A Short History on Training Railway Engineers in Meiji Japan

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Overview

This article describes the training of railway engineers from a human resources development (HRD) perspective, especially foreign railway engineers hired as instructors and Japanese trainees who learned railway construction and rolling-stock manufacturing in rail's early days in Japan. It also mentions Japanese railway engineers who received special overseas education and training. First, we look at railway engineers involved in the manufacture of rolling stock and how they were trained. Then, we cover foreign railway engineers who were active in the Japanese Imperial Government Railways during the early Meiji era (1868–82) as well as Japanese railway engineers who trained at government works to develop their own skills.

Training Railway Rolling Stock Engineers

When railway lines were first built in Japan from 1870, foreign railway engineers were hired to give direct instruction to government and private railways. British engineers provided instruction for government railways in Honshu, Americans for government railways in Hokkaido (Horonai Railway under the control of the Hokkaido Colonization Office), and Germans for the private Kyushu Railway and Sanuki Railway in Kyushu and Shikoku, respectively. The number of these foreign advisors who were referred to as *oyatoi gaikokujin* (officially hired foreigners) peaked at 119 in 1874 and then dropped as they gradually returned to their homes when their contracts with the Japanese government expired. Many resumed working as railway engineers in their own countries.

When Japan began modernizing in the early Meiji era, Japanese railway engineers were trained by two methods. The first method used mostly in the pre-Meiji Edo era (1603–1868) and into the early Meiji era was to send handpicked men to study abroad where they could gain a technical education and experience before returning to Japan. These returnees included railway engineers who entered the Ministry of Public Works established in 1870 as technical officials involved in railway policymaking and construction and in rolling-stock manufacture. The second method was to enter the Vocational Training School for Training Japanese Railway Engineers established at Osaka Station in 1877 by the Railway Bureau. Here trainees acquired railway knowledge and skills on the job to become railway engineers and instructors involved in construction and rolling stock manufacture at railways. The Vocational Training School gradually lost its mission as graduates of the Imperial College of Engineering, an institute of higher learning affiliated with the Ministry of Public Works, entered the Railway Bureau but it succeeded in producing 24 graduates by the time it closed in 1882.

Five of the many foreign instructors in railway rolling stock manufacturing are described below; four were British and one was German.

Foreign Railway Engineers at Government Railways

Walter Mackersie Smith (1842–1906)

The Locomotive Superintendent and Chief Mechanical Engineer (CME) for Japanese Government Railways was Walter Mackersie Smith. Born in Scotland, Smith was apprenticed as a machinist and machine installer after leaving school in 1858. After gaining experience working in a factory, he joined Neilson & Co., a steam locomotive manufacturer in Glasgow. In 1866, Smith became engineer in charge of rolling stock design for the Great Eastern Railway (GER).

Smith arrived in Japan in 1874 and was appointed the first CME of Kobe Works of Imperial Government Railways (IGR). He imported many machine tools from England to build factories that could manufacture rolling stock and various railway items, installing the machines at the works in Kobe and Shimbashi. Under his instruction, a 100-passenger, four-wheel bogie, third-class, wooden coach was built in 1876 (Fig. 1). He also instructed Japanese engineering trainees in techniques to convert freight steam locomotives into passenger train locomotives to solve the problem of a shortage of steam locomotives for passenger trains on the Kyoto section of the Osaka–Kobe line opened in 1874.

In 1883, Smith returned to England, where he was in charge of optimizing the rolling stock production line at the Gateshead Railway Works of North Eastern Railway (NER). The works built many famous British steam locomotives, such as the NER 4-4-0 tender locomotive No.1619 in 1885

based on his experience and ability. He also made great contributions in technical areas such as inventing a driving mechanism for steam locomotives.

While a great railway engineer, Smith suffered from various chronic illnesses and died in 1906. His grave is at St. Andrews Cemetery in Newcastle-upon-Tyne.

Frederic Wright (?–1888)

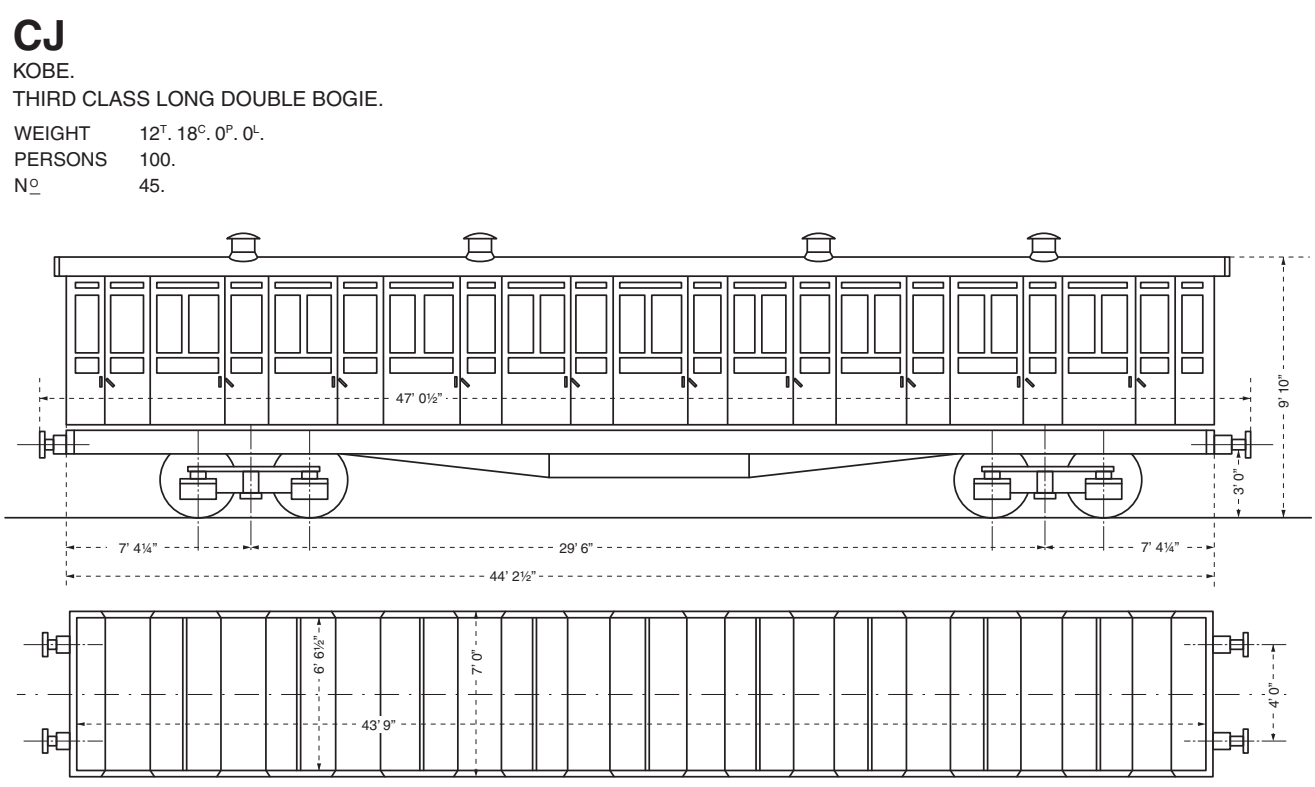
The second Locomotive Superintendent and CME of the Kobe Works was B. Frederic Wright. He was commissioned as CME of the IGR Shimbashi Works in 1878, and transferred to Kobe Works in 1883 where he worked for 5 years before dying in Japan in 1888. There are few records about Wright, but the following anecdote about Japanese engineering trainees provides valuable information on their progress. He wrote, 'The improvement in skills of Japanese engineer trainees is remarkable. All of the work currently being done at Kobe Works, except that for one foreign assembly engineer, is performed by Japanese engineer trainees. At the start in 1878, there was a foreign painter and a passenger carriages assembly engineer/boiler engineer and six foreign assembly engineers. But now, two foreign foremen oversee all work. This year (1878), all passenger, goods, and other cars were assembled under the supervision of the Japanese foreman in charge of the factory. Japanese trainees who received training from foreign supervisors perform all assembly and disassembly along with iron beam manufacture and forging. Japanese assembly engineers have also been in charge of major repair of locomotives for some time.'

Richard Francis Trevithick (1845–1913)

The third Locomotive Superintendent and CME of Kobe Works was Richard Francis Trevithick, a grandson of Richard Trevithick (1771–1833) the inventor of the high-pressure steam engine and a steam locomotive incorporating a smaller version of that engine on a bogie. Trevithick was born in Crewe where there was a factory of the London and North Western Railway (LNWR). After completing his apprenticeship, he started work at the LNWR Crewe Works where he improved his skills before moving on to take charge as CME of construction at the Central Argentine Railway and Ceylon National Railway.

When he took up his post at Kobe Works in 1888, Trevithick first instructed Japanese engineer trainees on converting freight steam engines to passenger locomotives. In 1892, he instructed trainees in the manufacture of a two-cylinder, compound engine of his own design. Completed in June 1893, this was the first domestically manufactured steam locomotive built by Japanese. Initially named No.

Figure 1 100-passenger, Four-wheel Bogie, Third-class, Wooden Coach Built by IGR Kobe Works in 1876



Source: *100 Year History of Japanese National Railways*, Vol. 2

221, the locomotive series was renamed No. 137, which was subsequently changed to class 860 by the Railway Agency in 1909 (photo below). The wheels were arranged in the Meiji 2-4-2 standard. Some springs, boiler injectors, pressure gauges, vacuum gauges, ejectors, and main-frame steel plates were imported from England, but the left and right cylinders, wheel sets, boiler, and other major components were manufactured at Kobe Works.

Trevithick returned to England in 1904 but he had made a great contribution to training engineers at Kobe Works and his standardized manufacturing system was handed on to Japanese engineers building steam locomotives, passenger carriages and wagons for many years. He died in England in 1913.

His younger brother Francis Henry Trevithick, worked at the IGR Shimbashi Works.

Francis Henry Trevithick (1850–1931)

Francis Henry Trevithick came to Japan in 1876 before his brother Richard. He worked as boiler superintendent at Kobe Works, and after a stint as Assistant Locomotive Superintendent CME at Shimbashi Works, was appointed CME in 1878. Some Abt rack-and-pinion steam locomotives built by Esslingen in Germany had been imported for the Usui Pass section on the Naoetsu Line (now Shin'etsu main line and Shinano Railway) in 1893, and Trevithick confirmed the safety of these locomotives (later class 3900 with 0-6-0 arrangement) on the steep pass.

After teaching the manufacture of four-wheel bogie wooden coaches, Trevithick returned to England in 1897 where he died in 1931. Trevithick had many achievements, but he is most famous in Japan for his *Japanese Railways Locomotives Carriages Wagons and Crossings & C. & C. 1893* that he used to teach the Trainee Draftsmen Group at

First domestically manufactured compound engine No. 221 built by IGR Kobe Works in 1892 (The Railway Museum)

Shimbashi Works. His drawings are a valuable resource for learning about railway rolling stock at the time.

Hermann Rumschöttel (1844–1932)

Hermann Rumschöttel was born in Trier, Germany, near Luxembourg. After graduating from the Prussian Technical University, he worked for the Berlin City Railway Department, German Railway Construction Company, and Prussian National Railway where he was CME.

Rumschöttel was invited to take the post of CME at the private Kyushu Railway (today's Kagoshima Line) in 1887 and ordered steam locomotives from Hohenzollern and Krauss Maffei, passenger carriages and wagons from Van der Zypen und Charlier, and railway materials from Dortmund Union. Rumschöttel also gave a lot of valuable advice on railway management, contributing generously to Kyushu Railway.

A four-wheel third-class, wooden coach built by Kyushu Railway's Kokura Works in 1897 is still preserved at the red-brick Kyushu Railway History Museum (former head office of Kyushu Railway) next to Mojiko Station in Kita-Kyushu (photo on pp 38). The Works manufactured it entirely domestically, modelled on four-wheel bogie wooden carriages imported from Germany to deal with the severe shortage of passenger carriages and wagons following the expansion of rail lines. Louis Garland (mechanical engineer) and Carl Duissung (locomotive engineer), both from Germany, provided instruction on the manufacture. They both assisted Rumschöttel, with Garland probably instructing Japanese engineering trainees in passenger carriage and wagon manufacturing.

Rumschöttel was also involved in construction of Sanuki Railway (today's Yosan main line) and the Besshi Mine Railway in Shikoku. The Sumitomo family who owned Besshi copper mine managed the lower mining line to Niihama but the upper track (762 mm, steam traction) was built under Rumschöttel's directions. Louis Garland provided instruction on locomotive driving on the upper track. Rumschöttel also had a hand in the elevated tracks in Tokyo City, proposing the elevated line connecting Ueno Station of the private Nippon Railway to the IGR's Shimbashi Station. It later became the elevated section between Tokyo and Ueno of the Tohoku main line. Rumschöttel returned to Germany in 1897 to again work for the Prussian National Railway, later becoming president and chairman of the Berliner Maschinenbau Aktien-Gesellschaft (BMAG, formerly L. Schwarzkopf). He died in Berlin.

Most early railways in Japan were based on technology from Great Britain, so the units of measurement were naturally feet, yards, and pounds. Kyushu Railway and Shikoku's Sanuki Railway introduced technology from Germany, but were special cases. German railway technology was based on the metric system, and its introduction coincided with Japan's adoption of the metric system when the Meiji Government signed the Metre Convention and officially adopted the metric system in 1885. With the nationalization of 17 main line railways, the units on Kyushu Railway were changed to feet, yards, and pounds. But the Ministry of Railways officially adopted the metric system in 1930, returning Kyushu Railways to the metric system.

Training Master Japanese Railway Engineers at Government Works

Who were the Japanese engineer trainees who contributed to the improvement in technical levels in the Meiji era when Japan was just starting to develop its own railway engineering? The principle men were Hikozo Mori and Kichimatsu Ota of Kobe Works and Hiroshi Hiraoka of Shimbashi Works. They were instructed by Richard Francis Trevithick and Francis Henry Trevithick, and are famous names in the history of Japanese railway engineering.

Hikozo Mori (1867–1958)

Hikozo Mori was born in Okayama Prefecture. After graduating from the Imperial College of Engineering in 1881 he joined IGR. In 1888, when Richard Francis Trevithick became third Locomotive Superintendent and CME at Kobe Works, Mori studied rolling stock engineering and mechanical engineering under Trevithick, participating in and completing the work to convert two 0-6-0 tender class 7010 freight locomotives to 4-4-0 tender passenger locomotives. In 1893, he was part of the team with Kichimatsu Ota building Japan's first domestically manufactured two-cylinder, compound, tank locomotive No. 221 (later renamed 2-4-2 class 860) making his mark in history in 1894 when running tests proved No. 221 had comparable performance and economy to the 2-4-2 tank locomotive imported from Great Britain at the time.

Mori was appointed CME of the Railway Works Department at Kobe Works in 1900, later becoming plant manager for Shimbashi Works in 1904. He moved as CME to the South Manchurian Railway in 1912 teaching rolling stock design and manufacturing. In 1920, he became Professor and Head of Nagoya Technical College (now Nagoya Institute of Technology) where he taught engineering students. His *magnum opus* is the three-volume *Steam Locomotive Engineering* co-authored with Chikatsu Matsuno (9th Shimbashi Works factory manager who succeeded Mori in 1912). This work incorporated much English steam locomotive design and manufacturing engineering learned from Trevithick. Mori died in 1958 and his grave is at Kodaira Cemetery in Kodaira City, Tokyo.

Kichimatsu Ota (?–1927)

Kichimatsu Ota was from Hyogo Prefecture. During his days as a trainee, he honed his skills under Trevithick along with Mori, improving to a level where he could stand on his own

Four-wheel, third-class wooden coach built by Kyushu Railway's Kokura Works in 1897 (Author)

as a mechanical engineer through activities such as building locomotive No. 221. In 1904, he transferred to the Railway Works Department of Shimbashi Works where he assisted Mori. Next he transferred as an engineer to the Rolling Stock Manufacturing Division of Kawasaki Shipyard Company in 1910 where he designed and manufactured the class 6700 4-4-0 passenger steam locomotive along with Railway Agency Rolling Stock and Mechanical Engineering Department Chief Engineer Yasujiro Shima (1870–1946) and Engineer Kiichi Asakura (1883–1978). The class 6700 was manufactured to replace aging 4-4-0 tender passenger locomotives imported from Great Britain and elsewhere at the start of Japanese railways. It was a standard saturated boiler (high-temperature steam generated in boiler collected in steam reservoir and fed directly to cylinders), using Walschaerts' valve gear for the first time on the tender type locomotive in Japan. He built a total of 46 locomotives at Kisha Seizo Company in Osaka founded by Masaru Inoue (1843–1910) the former head of the Railway Bureau and at Kawasaki Shipyard. In 1913, the class 6700 evolved into the class 6750 with superheated boiler (high-temperature steam generated in boiler collected in steam reservoir, fed through superheater tubes in boiler tubes where reheated, and supplied to cylinders). Six class 6750s were manufactured by Kawasaki Shipyard and were eventually improved to become the superheated-boiler class 6760. Ota became CME at Kawasaki Shipyard in 1916, taking on a key role in steam locomotive design and manufacturing to specifications by the Railway Agency.

At the Railway Agency, Rolling Stock and Mechanical Engineering Department Chief Engineer Yasujiro Shima's policy was for railway rolling stock repairs to be done at railway works and rolling stock manufacturing to be done at private railway rolling stock manufacturers. This policy was introduced directly from the Prussian National Railway where Shima studied at his own expense from 1903 to 1904. It was a measure to improve private sector industrial capabilities. The president of BMAG when Shima was studying there, was none other than the famous Hermann Rumschöttel.

In 1912, Ota and Kiichi Asakura designed the class 9550 2-8-0 tender freight steam locomotive. Ota also worked on the design for the class 9580 with the same wheel arrangement using a superheated boiler and the mass-

Class 9600 mass-produced tender locomotive for freight transport (Author)

produced class 9600 (photo above). Those designs were based on tender steam locomotives delivered by European and American builders to Railway Agency specifications. Famous locomotives are the 4-6-0 class 8800 from BMAG in 1911 and the 4-6-0 class 8850 from Borsig. Both models were superheated by a Schmitt superheater. The main driving wheels of locomotives with six wheels are normally the second wheels (sometimes flangeless), but the class 8850 locomotive used the first wheels for driving. The astounding ability to build a class 8850 in just 2 months from order to delivery was talked about for generations.

The first class 9600 was completed in 1913. This 2-8-0 superheated boiler locomotive has a wide fire box located over the driving wheels, effectively making the height of the boiler centre 102.1 inches (2594 mm) above the rails, the largest ever for narrow gauge. With narrow gauge, a higher locomotive centre of gravity leads to easy derailment, but this locomotive cleared the issue without problems. The origin of the design was the class 8850 tender locomotive imported from Germany. The class 9600 tender locomotive was mass produced by Kawasaki Shipbuilding and others for the next 13 years, with a total of 770 built. It was the mainstay freight locomotive until the mid-20th century. The design was packed with the fruit of Ota's years of locomotive design and manufacturing engineering, and it was the pinnacle of his career. Ota died in 1927.

Hiroshi Hiraoka (1856–1934)

Hiroshi Hiraoka was born in Edo (now Tokyo) as the eldest son of the Tayasu clan chief retainer Shoshichi Hiraoka. He went to the USA in 1871 where he interned at Baldwin Locomotive Works and elsewhere, returning to Japan in 1874. In 1876, Hiraoka started to work in railway rolling stock manufacturing as a third-class assistant engineer at the Shimbashi Works under Francis Henry Trevithick. He was in charge of four-wheel bogie passenger carriage and wagon design and manufacturing, learning hands-on English passenger carriage and wagon engineering techniques from Trevithick. Based on that experience, he established his unique Japanese rolling stock manufacturing engineering, completing the first four-wheel third-class wooden coach at Shimbashi Works in 1879. Imported steel was processed

for the running gear, the body was built by woodworking methods in use since the Edo era (highly refined skills related to building, furniture, and Japanese boat manufacturing), and was assembled on-site.

With a reorganization in 1883, Hiraoka became the first Japanese plant manager at Shimbashi Works, a position he held until 1890. Further expansion of government railways and nationalization of private railways increased demand for carriages and wagons, forcing railway works to handle both repairs and manufacturing. To accomplish the task, templates needed to be standardized along with design requirements. Standardization of major components and parts was also essential. English-style design specifications were modified for Japan, and passenger carriages and wagons were built based on these specifications at government works and private rolling stock manufacturers.

Hiraoka resigned his position at Shimbashi Works in 1890 to establish Hiraoka Works within the Tokyo Arsenal in Koishikawa for manufacture of both railway rolling stock and machinery. Passenger carriage and wagon manufacturing technology amassed over the years at Shimbashi Works was applied rigorously to his designs and manufacturing, which became famous for originality and creativity, earning him membership of Great Britain's Institute of Mechanical Engineers (I.Mech.E.) in 1897. Hiraoka is buried at Honkyuji Temple in Sumida Ward, Tokyo.

Notes on Locomotive Designs and Technical Terms

Steam locomotive wheel arrangement is expressed as the number of leading wheels, driving wheels, and trailing wheels in that order from the front of the locomotive. Wheel arrangement is used in this article, but another method is axle arrangement. Axle arrangement is expressed as the number of leading axles, driving axles, and trailing axles in that order from the front. For example, a 2-4-0 wheel arrangement is a 1-2-0 axle arrangement. Steam locomotives are either tank or tender type. Tank locomotives have a water tank and coal bunker in the locomotive body, with the water tank on both sides of the boiler (side tank), on top of the boiler (saddle tank, pannier tank), between the main frames (well tank, bottom tank), or behind the cab (rear tank). Some locomotives have combinations. The coal bunker is on both sides of the boiler or behind the cab. Tender locomotives have a tender for water and coal behind the locomotive. ■

Further Reading

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