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The JE project is co-ordinated by UNU Project Co-ordinator Dr. Takeshi Hayashi, with the support of the Institute of Developing Economies, Address: UNU Project on Technology Transfer, Transformation, and Development: The Japanese Experience, c/o Institute of Developing Economies, 42 Ichigaya-Honmuracho, Shinjuku-ku, Tokyo 162, Japan. Tel: (03) 353-7501. Cable: AJIKEN TOKYO.

The United Nations University: 29th Floor, Toho Seimei Building, 15-1, Shibuya 2-chome, Shibuya-ku, Tokyo 150, Japan. Tel.: (03) 499-2811; Telex: J25442; Cable: UNATUNIV TOKYO

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JAPAN'S DISCOVERY, IMPORT,
AND TECHNICAL MASTERY OF RAILWAYS

Harada Katsumasa

Lecturer
Wako University
Tokyo, Japan



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This paper is being circulated in a pre-publication form to elicit comments from readers and generate a dialogue on this subject even at this stage of the research.

I. THE RAILWAY AS AN IMPORTED TECHNOLOGY

Japan, upon opening her doors to the West in the latter part of the nineteenth century following two hundred-odd years of isolation, found the machine civilization of Western countries to be largely an alien culture. The railway, that revolutionary means of transport in the nineteenth century, was no exception. During the years of seclusion (ca. 1640-1853), the shogunate had imposed a rigorous framework of control on the domains and populace. This system of controls, instituted for political and military purposes, obstructed the development of any means of mass land transport. By the mid-nineteenth century, although a nationwide commercial network was already developing, mass land transportation was still in its infancy. Travellers and goods in transit were both strictly regulated, as evidenced by the prohibition of the use of vehicles on highways and the construction of bridges on major rivers, the establishment of barrier stations at key points, and the requirement that travellers carry travel permits. Under these circumstances, the development of a means of mass transport could hardly have taken place. And in view of the undeveloped state of communications in Japan at mid-century, the fright and astonishment elicited by the imposing sight of Commodore Perry's "Black Ships" in 1853-54 were readily transmitted into amazement over the model locomotive and telegraph brought by the American squadron.

Nevertheless, shogunate and domain officials, together with a handful of intellectuals, were not entirely surprised by these appurtenances of "civilization." A sizeable number of this elite had already learned much about Western culture through the medium

of the Dutch language. However limited, new knowledge had flowed into the country via Holland, the only European nation allowed to trade with Japan during the years of Japanese seclusion. The introduction of knowledge and information about Western technology through "Dutch studies" was not inconsequential.

As a result, once the nation's isolation came to an end, and Japanese could openly make contact with the new culture of the West, an active movement to assimilate that culture quickly developed. The process of assimilation will be treated later in this paper, but it should be noted here that this movement began with a recognition of the gap between Japan's technological level and that of the West. In other words, the members of the Japanese elite fully realized that the dominating influence of the Western powers, which had extended to Asia and Africa, was now beginning to reach Asia's eastern extremity—Japan.

Consequently, the intellectuals of the day, gripped by a sense of crisis over Japan's potential colonization, took a positive attitude towards the assimilation of advanced technology. Because their objective was to enable Japan to ward off foreign encroachment, they concentrated at first on the modernization of weapons and warships. Acquisition of advanced military technology thus became the immediate task.

Following closely behind the modernization of armaments on their list of priorities was the modernization of transportation means for strengthening the nation's economic power. Like the introduction of coal-mining and spinning machinery, improved transport was regarded as indispensable for modernizing the production and movement of goods. In 1867, shortly before its collapse, the shogunate had adopted the above outlook in its program of political reform. Subsequently, the shogunate's successor, the Meiji government, inherited this point of view upon taking power in 1868. "Rich country, strong military" (fukoku Kyohei), the slogan proclaimed by

the new regime, expressed succinctly the government's policy of regarding economic development and military build-up as two sides of the same coin.

Railways were introduced in line with this policy. From 1869, when the Meiji government decided to build railways, to 1872, when the first trains began to run, the government authorities responsible for introducing railways were confronted with a variety of new problems. Extraordinary effort was required before the Japanese could overcome these problems and begin to operate railways on their own.

Although the approach initially taken to building and operating railways was to borrow the capital, purchase the materials, and hire engineers and skilled labourers from Britain, this step was only a temporary measure, for the Japanese planned from the start to take over railway construction and operation themselves as soon as possible. Therefore, they could ill afford to take a detached view of railways as simply representing a form of imported technology. In the case of railways, as in other fields, acquisition and mastery of technology became the top priority.

In short, when railways were introduced into Japan, it had already been decided that they would eventually be operated by the Japanese themselves. Herein lies the uniqueness of Japan's experience in importing railways. Although Japan was not the first Asian country to import railways, it stands alone in having planned from the outset to develop and operate railways on its own and in having realized this plan, by and large, in a period of less than twenty years from the start of construction. In this sense, Japan's drive for technical independence was clearly remarkable.

This paper will examine the process leading up to Japan's mastery of railway technology, focusing on major issues and phases of development. In so doing, we must bear in mind the government's basic posture of trying to reduce the gap between Japan and the

West through the policy of "rich country, strong military," i.e., through strengthening economic and military power alike. The importance of political and strategic factors in the impetus behind Japanese railway development—and economic development in general—is underscored by the absence of demand generated by an ongoing industrial revolution, as there had been in Britain. From the fact that Japan's inauguration of railways preceded her industrial revolution stems the unique character of the construction and subsequent development of railways in Japan. The above issues apply not only to Japanese railway history, but also to the country's history as a whole.

II. THE INFLOW OF KNOWLEDGE ABOUT RAILWAYS

At present we lack conclusive evidence as to when Japanese first became aware of the existence of railways. Nevertheless, there are a few reliable materials which allow us to infer that it was in the 1840s.

First of all, there are the so-called Fūsetsu sho, which were reports on overseas developments submitted periodically to the shogunate by the captain of the Dutch Factory at Nagasaki. The captain would collect information from the home country and present this to the shogunate in Dutch. The shogunate would then translate the captain's report, giving it the title of Fūsetsu sho. These Dutch reports were the sole means by which the shogunate officially obtained information about conditions abroad.

It has been claimed that an article on railways appeared in a Dutch report as early as the 1830s, but this has not been confirmed. The oldest railway-related article that we have been able to verify so far appeared in a report in 1846. This article noted that France was making plans to build a railway across the isthmus of Panama. Subsequently, the report of 1851 included news of American plans to build a railway across the same isthmus.

From this time on, railway articles appeared repeatedly in the Fūsetsu sho, their subjects ranging from the outbreak of a dispute between Egypt and Turkey in 1852 over construction of a railway across the Suez to the completion of a railway in southern Australia in 1857.

These reports raised considerable interest in railways among the Japanese who read them. This is evidenced by the fact that, when the Perry squadron returned to Japan in 1854, shogunate officials are reported to have asked the Americans about the construction of railway tunnels, the difference between steamship and locomotive boilers, the state of railway construction in the Suez, and the like.¹ One after another, these questions took the Americans by surprise. The Japanese, of course, had obtained much information from the Dutch reports. In addition to the latter, however, the shogunate officials relied on information supplied by Japanese castaways who, having been rescued by America-bound ships, had crossed over to the United States and, following their repatriation, had reported on the American scene.

One of these castaways was Nakahama Manjiro, who was known in the United States as John Manjiro. A fisherman from Tosa (present-day Kochi Prefecture), Manjiro was shipwrecked while out fishing in 1841. He was rescued and taken to the United States by an American ship, finally returning to Japan in 1851. During the years of seclusion, when overseas travel was regarded as a capital offense, the Japanese authorities would subject returned castaways to close questioning. After repeated interrogations, the shogunate pardoned Manjiro, in view of the special circumstances affecting his case, and subsequently employed him as a translator. In the report which Manjiro submitted to the shogunate on his experiences abroad, Hyoryu shimatsusho (Narratives of a Castaway), he gave the following description of railways, based on a train ride he took on the East Coast in 1845:

Usually when people take long trips, they go by a fire-burning vehicle known as reirote [railroad]. This device is shaped like a ship; water is boiled in a cauldron [i.e., boiler], and with the force of the hot water [i.e., steam] the device can run about 300 ri [1,200 km] in a day. When you look outside the house-shaped object [i.e., passenger car], it's as though you were a bird in flight, and there's no time to get a good look at things. They have iron [rails] laid along the vehicle's path.

It probably would have been impossible for Manjirō's listeners to believe that any vehicle could attain a speed of 300 ri per day. For this reason, perhaps, he tried to describe the train's speed by comparing it to a "bird in flight."

A similar description was given by another castaway, Hamada Hikozi, known in the United States as Joseph Hiko. Hikozi noted in the record he made of his experiences abroad that "feeling like flying bird, you cannot look carefully at things outside, but the vehicle doesn't shake much, and you can do at least a little bit of writing."

Added to these first-hand accounts was information derived from Dutch studies. At the time, the only Western books which the shogunate allowed into Japan were Dutch works. One of these works was P. van der Burg's Erste Grondbeginselen der Naturkunde, published in 1844. This book provides descriptions of the principles, construction, and operation of the various machines developed in the Industrial Revolution, including photographic equipment, telegraphs, steam engines, steamships, and locomotives. In the section on locomotives, there is an illustration giving a cross-sectional view of a locomotive, and from this one can easily grasp the construction of the boiler and cylinders. The description of locomotives appearing in this work was probably the first to enter Japan.

Apparently, other Dutch works which included descriptions of railways were available in Japan at this time; this particular book, however, became well known because it was translated into Japanese. Kawamoto Kōmin, a Dutch scholar in the southern domain of Satsuma (present-day Kagoshima Prefecture), dictated this book in Japanese to his pupil Tanaka Tsunanori, with the latter making a record of Kōmin's oral translation. The resulting book, entitled Enzei kiki jutsu (A Description of Unusual Machines Made in the Far West), was published in 1854. This translation enabled Japanese who were not versed in the Dutch language to obtain information on Western mechanical inventions in a variety of fields.

That the Japanese wanted to acquire a certain fund of knowledge, and also to disseminate that knowledge by translating its source indicates that they recognized the usefulness of that knowledge and actively sought to apply it. The positive attitude which the Japanese displayed towards acquisition and dissemination of knowledge at the time also found expression in the manufacture of models.

Japanese had the opportunity to see two foreign-made model locomotives before building their own. One was the model brought by a Russian squadron, the other by Perry's. On 22 August 1853 a Russian rear-admiral, E. V. Putyatin, arrived in Nagasaki on board the flagship Pallada with a squadron of four ships. The squadron was on a mission to demand that the shogunate bring an end to seclusion. Several officials were dispatched by the shogunate to engage in negotiations with the Russians. The Japanese ultimately rejected the Russian demands, and the Russian squadron left Nagasaki on 8 January 1854. During their stay, the Russians had invited the shogun's emissaries to inspect the interior of one of their warships. In one room inside the warship, the Japanese were shown a model train which ran on a track laid on top of a table. One of the Japanese officials, Kawaji Toshiakira, who was progressive in his thinking, recorded this experience in his diary and also included a description of the train in his report to the shogunate.

The shogunate officials, however, were not the only Japanese to observe this model. Two samurai from the Saga domain (present-day Saga Prefecture), Motojima Tōdayū and Nakamura Kisuke, actually saw it before they did. Nakamura was an engineer at the Seirenjo (technical laboratory) which had been set up in Saga at the time. This workshop was being sponsored by the Saga domain for the trial production of new machinery aimed at enabling the domain to develop military technology on its own.

Aboard the Russian ship, Nakamura and Motojima watched with mouths agape as the model train, using alcohol as fuel, ran on the circular

track on top of the table. And, as soon as he and Motojima returned to Saga, Nakamura made plans to build a similar model.

In the summer of 1855 he enlisted two other engineers at the Seirenjo, Tanaka Hisashige and Ishiguro Kanji, and set about producing a model steamship and locomotive. As a reference in building these models, Nakamura and his assistants had only one small steamship. They learned how to construct a steam engine by taking this ship apart, but other than that they had to work without any blueprint.

Furthermore, considering that they lacked machine tools, it must have taken tremendous effort to manufacture each part. Tanaka Hisashige was a mechanical expert who had produced a series of ingenious gadgets and machines. The Seirenjo undoubtedly made the most of Tanaka's expertise. With a handicraft technology—the skilled craftsmanship of early modern Japan—Nakamura and his co-workers overcame great difficulties.

Although the date of completion, and therefore the amount of time the work required, is unclear, Nakamura and his assistants completed two model steamships and one model locomotive. The latter was successfully put through a trial run on the grounds of the Seirenjo. Observing this test run in the company of domain officials was the lord of the Saga domain, Nabeshima Naomasa, who had supported the trio in their work.

In those days, various domains, including Saga and the leading southwestern domains of Satsuma and Chōshū (present-day Yamaguchi Prefecture), were competing with the shogunate in building up their armaments and, especially, in strengthening and modernizing their military forces. The enthusiasm for model building illustrated above was one expression of these objectives. Besides Saga, model locomotives were apparently also produced in the Satsuma and Fukuoka domains; Chōshū, meanwhile, purchased a model, and there is evidence

that the Kaga domain (present-day Ishikawa Prefecture) bought one as well.

Thus, the zeal for the manufacture of models, although it did not at this stage lead immediately to railway construction, did reveal an enthusiasm for the import of new technology. This point applies equally well to the second case in which Japanese set eyes on a foreign-made model of a steam locomotive. The occasion for this was the second arrival of the Perry squadron in February 1854. Among the presents from the U.S. president which Perry brought to the shogun at this time was a model train, including a locomotive, tender, and carriage.

Tracks were laid in back of the treaty house in Yokohama, and the model train was run by the Americans. A number of Japanese, including the officials at the treaty house, witnessed this spectacle. Among them was one spectator-turned-participant who dared ride on the roof of the carriage as the train sped around the circular track. In the official record of Perry's trip, this character is described as "grinning with intense interest" and "shaking convulsively with a kind of laughing timidity."² This individual was certainly doing a thorough job of inspecting the performance and construction of the locomotive and carriage.

Another enthusiast was the magistrate of the shogunate-administered region of Izu Nirayama, Egawa Hidetatsu. Not having been assigned to the treaty house, Egawa contrived some excuse so that he could come to Yokohama to observe the running of the model train. This official, who some time before had built a reverberatory furnace with which he had cast cannon, held a great interest in Western mechanical inventions.

III. FIRST-HAND EXPERIENCES WITH RAILWAYS AND EARLY PROPOSALS FOR CONSTRUCTION

The positive attitude towards acquisition of railway technology, expressed first in the introduction and diffusion of knowledge about railways and second in the making of models, stemmed from the demand not for railway construction itself but rather for the modernization of armaments. Needless to say, this motive represented one of the problems with Japan's experience of modernization as a whole.

Nonetheless, it is also true that this positive attitude, bolstered by the addition of yet another channel of information, gradually encouraged and facilitated the desire actually to attempt to build railways.

The "other channel" in this case was the experience of riding on trains, of actually utilizing railways. As noted earlier, the first Japanese to experience train rides were castaways who crossed over to the United States, such as Nakahama Manjirō and Hamada Hikozi. Of far greater significance for the introduction of railways, however, was the first-hand experience of this mode of transport by men in a position to exert a direct influence on policy, namely, members of the ruling samurai class in the shogunate and domains. Those samurai who had the opportunity to take train rides while overseas had until then only been able to grasp railways as a general concept through such descriptions as "like a bird in flight." The experience of riding on trains, however, enabled them to "rediscover" railways on the basis of a concrete understanding acquired directly through

the senses—by observing the appearance of a passenger car's interior, by feeling the movement and hearing the sounds of a train, by viewing the ever-changing landscape outside a window while being transported from one point to another.

The first samurai to experience railways first-hand were members of the mission sent to the United States in 1860 to exchange instruments of ratification of the Japan-U.S. Treaty of Friendship and Commerce. The first time they rode on a train was on 26 April 1860, on the 76-km line between Panama and Colon (at that time known as Aspinwall). The Japanese had heard of this line when it was still in the planning stages as a result of the Dutch reports concerning French and American plans to build the railway. Eventually the United States, which had taken a great interest in the peninsula, had built the railway with private capital, and the line had been opened to traffic on 28 January 1855. The members of the Japanese mission, led by senior envoy Shinmi Masaoki, boarded a six-car passenger train on this line, with the Americans no doubt running a special train for them.

Several of the Japanese wrote about this train ride. Vice-envoy Muragaki Norimasa, perhaps because he was assigned to report to the shogunate on the mission following its return to Japan, made a careful record of his observations, which covered, among other items, the construction of the locomotive and passenger cars, the connection between the wheels and the track, and the structure of the flange. Furthermore, Muragaki expressed surprise at the fact that a number of people could ride together in one passenger car, stating that "it's as though a flock of birds was perched on one branch in such a way that the birds are jostling one another."

Undoubtedly, this experience was startling, since at the time Japanese had hardly any occasion to ride together on transportation means and, in the case of land transport, none at all. Moreover, it would probably have been unthinkable for high-ranking samurai to sit

side by side with men of lower rank. Experiencing the latter must have had a strong impact on the status consciousness of the upper samurai.

Thus, the experience of riding on trains required an unimaginable change in consciousness. The mission members did have some idea of what a moving train would be like: "We had heard beforehand that it makes you feel dizzy...." Before leaving Japan they probably had the opportunity to read Manjiro's report or to interview him or foreigners in Japan. Therefore, they must surely have had some preliminary knowledge. Nevertheless, they still would not have been able to comprehend what riding together was like without actually experiencing it. It is in this area that the significance of the train ride is ultimately to be found.

In contrast to most of the senior officials, their attendants made fairly detailed observations concerning the construction of railways. Outstanding among the records kept by junior members of the mission was the report of Tamamushi Yasushige, attendant to Shinmi Masaoki. In the record he made of his observations, Tamamushi first analyzes the construction of the steam locomotive, including descriptions of the boiler, cylinder, piston, and drive wheel, and his coverage even extends to the structure of the steam whistle and its role as a signalling device. Tamamushi follows this by examining the tender and the passenger car.

Concerning the latter, he describes the bogie and coupler, pointing out that it is these features which make possible passage along curves. Tamamushi's treatment of the railway line covers gradient, curves, and the structure of rails and cross ties, as well as related facilities such as distance markers and water stations. Furthermore, he describes the block section and block system, including telegraphic signalling, and explains the construction of telegraph lines and insulators.

For some of his explanations Tamamushi probably relied on information obtained from Americans or other informants; nonetheless, it appears that he inspected the Panamanian railway quite carefully, setting down his observations in systematic fashion.

In closing, he states:

When the train starts running, it moves so rapidly that, looking outside, you cannot distinguish trees standing next to each other. The train is very noisy such that, even if you talk with a person facing you, you cannot hear one another very well. The train doesn't shake that much, so you can sit comfortably and even write characters. When every now and then you open the glass window, a cool breeze comes in and makes you forget the heat. At any rate, I can only say that I was absolutely filled with amazement at how well this device was made.

Tamamushi's account reveals quite clearly the positive attitude of seeking comprehensive knowledge of the working of railways.

Subsequently, members of a diplomatic mission dispatched to Europe in 1862 also rode on trains. Other Japanese to have this experience were overseas students, including a group sent by the shogunate to Holland in 1862. The train-riding experience was just as eye-opening for them as it had been for members of the mission to the United States. Among students sent abroad by the domains was Inoue Masaru, who later became chief of the government railway bureau during the early years of railway construction. With a group of fellow students from the Chōshū domain, Inoue obtained secret passage to London in 1863, the domains being forbidden to send students abroad at this time. Arriving in England, he studied mining and civil engineering at London University. Inoue's field of study, compared to the military-related subjects on which most overseas students concentrated, can only be described as unique. The motive behind this is not entirely clear, but part of the reason no doubt was the concern shown by Chōshū at the time for the development of mines and the improvement of bridges, as well as the acquisition of military technology. The "rich country, strong military" policy of the Meiji

government, which, under the leadership of Chōshū and other southwestern domains, displaced the shogunate in 1868, perhaps originated in this fusion of concerns.

From the mid-1860s, fairly concrete proposals for railway construction began to appear within the country. The first of these was a plan advanced in 1865 by Godai Tomoatsu, a samurai from the Satsuma domain, to build a railway between Kyoto and Osaka. This was followed in 1866 and 1867 by several proposals from foreigners who applied to the shogunate for railway concessions. Godai's plan called for the import of French capital, and the foreigners' applications were likewise premised on the introduction of foreign money. In proposing the import of capital from abroad, the foreigners were, of course, seeking to make profits. Beyond this, however, the acquisition of railway concessions by one country in another has historically marked the first step in tightening economic control by the recipient of the concession over the country in which investment is made; it is unclear to what extent shogunate authorities recognized this danger. In any case, they responded to these proposals by rejecting them or by delaying a decision, and in the end all but one of the applications failed to gain approval.

The one exception was an application made in 1867 by the secretary of the U.S. legation, A.L.C. Portman; it was accepted by the shogunate grand councillor (rōjū) and commissioner of foreign affairs, Ogasawara Nagamichi, in a reply dated 17 January 1868.

From the outset, the foreigners' applications were restricted to lines connecting open ports with market centres such as the section between Yokohama and Edo (present-day Tokyo) and between Kobe and Osaka. The Portman application was likewise for construction of a Yokohama-Edo line. Earlier, in 1866, the shogunate had privately disclosed to Portman a scheme for the construction of railways linking Edo with the northern Kanto and southern Tohoku

regions and Edo with Kyoto. It appears from this that there were definite plans for railway construction within the shogunate at this time; however, the shogunate was facing serious internal political disorder, and its very survival was at stake. Consequently, the regime could hardly have expected to carry out railway construction by itself. Perhaps it is for this reason that the shogunate offered the concession to Portman, a man with whom it had previously been in contact. Questions nevertheless remain. The terms of the license granted Portman called for construction of a single short line, failed to specify the method of revenue distribution, and would have enabled the Americans to appropriate all rights to the concession. Why the shogunate would have accepted such an arrangement is a mystery.

At any rate, the license gave clear indication of the danger which railway concessions posed to Japanese sovereignty. Happily for Japan, however, this license became a dead letter with the collapse of the shogunate in 1868. About half a month before Ogasawara approved Portman's application, a new government, the nascent Meiji regime, had been established in Kyoto, and in the ensuing civil war between the Kyoto-based government and the Edo shogunate, Ogasawara fled to the northern island of Hokkaido with the last holdouts from the old regime. The Americans would later demand a reconfirmation of the Portman concession from the shogunate's successor; however, the new Meiji government, which after occupying Edo had renamed it Tokyo and made it the national capital, refused to recognize the license issued to Portman.

Thus, Japan avoided the establishment of foreign railway concessions, and the nation subsequently entered a phase of railway construction under the leadership of the Meiji government.

IV. THE BEGINNINGS OF RAILWAY CONSTRUCTION

Japanese railways were launched as state enterprises, the first lines being built and operated by the Meiji government. Japan's early experience in railway development is distinctive in two regards: first, unlike Britain, which built the world's first railway lines, Japan did not rely initially on private construction and operation of railways; and second, unlike the colonial regimes of Asia and Africa, Japan depended hardly at all on the import of foreign capital.

Thus, the Meiji state sought to build the first railways itself by marshalling domestic resources. Given the level of industrial development in Japan at the time of the Meiji Restoration, however, it would have been impossible for the newly established government to have embarked on railway construction without outside help. Japanese industry had only developed by then to the point at which the putting-out system and small-scale rural manufacturing were finally beginning to push against the bounds of the feudal control system, contributing to the economic factors behind the collapse of the Tokugawa shogunate. Accordingly, the onset of an industrial revolution which would thrust up machine-powered industry as the centre of productivity was still well in the future.

Under these circumstances, there was no demand as yet on the part of the bourgeoisie for such a new means of transport as railways. Consequently, in the impetus behind the Meiji government's construction of railways, the political aim of furthering centralization of administrative power naturally carried greater weight than

economic motivation.

Thus, a distinctive feature of Japanese railway history is that Japan made a bold start on railway construction while still lacking the economic infrastructure needed for independent development of railways. This characteristic would appear in sharp relief during the course of subsequent development. At any rate, under these conditions, self-sustained railway construction could never have gone beyond the planning stage. In the case of rails, for example, there was no iron- or steel-manufacturing sector for domestic production and supply of rails. As for locomotives, the establishment of manufacturing plants for rolling stock requires the development of a machine industry under the impetus of an industrial revolution, a prerequisite missing in Japan. At least in the case of rails and rolling stock, the technological and industrial base for railway construction was totally lacking.

Hence, Japan was compelled to rely entirely on imports to provide these materials essential to railway construction. In building as well as in operating railways, the government had to import, in some form or other, both materials and engineers from the advanced industrial nations of the West. In short, it was necessary at the outset to introduce railways as a "ready-made" product.

The formal decision to embark on railway construction was taken by the Meiji government on 12 December 1869. Playing a key role in the events leading up to that decision was Sir Harry S. Parkes, who as British Minister to Japan held great influence in the Meiji government. Parkes appears to have strongly urged Meiji leaders to carry out railway construction under the policy of native control. The question this raises is why Britain, which until then had been devoting itself to the acquisition of colonies, did not seek to build and operate Japan's railways. Inasmuch as Britain carried the greatest weight among the foreign powers in Meiji government circles, the stand taken by Britain in this matter proved to be the decisive

factor preventing the "colonization" of Japanese railways. The British attitude thus played a vital part in determining the course of railway development in Japan.

Britain's aim apparently centred on making Japan not into a colony but into a trading partner. British foreign policy had gone through a major transformation around the middle of the nineteenth century. Britain had moved away from the Asian policy it had pursued until at least the Opium War of the early 1840s, and the resulting "Little Englandism" came to be reflected in her policy towards Japan during the 1860s and 1870s. In sum, one can ill afford to ignore the international setting in dealing with railway construction in Meiji Japan.

In 1869 the British were actively encouraging Meiji leaders to undertake railway construction for themselves. In March of that year, R.H. Brunton, a British engineer who had arrived in Japan in the previous year to supervise the building of lighthouses, submitted a recommendation to the Ministry of Foreign Affairs, urging government construction of railways. In addition, Minister Parkes met frequently with leaders of the Foreign Ministry, impressing on them the possibility and necessity of railway construction. His contacts in these discussions included Ōkuma Shigenobu, a bureau chief in the Foreign Ministry. Ōkuma was a native of Saga, a leading southwestern domain, whose ruler, Nabeshima Naomasa, we encountered earlier in connection with the technical laboratory established for the purpose of introducing modern armaments. Ōkuma originated from the lower samurai class of the Saga domain, but he was appointed to important positions in the Meiji government and was active in promoting progressive policies. Parkes may well have deliberately singled out Ōkuma as a progressive and sought to persuade government leaders through him.

Besides Ōkuma, it appears that Inoue Masaru, who as mentioned earlier was secretly sent to England by his native Chōshū domain

to study engineering, was also involved in the discussions with Parkes. After graduating from London University, Inoue had returned to Japan in 1868 and had entered the new government as head of the mint and assistant commissioner of mines. It is quite conceivable that the English-speaking Inoue attended the discussions. According to Inoue, Parkes persuaded Ōkuma and his colleagues in the following way:

It happened in this year [1869] that the Government had to import foreign rice in order to relieve a famine in the northeast and Kyūshū. They were not able to meet this emergency by introducing rice from the districts of Hokurikudō and other places where the cereal was abundant, for the lack of means of land transport stood in the way. Taking this fact as an illustration, Sir Harry Parkes urged the Government to construct railroads, which would make desolation by famine impossible in future.³

In this manner, Parkes mainly sought to persuade younger bureaucrats, and, once he had succeeded in doing this, he then met privately with officials of ministerial rank to make doubly sure that a formal decision would be made. At this informal meeting held on 6 December 1869 the Meiji leaders reached a final consensus on railway construction.

At this time, it was decided to build a trunk line from Tokyo to Kyoto and several branch lines, including sections between Tokyo and Yokohama (provided an interior, as opposed to a coastal, route was chosen for the trunk line), Maibara and Tsuruga, and Kyoto and Kobe. Britain was to furnish the necessary capital for building these railways as well as to assist the Japanese in importing materials and securing the services of engineers and labourers.

As soon as these matters were decided, the British and the Meiji government began negotiations on how to implement them. To say "the Meiji government," however, is to oversimplify: the central figures involved in the negotiations were Ōkuma Shigenobu, who by this time had been promoted to the office of Assistant Minister of Civil Affairs and Finance, and Second Assistant Minister of Civil

Affairs and Finance Itō Hirobumi; in fact, many members of the ruling group were not even informed about these negotiations. The reason they were kept uninformed is that opposition to railway construction was quite strong within the government, and Ōkuma and Itō were fully aware of the danger that, if these negotiations were made public from the start, opponents might resort to assassination.

A major reason for opposition was out-and-out anti-foreignism. ("To bring vile foreign technology into the land of the gods is out of the question.") In addition, there was the argument advanced by Saigō Takamori for giving priority to armaments expansion. In order to consolidate its foundation, Saigō maintained, the government should concentrate first on strengthening its military might and avoid huge investments in secondary undertakings such as railway construction.

Railway construction had thus become a subject of heated debate. Consequently, Ōkuma and Itō decided not to reveal from the outset to the entire government the details of their negotiations and agreements with the British. Yet this decision was also to result in their being placed in a predicament when the arrangements ran into difficulties.

An Englishman named Horatio Nelson Lay was commissioned by Ōkuma and Itō to secure funds in Britain. When Lay proceeded to raise the money by floating Japanese government bonds on the London stock exchange, an announcement of the loan subscription appeared in the London Times, and the scheme for importing foreign capital became public knowledge in Japan. Furthermore, it became clear that Lay was after a considerable profit, for, although he had promised to advance funds to the Japanese government at 12 per cent interest, he had set the interest rate on the national bonds at 9 per cent. When these facts became known in Japan, Ōkuma and Itō came under heavy criticism, and the resulting crisis brought the entire plan for introducing British capital to the verge of collapse.

Ōkuma and Itō managed to tide over this crisis by cancelling Lay's commission and appointing the Oriental Bank Corporation of London to replace him as the agent of the Japanese government.

Ōkuma later recalled: "In those days, we did not fully understand the meaning of the word 'loan.'" There is also evidence that the Japanese believed Lay was going to raise the money privately among his friends from the fact that he bore the same name as the famous British admiral Horatio Nelson. Given the level of sophistication with which they entered negotiations, the Japanese certainly went ahead boldly.

Their efforts seem all the more audacious in view of the paucity of technical knowledge they possessed concerning railways. Ōkuma apparently had witnessed the running of the model locomotive at the technical laboratory in Saga, but just how extensive his knowledge of railways was is not clear. Itō had gone to England as a member of the group of students that had included Inoue Masaru. But, according to Ōkuma, he was a complete novice who knew nothing about railways. In consequence, during the initial phase of railway construction, there was no alternative but to entrust everything to the British.

Orders were given on 17 April 1870 to start with construction of the Tokyo-Yokohama section, and work was begun with the arrival of the British engineer-in-chief, Edmund Morell. The Japanese had to place everything from surveying the lines to procuring the necessary materials in British hands. This also applied to determination of the gauge to be used, for, when Morell asked Ōkuma and his colleagues what he should do about this, the Japanese, not knowing the meaning of the word "gauge," responded with blank faces and had to have the term explained to them. Such being the case, it appears that, even though the Japanese were compelled to purchase prohibitively priced imports of materials, such as cross ties, which they could have obtained domestically, they were unable to raise any objections at all.

In this regard, Morell was a conscientious engineer. He apparently advised Ōkuma that, in order to fit the climatic conditions of Japan, cross ties should be made out of wood, not iron, as were the imported articles. Moreover, he pointed out that Japan possessed abundant wood of good quality; the government, therefore, should stop importing cross ties and instead order wooden ones to be made domestically.

In any case, the list of imports was staggering, extending from rails and locomotives all the way to such writing materials as ink, pencils, and Western-style stationery. Ōkuma and his colleagues soon realized that a far greater outlay would be required for railway construction than they had originally anticipated.

Of the one-million-pound loan floated on the London money market, 300,000 pounds was allocated for building both the Tokyo-Yokohama line and the next section slated for construction, the Osaka-Kobe line. Yet, in the end, more than twice this amount had to be extended in constructing these lines.

Thus, the railway endeavour pulled government authorities willy-nilly into a totally unfamiliar world. Japan's first railway, the section between Shinbashi (in Tokyo) and Yokohama, was opened to traffic on 14 October 1872, but the path to completion had not been without its share of obstacles.

V. THE ROAD TO TECHNOLOGICAL INDEPENDENCE

A railway office was set up under the Ministry of Civil Affairs to administer the construction work, which began in March 1870. The hired British engineers, however, took charge of planning and supervising the work. Serving under the engineer-in-chief, Morell, were engineers John Diack, John England, and Charles Shepherd, among others. The vicissitudes of the government employment of foreigners for railway development are revealed in the following figures showing the total number of foreign railway employees for selected years between 1870 and 1888:⁴

<u>Year</u>	<u>Number of Foreign Railway Employees</u>
1870	19
1871	62
1872	83
1873	101
1874	115
1875	109
1876	104
1877	70
1879	43
1882	22
1885	15
1888	14

The following table gives a breakdown by nationality of the 104 foreigners employed in 1876:⁵

<u>Nationality</u>	<u>Number of Railway Employees</u>
British	94
American	2
German	2
Danish	2
French	1
Italian	1
Finnish	1
Portuguese	1

As the above figures demonstrate, the British numerical predominance was overwhelming.

Foreigners were employed in variety of fields, as is illustrated by the following list of positions:

- director, secretary, clerk
- engineer-in-chief, deputy engineer, engineer, assistant
- locomotive superintendent, fitter, foreman painter, painter
- traffic manager, engine driver, pointman
- store keeper
- draughtsman
- time keeper, inspector of railway police
- foreman quarryman and mason, mason
- boilermaker, foreman blacksmith, blacksmith
- foreman platelayer, platelayer

This list indicates that, in addition to engineers, the foreign employees included a large number of labourers. Even after the construction work was completed and operation of the lines was actually begun, the British were employed not only to manage the railways, but also to run the trains. In short, Japan had to introduce both materials and personnel from England.

Morell argued, however, that under these circumstances Japanese railways would never become self-supporting and urged that the government train Japanese engineers and labourers as quickly as possible. In the recommendation he submitted to the Meiji government, Morell declared:

Japan must make preparations for taking charge of the operation [of railways] without relying on the assistance of Europeans in the future. Towards this end, you should establish a training facility for engineers, select outstanding young men to receive an education there, have them become skilled in technology, and thereby foster the

engineers needed to undertake construction and management in all areas. I recommend that an engineering school be founded in either Tokyo or Osaka.⁶

Without having witnessed the completion of the Tokyo-Yokohama line, Morell died of tuberculosis in October 1871. However, his proposal for the establishment of a training facility was realized in August 1871 in the form of the Kōgaku-ryō (engineering school), which was set up under the Public Works Ministry, founded in November 1870. In addition, a technical training centre, the Kōgisei Yōsei-jo, was established in Osaka in May 1877. At the Kōgaku-ryō, the training of engineers in fields other than railways was initiated as well. The movement towards technological independence in Japan was thus launched side by side with the introduction of technology.

In September 1871 the section between Yokohama and Kawasaki was completed. Imported locomotives, initially ten of them, were assembled in Yokohama, and trial runs were begun on the completed section of line. The British, of course, supervised the work of assembling the locomotives as well as passenger and freight cars, but a number of Japanese labourers undoubtedly took part. Furthermore, on each of trains, a Japanese served as fireman, assisting the British engine driver. These labourers, by working on the assembly of locomotives or serving on train crews, gradually learned the technology of building rolling stock and operating trains. The same point can be made about railway construction. Japanese engineers followed the instructions of the British in all matters from the survey of lines and the planning of construction to the supervision and control of workers, but through on-the-job training they steadily mastered the technology of railway construction. In addition, a large number of Japanese served as construction workers engaged directly in the work of building the railways. They also gradually absorbed British methods of performing such forms of large-scale earthwork as quarrying rock and building embankments and such types of "finishing" work as building roadbeds and digging sewers.

In the area of civil engineering, however, Japan's traditional technology was fairly advanced. As a result, it appears that in some instances the difference between British and Japanese methods created problems. Inoue Masaru, who as head of the railway bureau had become the Japanese superintendent of railways, later had the following recollection of such difficulties

For instance, in constructing stone walls for bridges, the [British] workmen used to smooth all the faces of each stone, including the four which did not join with other stones, when it was really necessary to smooth only the upper and lower joint-faces. In another case it was found that only cross ties which would lie at a right angle [to the rails] were used, the rest being thrown away as unserviceable.⁷

The British probably brought their construction methods into Japan without making any adjustments to account for local conditions, and this occasionally triggered conflicts of opinion. In Japan the technology of building stone walls had already undergone a long period of development. In particular, stone walls of a quite sturdy nature had been built for castles ever since medieval times. As Inoue suggested, it was usual in building these walls to smooth only the two joint-faces. Therefore, it was only to be expected that conflicts would arise between the traditional technology of the Japanese and the technology introduced by the British.

This clash of technologies led to an important development in the process of technology transfer: based on the technological level attained by Japan's traditional civil engineering methods, a movement began to apply the time-honoured, native technology to the novel enterprise of building railways. Virtually all of the authorities responsible for railway construction at the time seem to have shared an interest in realizing the application of traditional technology.

Let us take the example of tunnel construction. From around the seventeenth century, gold, silver, and copper mines had been devel-

oped to a large extent in various parts of Japan, and the technology of excavation at these mines was quite advanced. Furthermore, in 1666 farmers in the eastern part of Suruga province (present-day Shizuoka Prefecture) located at the foot of Mount Fuji began construction work on a tunnel to draw irrigation water from a lake on Mount Hakone. This tunnel was finished in 1670, and water drawn from the lake was used to irrigate ten square kilometers of farmland. Hence, the technology to excavate a tunnel of this magnitude had also been developed by the end of the seventeenth century.

Consequently, in the early Meiji period Japanese could claim to have already attained a respectable level of technology in the field of tunnel construction. Japan's first railway tunnels were built on the Osaka-Kobe line, whose construction followed that of the line between Tokyo and Yokohama. These tunnels were constructed, not through mountains, but under rivers. The rivers flowing precipitously from the Rokkō mountain range to the sea followed channels that were higher than the river basin, owing to the gradual accumulation of sediment along the river bottoms. The railway was to make its way through tunnels dug under the channels of three of these rivers, the Ashiya, Sumiyoshi, and Ishiya rivers.

The construction work was carried forward under British planning and supervision. The method employed was to excavate from the surface by closing off half of the river channel and digging down from the closed-off area. When part of the tunnel had been excavated and the area filled in, the river current was diverted to the completed section, and the remaining half of the tunnel was built in the same manner. Using this method of construction, single-track tunnels were excavated under the Ishiya and Sumiyoshi rivers and a double-track tunnel under the Ashiya River.

At least part of the reason British were placed in charge of planning and supervising the construction of this series of tunnels is that the Japanese, owing to their unfamiliarity with railways at this

stage, had taken to entrusting everything to the hired foreign engineers. This held true in all areas, including earthwork. Nevertheless, as the work actually progressed, the Japanese discovered a number of activities which they realized they could do by themselves.

It is with this recognition that the road to technological independence began. Because of limitations of space, I cannot deal with this topic in detail, and I will therefore defer a fuller treatment of the issue until a later time. The remainder of this paper presents a general chronology of the actual steps involved in the process of acquiring technological independence.

In 1875 production of passenger and freight cars was started at the state railways' Kobe workshop (the present-day Takadori factory). In producing each car, the Japanese used an imported chassis and made the body domestically.

In 1878 work was begun on the Otsu-Kyoto line. British engineers were commissioned to plan some of the bridges, but other than that, construction of the approximately 18-km line was carried out entirely by the Japanese. Included in this section was the 664.8-meter-long Osaka-yama (Mount Osaka) tunnel. The first mountain tunnel built by the Japanese, this tunnel was completed on 28 June 1880. From this project on, the foundation was set for the Japanese to build all tunnels for themselves.

April 1879 marked the appearance of the first Japanese engine driver, operating a train between Shinbashi and Yokohama. Japanese who had served from the start as firemen, accompanying British engine drivers, had gradually acquired the necessary operating skills and they thus became able to run the trains by themselves. After the appearance of the first native driver, preparations were rapidly made to have all trains operated by Japanese.

In this way, technical independence was realized most quickly in the area of civil engineering, followed closely by mastery of the technique of train operation. With regard to the technology of rolling-stock manufacture, under the conditions then prevailing prior to the onset of an industrial revolution, the production of engines and chassis was hardly possible, and compared to other sectors, independence in this area lagged behind considerably. However, at the railway workshops established in Shinbashi and Kobe, repair work was carried out from an early date using imported machine tools. Based on the experience accumulated in this kind of work, the Japanese produced a locomotive for the first time, though mainly with imported materials and under British supervision, at the Kobe works in 1893. Fully domestic production of locomotives began in 1912, forty years after the opening of the first railway line. Domestic manufacture of passenger and freight cars had also advanced considerably after the 1890s.

Thus, Japan made steady headway on the road to technological independence. The progress recorded in mastering railway technology reflected, in turn, the advancement of the industrial revolution within Japan.

Notes

1. F.L. Hawks, Narrative of the Expedition of an American Squadron to the China Sea and Japan, Performed in the Years 1852, '53 and '54, under the Command of Commodore M.C. Perry, United States Navy, 3 vols., Washington, 1856.
2. Ibid.
3. Masaru Inoue, "Japanese Communications: Railroads," in Shigenobu, ed., Fifty Years of New Japan, vol. 1, p. 430.
4. Nihon kokuyū tetsudō hyaku-nen shi [History of One Hundred Years of the Japanese National Railway System], vol. 1, p. 316.
5. Ibid.
6. Nihon tetsudō shi [History of Japanese Railways], vol. 1.
7. Adapted from Inoue, "Japanese Communications: Railroads," in Okuma, ed., Fifty Years of New Japan, vol. 1, p. 435.