, later to be owned by the Mitsubishi Shipbuilding Company.¹⁰

The purchase of ships and the construction of a dockyard entailed, of course, an extraordinary large expenditure for the already ailing Tokugawa government. To compete with, and in some instances to fight against, enemy clans inside Japan, the government decided that it needed a dockyard in a place much nearer than Nagasaki. Space around the existing Ishikawajima Dockyard at the mouth of the Sumida River proved to be too constricted to permit expansion. The authorities thus launched a plan to build another dockyard in Edo Bay. To search

Hiroyuki Adachi, *Iyō no Funē: Yōshikisen Dōnyū to Sakoku Taisei (Extraordinary Ships: The Introduction of Western Ships and the Closed Country System)* (Tokyo: Heibonsha, 1987).

8. "The Japanese did not know of the spiral nail for industrial use, and built ships with ordinary nails. As a result, [the structure of] some ships reportedly loosened because of this." *Yokosuka Kaigun Senshōshi (The History of the Yokosuka Naval Dockyard)* (Yokosuka: Yokosuka Arsenal, 1915), vol. 1, p. 3.
9. On the school at Nagasaki, see Tetsuhiro Fujii, *Nagasaki Kaigun Denshūjo: Jūkyū Seiki Tōzai Bunka no Setten (The Nagasaki Naval Training School: A Contact Point between Eastern and western Cultures in the Nineteenth Century)* (Tokyo: Chūō Kōronsha, 1991).
10. The origin and the evolution of this dockyard, which can be contrasted with the Yokosuka Dockyard, has been analyzed in detail by Nakanishi Hiroshi, *Nihon Kindaika no Kiso Katei: Nagasaki Zōsenjo to Sono Rōshi Kankei, 1855–1899 (The Basic Process of Japanese Modernization: The Nagasaki Dockyard and Its Labor-Capital Relations, 1855–1899)*, 3 vols. (Tokyo: University of Tokyo Press, 1982–2003).

for a suitable site, they sought the aid of France. Their decision to turn to France mainly arose from a connection with the new French ambassador, which was based on a cordial relationship between the secretary of the French Embassy and Jōun Kurimoto, a subordinate of Tadamasu Oguri, chief treasurer of the Tokugawa government.

In his dealings with the Tokugawa government, the French ambassador Léon Roches displayed consummate diplomatic skill.¹¹ By the time he arrived in Japan in April 1864, the Western Powers were well aware of the increasing weakness of the Tokugawa regime, yet they agreed to recognize it as the legitimate government of Japan while at the same time remaining neutral in the conflict between the central government and the rival clans. When Roches stepped ashore in Japan, four Western countries—Britain, France, the Netherlands, and the United States—were about to go to war against one of the powerful clans, the Chōshū. This war, which continued for only a few days, was prosecuted under the initiative of the British ambassador, Rutherford Alcock. Roches considered it undesirable to let Britain take the initiative in negotiating an end to the hostilities, and thus around this time he began to make friendly overtures to the Tokugawa government. The government responded by asking the French diplomat to arrange for the repair of one of its Western-style ships that frequently gave trouble. Roches was happy to oblige and promptly had the vessel made ship shape. Oguri, impressed with the results, became convinced of the need of a dockyard near Edo. According to Kurimoto's recollection, Oguri selected France because its representatives were "courteous and reliable," whereas those of other countries were sometimes "arrogant and avaricious," and also because he considered that even if the Tokugawa regime were to fall, cooperation with the French could leave "a house for sale with godown."¹² He thus officially asked

11. On Roches's activities as ambassador to Japan, see Naruiwa Sōzō, *Bakumatsu Nippon to Furansu Gaikō (Japan at the End of the Edo Period and Its Diplomatic Relations with France)* (Tokyo: Sōgensha, 1998).

12. Jōun Kurimoto, *Kurimoto Jōun Ikō (Posthumous Manuscripts of Jōun Kurimoto)*, cited in Nihon Kagakushi Gakkai (History of Science Society of Japan), ed., *Nihon Kagaku Gijyutsushi Taikei (A Comprehensive History of Japanese Science and Technology)* (Tokyo: Daiichi Hōki, 1964–70), vol. 17, p. 47.

Roches about the possibility of constructing a dockyard near Edo. Roches and his staff reconnoitered around Edo Bay and discovered a spot—Yokosuka—that immediately appealed because of its topographical similarity to Toulon, France. It was here that Roches proposed the dockyard be built.

Behind this French move one may detect an economic motivation: France was anxious to import Japanese silk for its own textile industry at a time when almost ninety percent of Japan's silk exports went to Britain. This French economic interest was apparent in Roches's advice to the Tokugawa government on the question of payment. He urged them to export their silk, but at the same time advised that they choose their markets carefully. Underlying this generous advice was an imperialist agenda. In a letter to the French foreign minister, Roches set forth his plan to develop trade with Japan, being explicit on the question of economic motivation: "Japan will become for France what China became for Britain; in other words she will be our market."¹³ All these arrangements for the construction of the Yokosuka Dockyard were carried out before the new British ambassador, Harry Parkes, arrived at Yokohama in July 1865.

Aside from the construction of a large dockyard, Roches also agreed to provide assistance in training the Japanese army. The Tokugawa government had also asked for assistance with naval training, but Roches declined in view of the delicate diplomatic relationship between France and Britain. Although he diligently cultivated the Japanese government, Roches was careful not to offend the British. He duly advised the Japanese that for naval training they should seek British personnel. Aware of the inconvenience that would arise from having two foreign countries assist with the construction of the new Japanese navy, Roches suggested the possibility of a quick and temporary training of naval officers at the Yokosuka dockyard.¹⁴ It was thus decided that the dockyard would be constructed by French engineers, while the Japanese Navy as a whole would be built up with the help

13. Quoted in Naruiwa, *op.cit.*(note 11), p. 74.

14. Hiroshi Shinohara, *Kaigun Sōsetsushi: Igrisū Gunji Komondan no Kage (A History of the Establishment of the Navy: The Shadow of the British Naval Consultants)* (Tokyo: Libropoort, 1986), pp. 131–137.

of British naval officers.¹⁵

2. Construction of the Dockyard

For the post of director of construction and management of the dockyard, the French side proposed a young naval engineer, François-Léonce Verny, who was just finishing up a shipbuilding project at the dockyard in Ningbo, China, and was about to return to France. Verny had graduated from the *École Polytechnique* in 1858 and the *École du Génie Maritime*, which was then located in Paris, in 1860.¹⁶ As a fledging naval engineer, Verny first went to the dockyard at Brest and then was sent to China in 1862. After working in Ningbo and Shanghai for two years, he was picked for the important job of building a dockyard in Japan. Upon his arrival in Japan in 1865 at the age of twenty-seven, Verny consulted Japanese and French officials and then set to drawing up a plan and schedule for the Yokosuka project.¹⁷

Verny's proposal began with a plan to construct first a smaller factory complex for ship repair in Yokohama, which was to be called the Yokohama Ironworks (*Yokohama Seitetsusho* 横浜製鉄所). It then laid out procedures for the actual construction of the dockyard at Yokosuka. In his proposal, Verny emphasized that the Yokosuka project would be Japan's first complex built and operated according to Western technological know-how. All matters, Verny insisted, should be subject to the direction of French naval officers. Although a hundred Japanese artisans would be recruited to build and man the dockyard, in technical matters these artisans would be required to follow the orders of French engineers. Furthermore, French mechanics and technicians would also be recruited, and all machinery would be purchased in Japan and France. The plan also specified the financial

15. On the role of foreign advisers in the development of the Japanese navy, see *ibid* and *idem*, *Nihon Kaigun Oyatoi Gaijin (Foreigners Employed by the Japanese Navy)* (Tokyo: Chūō Kōronsha).

16. For biographical information on Verny, see Georges Balay, *Léonce Verny* (Les Vans: G. Balay, 1990).

17. *Senshōshi*, *op.cit.*, vol. 1, pp. 5–18.

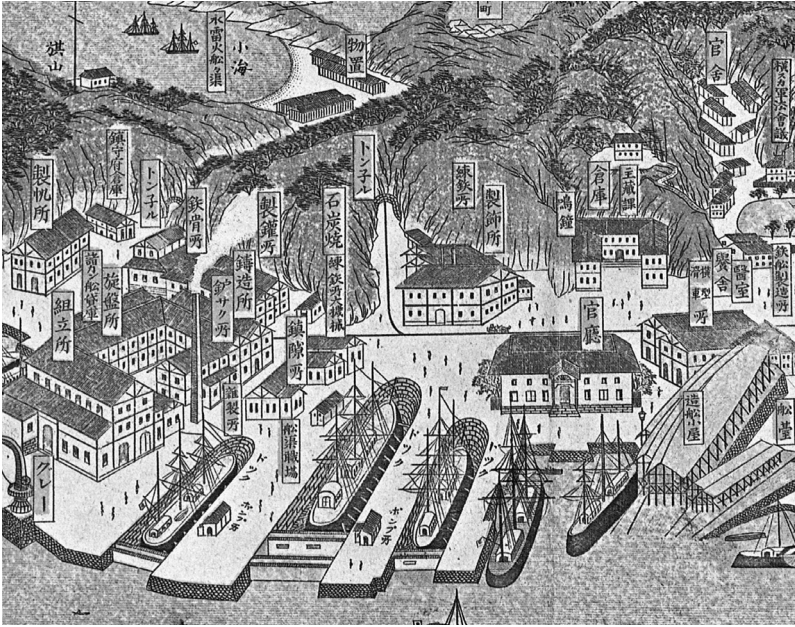
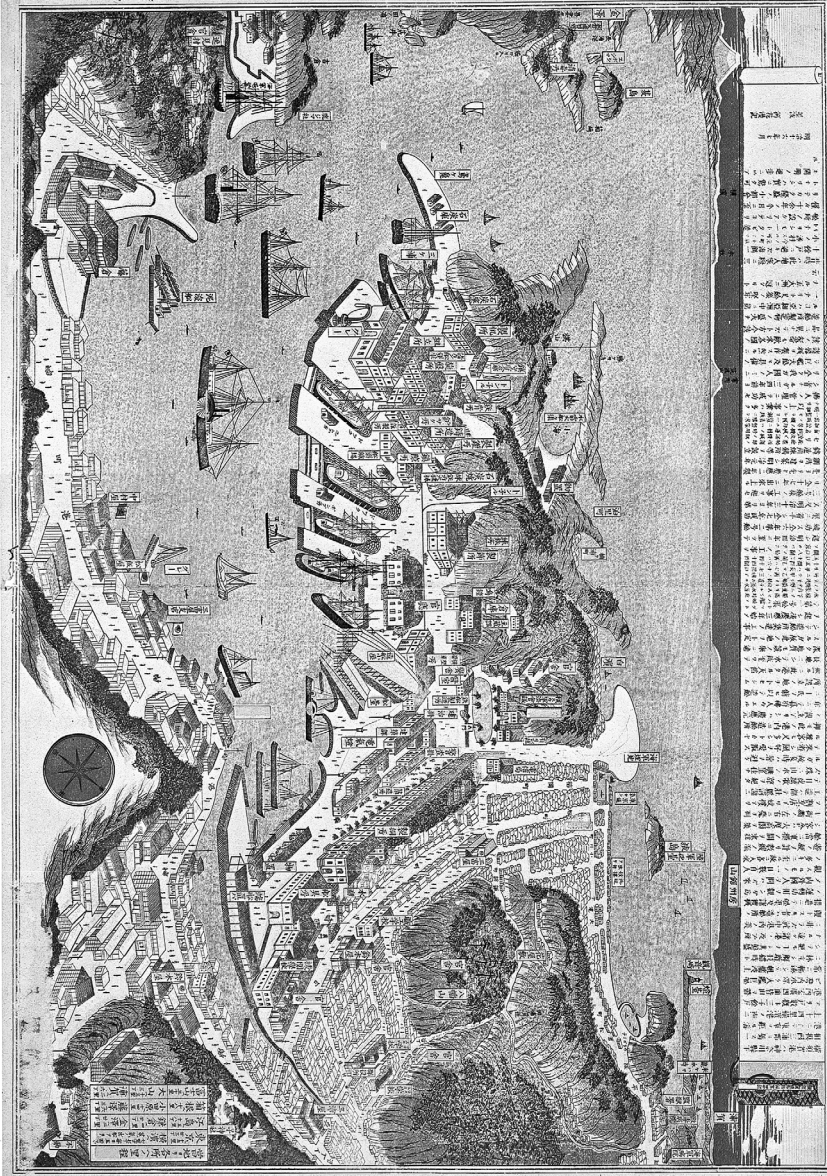


Fig. 3.1 A bird's-eye view of the Yokosuka Dockyard in 1883 (opposite page) and a detail of its part (above)

NOTE: There were three main docks (*dokku* ドック) at the Yokosuka Dockyard. To the left of these docks were a number of factories. The largest, the C-shaped building with a tall smokestack, contained machining (*senbansho* 旋盤所), drilling (*rosakusho* 鑿サク所), and assembling works (*kumitatesho* 組立所). Adjacent to this C-shaped building were factories for caulking (*tengekisho* 鎮隙所). The larger building at the left end of the complex was a canvas-making factory (*seihansho* 製帆所). In the central open area was the main office building (*kanchō* 官廳); behind it were factories for decoration making (*seishokusho* 製飾所) and for puddling (*rentetsusho* 練鉄所) and a warehouse (*soko* 倉庫); and to the right was a plant that constructed models and pulleys (*mokei-kasshajo* 模型滑車所). Behind this plant was a hospital (*ishitsu* 医室) and a school for engineers (*kōsha* 曩舎). The conspicuously long building at the right of the dockyard site housed a rope-making factory (*seikōsho* 製綱所), reminding us that this dockyard constructed sailing ships as well as steamers. Behind the rope-making factory and across the street was the school for technicians (*shokkō gakkō* 職工学校).

SOURCE: Kanagawaken Kikakuchōsabū Kenshihenshūshitsu, ed., *Kanagawaken Shi* (*The History of Kanagawa Prefecture*), *Shiryō Hen* (*Sources*) (Yokohama: Kanagawa Prefecture, 1970), vol. 17, appendix. (Courtesy of Kanagawa Prefecture.)

圖覽式細明賀須橫



明治六年八月一日出版
 總發行所 山本良助

發賣元 諸君幸觀
 繪本明夫 繪
 築設於二十五年

procedures, which were to be under the control of a French accountant: even purchases by Japanese officials were subject to the scrutiny of the French accountant and the director. A month after arriving in Japan Verny made a trip back to France, and soon thereafter a Japanese mission visited France to purchase machine tools and, under Verny's guidance, to recruit French mechanics and engineers. Most of those selected were from French dockyards: Cherbourg, Brest, Lorient, and Toulon. In 1867, the first dock at Yokosuka was completed. It was finally furnished with three docks and other engineering and logistic facilities. Figure 3.1 shows the bird's-eye view of Yokosuka Dockyard surrounded by its vicinity town and hills in 1883.

Tables 3.1 and 3.2 list the French staff at the Yokohama Ironworks and the Yokosuka Dockyard, respectively, recruited on the eve of the Meiji Restoration. At Yokohama, 16 French staff members were recruited, and at Yokosuka, 43. Of 16 working at Yokohama, 7 men, including its new director (Ferdinand N. Gautrin, who originally was to have been the Director of Machinists at Yokosuka), had originally been sent to Yokosuka and then transferred to Yokohama.

Among the dozens of French mechanics and professionals, there was a physician, Paul A.-L. Savatier, who was employed on Verny's insistence that a Western doctor was needed to care for the French staff. Because of his mastery in botanical knowledge, Savatier was also assigned the task of inspecting the quality of timbers for ship construction and of investigating Japan's flora.¹⁸ Soon after his arrival, Savatier was sent to Fukagawa to select timbers suitable for small ships to be used in the construction of the dockyard. The area at the mouth of the river (that is, Fukagawa) was chosen on the advice of the director of the Yokohama Dockyard that timbers be stocked where fresh water and sea water met. As for the collection of timbers,

18. Hiroshi Tomita and Akira Nishibori, *Yokosuka Seitetsusho no Hitobito: Hanabiraku Furansu Bunka (People at the Yokosuka Ironworks: The Blooming of French Culture)* (Yokohama: Yūrindō, 1983), pp. 45–48. Aside from discussing Savatier and Verny, Tomita and Nishibori also touch on the activities and fate of three French engineers: the canvass-maker Antoine Licchione (killed in a naval accident), the architect Edmond August Bastien (who constructed a textile mill in Tomioka), and the architect Louis Félix Florent (who constructed a lighthouse on a cape near Yokosuka).

Position	Monthly Salary US \$	Position	Monthly Salary US \$
Director (sent from Yokosuka)	400	Technician 3	75
Chief Engineer 1	150	id 4	75
id 2 (sent from Yokosuka)	150	id 5 (sent from Yokosuka)	75
id 3 (sent from Yokosuka)	150	id 6 (sent from Yokosuka)	75
id 4 (sent from Yokosuka)	145	id 7 (sent from Yokosuka)	75
id 5	75	id 8	70
Technician 1	80	id 9	60
id 2	75	id 10	60

Table 3.1 French Staff at the Yokohama Ironworks, 1886

Note: Salaries are in U.S. dollars, valued of 1866.

Source: *Senshōshi* 1915, vol. 1, p. 78.

Position	Monthly Salary US \$	Position	Monthly Salary US \$
Director	833	Boilermaker 3	75
Physician	417	id 4	75
Architectural Director	400	id 5	75
Machinery Director	400	Chief Hydraulist	75
Accounting Manager	270	Chief Mason	75
Chief Draftsman	225	Decorator	75
Chief Boilermaker	150	Drawer	75
Chief Founder	150	Drawer & Shipbuilder	75
Chief Puddler	150	Founder 1	75
Chief Hydraulist	145	id 2	75
Chief Mechanic	130	Mechanic 1	75
Draftsman for Architect	130	id 2	75
Chief Shipbuilder	120	id 3	75

Table 3.2 French Staff at the Yokosuka Dockyard, 1866

Note: Salaries are in U.S. dollars, valued of 1866.

Source: *Senshōshi* 1915, vol. 1, pp. 75–77.

Verny suggested to the government that it set up an office for forestry management in order to assure the availability of shipbuilding timber, pointing out that the cypress and oak that abounded in the area around what is now Shizuoka might be suitable, something which could be determined by an actual inspection by French experts.¹⁹ Later, Adolph E.-F. Dupont, then in charge of timber supply, made several tours to inspect trees and plants all over middle and western Japan.²⁰

Verny also proposed that the Japanese government foster the cultivation of trees which contained resin for waterproofing, essential for shipbuilding. In answer to this proposal, Oguri sent one of his subordinates, Tarokurō Masuda, to Yokosuka to learn how to manufacture waterproofing from vegetable bitumen. A few years earlier, a Russian ship had been wrecked off the coast of Izu Peninsula, and the Japanese government had agreed to replace it with a schooner to be built, with the assistance of Russian engineers who had been on board, in the town of Heda. Masuda had a hand in building this schooner—which was named *Heda* after the town—and had learned some shipbuilding skills from the Russians.²¹ Because of this experience, he was easily able to master the manufacturing of waterproofing. Impressed with the results, Oguri decided to launch the domestic production of bitumen. In a letter of appreciation to Verny, Oguri gave the Frenchman full credit for this success.²²

Minerals, too, were needed. At an early stage of the project, volcanic ash from Ōshima Island was sent to Yokosuka for examination.²³ Verny later ordered a search for good-quality limestone in the more immediate area, and planned to send calcined lime down the Tama River to Edo Bay. The plan was not realized, however, simply because

19. *Senshōshi*, op.cit., vol. 1, p. 84.

20. *Senshōshi*, op.cit., vol. 2, pp. 19–25.

21. *Senshōshi*, op.cit., vol. 1., p. 86. On the construction of the Heda, see Heda Mura Bunkazai Senmon Iinkai (Heda Village Cultural Assests Special Committee), ed., *Hedagō no Kenzō (The Construction of the Heda)* (Heda: Heda Mura Kyoiku Iinnkai, 1979). See also Kiyoshi Yamamoto, *Nibon niokeru Shokuba no Gijutsu-rōdōshi, 1854 nen–1990 nen (The Technological and Labor History of the Workplace in Japan, 1854–1990)* (Tokyo: University of Tokyo Press, 1994)

22. *Senshōshi*, op.cit., vol. 1., p. 86.

23. *Ibid.*, p. 31.

moving raw material down the Tama River proved too difficult.²⁴ Metal ores were also searched out. The dockyard employed a French chemist named Boel who was ordered to analyze metal ores produced throughout Japan.²⁵ He found clay from Izu suitable for brickmaking, and successfully manufactured bricks used at the dockyard.²⁶

The same Boel was ordered to make a pictorial record of the construction of the dockyard. He was directed to photograph the excavation of hills, the reclaiming of coastline, and the construction of buildings. All this was done quite openly. The French asked the Japanese authorities for permission to make a photographic record, and the Japanese agreed on the condition that the photographs be duplicated and preserved both in Japan and France.²⁷ Yet in the desire of the French to photograph the project and in certain statements in the official history of the dockyard, we see hints of the French perspective on Yokosuka as a part of their larger East Asian strategy. As we have noted, immediately before being sent to Yokosuka, Verny had worked at the important project at Ningbo and at Shanghai. France was involved in still another large naval project in China, at Fuzhou. At the beginning of 1868, it was proposed through Verny that an architect working at Yokosuka be given three months' leave so that he could be sent to work at the dockyard under construction in Fuzhou, which was to become one of China's largest modern factory-and-dockyard complexes.²⁸

In the midst of all this development the Meiji Restoration took place. The new rulers basically agreed to proceed with the inherited project at Yokosuka, but they also raised several important objections. They were most critical of the way money had been freely spent at a time of military and financial crisis. The official history of the dockyard is filled with reports of occasions when, upon Verny's decision,

24. *Ibid.*, pp. 82–83.

25. *Ibid.*, p. 72.

26. *Ibid.*, p. 84.

27. *Ibid.*, p. 72.

28. *Ibid.*, p. 91. In 1871, the director of construction at the Fuzhou dockyard visited Verny in Yokosuka. In a letter home, Verny enviously noted that the budget in Fuzhou was three times greater than his own. Balay, *Verny*, op.cit., p. 167.

the salaries of the French employees had been increased or they had been paid bonuses. For instance, Boel had received a bonus of 200 francs when he set up the brickmaking operation. The new government also complained about the cost of employing the doctor, Savatier, given the availability of a Western hospital in Yokohama which could also serve the French employees in Yokosuka, the two places being only about 15 kilometers apart. Verny insisted on the need for Savatier and in the end persuaded the new authorities to let him stay.²⁹ This proved to be a pyrrhic victory. On the all important question of decision-making, the Meiji government sought, and obtained, a crucial change in procedure: henceforth accounting was to be under joint control, and Verny was required to consult with Japanese officials before purchasing any goods, foreign or domestic.³⁰ As a result, expenses were reduced, although not without grumbling from the French staff, some of whom resigned, claiming that under the new regime they had become underpaid.³¹

The officials of the new government also clashed with the French staff over technical procedures. After the Restoration, the Yokosuka Dockyard was put under the Ministry of Public Works, but within four years it was transferred to the newly created Ministry of the Navy, which had been clamoring for a dockyard of its own.³² After this transfer, the naval bureau in charge of the dockyard complained to its parent ministry about work procedures under Verny's French staff. The bureau pointed out that some Japanese skilled craftsmen refused to permit every detail of their work be directed by French engineers.³³ Verny's plan, as we have noted, stipulated that "[Japanese] craftsmen should totally follow all the directions given by the officer and the head of construction, and should learn techniques from French engineers. They should never state their own opinions or fol-

29. *Senshōshi*, op.cit., vol. 1, pp. 113–114.

30. *Ibid.*, pp. 107–108.

31. Balay, *Verny*, op.cit., p. 183.

32. See Nakanishi, op.cit., vol. 2, pp. 322–323. The Ministry of Public Works retained control of the Nagasaki Dockyard until its disposal (to Mitsubishi) in 1884.

33. Kaigun Shō (Ministry of Navy), ed., *Kaigun Seido Enkaku (The Institutional Origins of the Navy)* vol. 3, no. 1, repr ed. (Tokyo: Hara Shobō, 1971), pp. 292–293.

low the directions of anyone else.”³⁴ Evidently, some of the Japanese craftsmen found this requirement sufficiently frustrating or humiliating that they left the dockyard. The conflict over work procedures was closely related to the question of finances. At that time, the dockyard employed more than thirty French technical experts. The Japanese bureaucrats in the bureau considered such a number excessive and believed that five or six foreign engineers would be sufficient. The Ministry of Navy found the bureau’s complaints persuasive and thereafter tried to fire French craftsmen and engineers whenever possible. Finally, by 1876, it had discharged the entire French staff, including Verny.

3. *The French School*

Both sides recognized from the outset that at some point the Japanese would assume full control over the dockyard. Verny’s proposed plan envisioned that when a trained Japanese staff was in place, it would replace the French experts. To this end, Verny proposed that a school be established in the dockyard where future engineers and technicians would be educated. For the training of engineers, Verny’s plan went on to state that young students be selected from the samurai class and taught French and engineering with the aid of the head interpreter. As for the education of technicians, the students—on whose class origins the plan was silent—were to work at the dockyard factories in the morning and study drafting and other relevant subjects in the afternoon. Finally, the plan declared that the rules of the school were to be modeled after those of French naval school.³⁵

In a letter to Roches, Verny laid out the details of the engineering curriculum. As educational historian Fumiya Iida has pointed out, the subjects to be taught and the number of sessions reflect the curriculum of the *École Polytechnique*, where Verny had been educated about ten years earlier, although the content and the level of the cur-

34. *Senshōshi*, op.cit., vol. 1, p. 13.

35. *Ibid.*, pp. 13–14.

riculum at the two schools may have differed greatly.³⁶ According to Verny's plan, engineering students (who were to be between the ages of 17 and 21) were to study mathematics, sciences, drawing, and French literature in the first two years, and then, in the third year, engineering subjects on materials, machinery, ships, and architecture. Verny expected that graduates of the Yokosuka school would be sent to France for further education at the school for naval engineers at Cherbourg. In this sense, the engineering school at Yokosuka differed from the later Imperial College of Engineering planned and launched by British engineers. While the former aimed at providing basic scientific knowledge, the Imperial College intended to provide both scientific knowledge and technical on-site training.³⁷

In practice, the selection of engineering and technical students at Yokosuka closely followed Verny's plan. Many of the engineering students were transferred from the Language School in Yokohama and from Kaiseijo, the national college which later became a part of the University of Tokyo, and all technical students were selected from children of local residents.³⁸ However, no graduates of the engineering course in this early period became naval engineers; most became French interpreters or took managerial positions at the Yokosuka

36. Verny's plan for the engineering course at Yokosuka is analyzed in Fumiya Iida, "Bakumatsu-ishi-ki ni okeru Futsugo-kei Gunji Kōgaku Jinzai no Keifu (A Genealogical Study of the Japanese Naval Architects Trained in the French Language in the Second Half of the Nineteenth Century)," *Nihon no Kyōiku Shigaku (Studies in the History of Education in Japan)*, 37 (1994): 4–19; idem, "Nihon ni okeru Ekōru-Poritekuniku shisō no juyō to henyō: F.L. Verny no gijūtsu kyōiku kōsō no igi (The Acceptance and Modification of the Idea of Ecole Polytechnique in Japan: The Significance of F.-L. Verny's Plan of Engineering Education)," *Nichifutsu Kyōiku Gakkai Nenpō (Annales de la Société franco-japonaise des Sciences de l'Éducation)*, 23 (1994): 4–19; and idem, "Meiji-ki Taishō-ki ni okeru Yokosuka Kaigun Kōshō no 'Gite' Kyōiku Karikyuramu no Hensen ni Kansuru Kenkyū (A Historical Study of the Curriculum for the Engineering Assistant in the Yokosuka Naval Arsenal in the Meiji and Taishō Eras)," *Bulletin of Fukuoka University of Education Part 4, Education and Psychology*, no. 44 (1995): 1–8.

37. On the Imperial College of Engineering, see Nobuhiro Miyoshi, *Nihon Kōgyō Kyōiku Seiristushi no Kenkyū (Research on the History of the Establishment of Engineering Education in Japan)* (Tokyo: Hara Shobō, 1979); and idem, *Meiji no Enjinia Kyōiku (Engineering Education in the Meiji Era)* (Tokyo: Chūō Kōronsha, 1983).

38. The official history tells us that there were only nine applicants for the first class.

Dockyard.³⁹

Soon after the Meiji Restoration, the new rulers closed down the Yokosuka Dockyard School as a cost-cutting measure. But the influential political figures Hirobumi Ito and Shigenobu Okuma decried this step and insisted on the need for an engineering school. In 1870 the government relented and reopened the school, intending to teach basic scientific and engineering subjects in order to turn out naval engineers rather than technicians. New students were to be between 13 and 20 years of age, but exceptional applicants outside that range were also to be admitted.⁴⁰ They were first to study French and basic mathematics and then to go on to study various advanced subjects in mathematics, sciences, and naval engineering. Before 1873, instructors were drawn from the dockyard engineers, who added teaching to their other duties. In that year, however, it was decided to employ a new, full-time instructor, the mechanical engineer Paul Sarda, a graduate of the *École Centrale de Arts et Manufactures* in Paris. At Yokosuka, Sarda taught mathematics, physics and chemistry.

We know what Sarda taught at Yokosuka from the lecture notes taken by one of his students, Hajime Tatsumi.⁴¹ Tatsumi's notebooks, preserved at the University of Tokyo, cover the years from 1875 to 1877 and number several thousand pages—an unusual, but valuable historical resource.⁴² In 1870, Tatsumi (who was then only 13 years old) and four others were admitted to *Kōsha*, the Yokosuka Dockyard School. (According to Tatsumi's recollection, two of his classmates

39. See Iida, "A Genealogical Study," op.cit., pp. 5–6, and the biographical sketches of Hiroyoshi Tanaka, Saikichi Nakajima, Nobutsura Yamadaka, and Tadanosuke Kawashima in Tomita and Nishibori, *Yokosuka Seitetsusho*, op.cit.

40. *Senshōshi*, op.cit., vol. 1, p. 155.

41. The collection of Hajime Tatsumi, consisting of a large number of lecture notes as well as technical treatises and design plans and specifications, was kept by his descendant and is now preserved at the Center for Modern Japanese Legal and Political Documents, the Graduate Schools for Law and Politics, the University of Tokyo.

42. Judging from the neat handwriting and from a comparison with other lecture notes taken in this period, these are not directly transcribed notes but fair copies later written by Tatsumi. On lecture notes in this period and the pedagogical policy of note taking at the *Ecole Centrale de Arts et Manufactures*, see Takehiko Hashimoto, "Gijutsusha to Kōgi Nōto (Engineers and Lecture Notes)," *Daigakushi Kenkyū (Historical Studies on Higher Education)*, 13 (1998): 30–44.

were quickly dismissed because they were over the age limit and replaced by students from the University of Tokyo.)⁴³ The new students first tackled French, and then turned to mathematical, scientific, and engineering subjects taught by Sarda through lectures on basic mathematics: geometry, descriptive geometry, algebra, analysis, calculus, and analytical geometry. It seems that under Sarda's tutelage, the teenaged Tatsumi mastered mathematical tools so that he was subsequently able to handle engineering problems in the design and construction of ships. When Tatsumi and his classmates completed their course of study at the Yokosuka school in 1877, they were sent to the *École du Génie Maritime* at Cherbourg to complete their education in naval engineering.

In 1876, the contract with Sarda ended and was not renewed. After Sarda departed, no appropriate teacher of middle-level subjects remained at the dockyard. Before his departure, the school had been divided into preparatory and regular courses. It was then decided that students at the preparatory level be sent to the University of Tokyo under the sponsorship of the navy and that only those in the regular courses be taught at Yokosuka. At that time, the physics department at the university's School of Science taught in English, French, and German, though the medium of instruction would soon be unified to English only. The plan was to send naval students to the "French physics class." The arrangement was accepted by the Ministry of Education, and five students enrolled at the University of Tokyo.⁴⁴ Sarda himself came to teach this physics class at the University of Tokyo for a short period.⁴⁵ The students who were educated both at Yokosuka and Tokyo form the third generation of engineering students from

43. Tatsumi was born in 1857, the only son of a samurai family of Kanazawa. In 1868, he entered the *Dōseikan*, the official school of his clan, where he learned arithmetic and foreign languages. Two years later, he was selected to attend the Yokosuka Dockyard School. See Tatsumi's autobiographical note in the Tatsumi Collection at the Center for Modern Japanese Legal and Political Documents.

44. *Senshōshi*, op.cit., vol. 2, pp. 77, 82–83, 85.

45. Tokyo Daigaku Hyakunenshi Henshū Iinkai (The Editorial Committee of the Centennial History of the University of Tokyo), ed., *Tokyo Daigaku Hyakunenshi (The Centennial History of the University of Tokyo)*, *Bukyokushi (The History of Divisions)*, vol. 2 (Tokyo: University of Tokyo Press, 1987), p. 337.

Yokosuka, and they too became important naval engineers.

In 1875, the dockyard naval engineering school, then still managed and instructed by an entirely French faculty, was officially, and aptly, named for the 1875 World's Fair exposition as the "French School."⁴⁶ But the next year, when Verny left Yokosuka, the school stopped teaching French to students in the technicians' course and began to use translated textbooks only.⁴⁷ In his concluding report Verny expressed his regret that the school was not as successful as he had expected, a disappointment he attributed to the frequent institutional changes.⁴⁸

In 1878, the Yokosuka Dockyard School announced that it was abandoning its French roots in favor of the British system. The school's official history declares:

This dockyard adopted the French system because it was originally founded with the assistance of French engineers. But our navy has generally relied on the British system, and this dockyard also should adopt that system. However, a total and immediate switch of systems would be difficult, and thus this goal should be realized gradually. As a first step, the teaching of the English language is to be started. It was therefore requested of the Ministry of Navy on the eighteenth day of this month that one English teacher be employed, and this request has been accepted.⁴⁹

These words concluded the early history of the French connection at the Yokosuka Dockyard. From then on, the dockyard hired an increasing number of British engineers. One of these, Francis Elgar, was employed to advise the Ministry of Navy on a number of engineering subjects. Noting the problems inherent in using the French (i.e., metric) system of measurement at the Yokosuka Dockyard while other Japanese naval facilities used the British system of measurement, he recommended the adoption of a single, unified system. The dock-

46. *Senshōshi*, op.cit., vol. 2, p. 20.

47. *Ibid.*, p. 98.

48. *Ibid.*, p. 49.

49. *Ibid.*, pp. 111–12.

yard decided to continue its use of the metric system because of its convenience in calculation. The adoption of the international metric system, it seems, remained the only visible evidence of the French tradition. In 1882, the school stopped accepting new students and only the course—using translated textbooks—for technicians continued. This institution was reorganized in 1889 as the Naval School of Shipbuilding, and produced an important group of engineers.

Conclusion

In the late nineteenth century, foreigners flocked to Japan, bringing with them Western knowledge and techniques demanded by a modernizing state. Most foreign experts recruited and invited by the Tokugawa and the Meiji governments were Dutch and British, but the French also played a key role because of the close connection between the French and the Tokugawa government forged toward the end of the old regime. The Yokosuka Dockyard was one of the fruits of this close relationship.

The job of François-Léonce Verny, who was chosen to direct the construction of this project, was to establish a large factory and dockyard complex, an institutional network for supplying material resources for the dockyard, and a school to train technical workers and naval engineers. Verny recognized that building such a complex in a country only recently opened to the outside world necessitated introducing a total technological system. With this in mind, he insisted that all Japanese workers, whether skilled or unskilled, follow the orders and procedures of the French staff. As one might have expected, this led to conflict with Japanese skilled workers. As a Polytechnicien, Verny was thorough and methodical in implementing his notion of a Western technological system, but perhaps lacked the pragmatic flexibility of the British, whose railroad engineers, for example, evaluated the level and condition of Japanese civil engineering and relied to some extent on Japanese craftsmen, following Japanese procedures.

Although the majority of the officers of the Imperial Japanese Navy were trained and educated after the British style, those who had stud-

ied at the Yokosuka school formed an important group of naval engineers. After finishing the polytechnical education at Yokosuka, some of the graduates were sent to the naval engineering school at Cherbourg;⁵⁰ after their return, this select group played an important role in the development of the Imperial Navy.

The above mentioned Tatsumi, for instance, briefly taught at Yokosuka after his return from France in 1881, and then worked as a naval architect and engineer at Kure, Yokosuka, and Sasebo until his retirement in 1903. During his career, he was sent again to France to supervise the construction of battleships for the Japanese navy designed by his teacher and the French leading naval engineer, Louis Emile Bertin.⁵¹ Ten years after the Yokosuka Dockyard had laid off the last of its French staff, the Japanese navy invited Bertin to Japan, where he proceeded to design a number of important ships for the Japanese navy.⁵² Of the three battleships he designed, Bertin himself supervised the construction of the third, at Toulon. The Yokosuka group of French-trained naval engineers served as indispensable assistants to Bertin, although during the Sino-Japanese war of 1894 the tactical effectiveness of Bertin's three battleships proved to be very limited.

Despite the dominance of the British in the formation of the modern Japanese navy, the influence of French engineers should not be underestimated. Through the construction and operation of the Yokosuka Dockyard, Verny and his staff instilled the skills and knowledge needed for an entire shipbuilding operation. In addition, the dockyard school produced those who would eventually replace the French engineers. Comparison of this French naval tradition with the British tradition as well evaluation of its historical significance in the

50. On one occasion, two students underwent an oral examination by a French engineer, who judged both to be capable, in a year, of following the course of the Ecole Centrale, and one capable of following the course of the Ecole d'Applications, an advanced school of engineering. See Balay, *Verny*, op.cit., p. 184.

51. See Bertin's curriculum vitae in the Tatsumi Collection; see also Tomita and Nishibori, op.cit., pp. 103–108.

52. For a biographical account of Bertin, see Christian Dedet, *Les fleurs d'acier du Mikado* (Paris: Flammarion, 1993), and a review of this book by Larrie Ferreiro, in *Naval Engineers Journal* (May 1998): 105–106.

formation of the modern Japanese navy are subjects that await further research.