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Siemens and the Business of Medicine in Japan, 1900–1945

This article focuses on the involvement of Siemens in the market for radiology equipment in Japan between 1900 and 1945. It explores why the German multinational company was unable to keep its dominant position in the Japanese market in the interwar years despite its technological competitiveness. At this time the Japanese medical market was already well structured when the country opened up to the West. In particular, it examines the firm's strategic choices in relation to the changing economic and technological environment, highlighting the importance for foreign multinationals of working together with national trading firms involved in the distribution of drugs and products for doctors.

Medicine experienced a paradigm shift in the twentieth century, changing from a small-scale, half-charitable activity to one of the main sectors of the economy. The transformation of medicine into a business came about in the first half of the twentieth century, largely driven by the introduction of new technologies, such as drugs mass-produced by the pharmaceutical industry, medical laboratories, and surgery equipment.¹ Among the innovations that made medicine a profitable and growing activity, X-ray machines changed the very nature of

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In this article, the names of persons follow the usage in Japan, that is, with the family name preceding the first name.

¹Stuart S. Blume, *Insight and Industry: On the Dynamics of Technological Change in Medicine* (London, 1992); Ilana Löwy, ed., *Medicine and Change: Historical and Sociological Studies of Medical Innovation* (Paris, 1993); Jennifer Stanton, "Making Sense of Technologies in Medicine," *Social History of Medicine* 12 (1999): 437–48; John Pickstone, *Ways of Knowing: A New History of Science, Technology and Medicine* (Manchester, 2000); and Jennifer Stanton, ed., *Innovations in Health and Medicine: Diffusion and Resistance in the Twentieth Century* (London, 2002), 1–18.

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hospitals, which became institutions managed like modern enterprises and established themselves in the health-care market.² Soon after Wilhelm Roentgen's discovery of X-rays in 1895, the manufacture of X-ray machines became a high-growth business, rapidly controlled by the multinationals of the electrical-appliances industry—General Electric, Westinghouse, Siemens, and Philips, as well as some independent specialized and mainly German firms, such as Müller; Reiniger, Gebbert & Schall; and Veifa.³ The key technology of these devices quickly appeared to be the X-ray tube, and the fact that the electrical-appliance enterprises had mastered vacuum-tube know-how allowed them to become the key actors of this new industry.

Within the general framework of the global expansion of this industry, Japan appears as a particular case for at least three reasons. First, one must consider the specific structure of the Japanese medical market. In comparison with other countries, it is characterized by relatively atomized, highly privatized health-care institutions, a particularity that meant that the health-care system relied on an increasing number of small institutions rather than on the concentration of health care in a few major urban hospitals.⁴ Indeed, the number of hospitals increased from 395 establishments (of which 38.7 percent were private) in 1880 to 1,344 (93.8 percent private) in 1920 and 2,925 (96.1 percent private) in 1935.⁵ Moreover, even if statistics on the production and sale of X-ray machines are lacking for the prewar period, one can assert it was a fast-growing business on which the worldwide depression of the 1930s had only a limited impact (the number of hospitals in Japan shows an average annual growth rate of 4.4 percent between 1930 and 1935). Keen competition in the Japanese health-care market obviously accelerated the diffusion of new medical technologies, as possession of state-of-the-art equipment gave establishments a clear edge.

Second, Japan was one of the very rare countries where domestic firms were able to compete effectively over time with global multinationals in the X-ray machine field. This was the case of the company Shimadzu Works (*Shimadzu seisakujo*), which arrived in this market

² David Rosner, *A Once Charitable Enterprise: Hospitals and Health Care in Brooklyn and New York, 1885–1915* (Cambridge, UK, 1982); and Joel Howell, *Technology in the Hospital: Transforming Patient Care in the Early Twentieth Century* (Baltimore, 1995).

³ About radiology in general, see Bettyann Holtzmann Kevles, *Naked to the Bone: Medical Imaging in the Twentieth Century* (New Brunswick, N.J., 1997); Alfred D. Chandler Jr., *Scale and Scope: The Dynamics of Industrial Capitalism* (Cambridge, Mass., 1990), 218–19 and 579; and Kees Boersma, “Tensions within an Industrial Research Laboratory: The Philips Laboratory's X-Ray Department between the Wars,” *Enterprise & Society* 4 (Mar. 2003): 65–98.

⁴ Shuhei Ikai, *Byoin no seiki no riron* (Tokyo, 2010); Akira Sugaya, *Nihon no byoin: Sono ayumi to mondaiten* (Tokyo, 1981).

⁵ Nihon tokei kyokai, ed., *Nihon choki tokei soran*, vol. 5 (Tokyo, 2006), 170–71.

after World War I, and succeeded in challenging Siemens and establishing itself as the dominant actor of this business in the 1920s.⁶ Third, X-ray machines are a particular technology that became stable in the 1930s, that is, in an environment that was not favorable for foreign enterprises in the case of Japan, due to an industrial policy aimed at helping a national industry grow.⁷ The features of this environment—a high-growth market with local competitors and unfavorable policy to foreign firms—made it necessary for the multinationals involved in this business to adopt specific strategies. This article focuses on the case of the German multinational enterprise Siemens, attempting to shed light on its strategy for the Japanese market for X-ray machines.⁸ The course of Siemens in this particular market between 1900 and 1945 was characterized by its failure to keep the dominant position it had until World War I. Even if it enjoyed an undeniable technological advantage on the worldwide market of X-ray machines, it was unable to prevent newcomers from challenging it in Japan.

As most of the German multinationals were doing on a global scale, Siemens gave priority to an export strategy rather than direct investments up to World War II, but did relocate part of its production when so compelled by local political conditions or competition with other firms, especially in Central and Eastern Europe.⁹ Kudo Akira clearly explained this phenomenon in the case of Japan.¹⁰ The presence of Siemens in Japan goes back to 1861, with the gift of a telegraph to the Emperor upon the occasion of the signing of the treaty between Germany and Japan.¹¹ In the 1870s, the German firm delivered several electrical

⁶ *Shimadzu Seisakujo shi* (Kyoto, 1967) and Pierre-Yves Donzé, “Making Medicine a Business in Japan: Shimadzu Co. and the Diffusion of Radiology (1900–1960),” *Gesnerus: Swiss Journal of the History of Medicine and Sciences* 64, no. 2 (2010): 241–62.

⁷ Mark Mason, *American Multinationals and Japan: The Political Economy of Japanese Capital Controls, 1899–1980* (Cambridge, Mass., 1992), 48–99; Masaru Udagawa, “Senzen Nihon no kigyo keiei to gaishikei kigyo,” *Keiei Shirin* 24, no. 1–2 (1987): 15–31; Takeshi Yuzawa and Masaru Udagawa, eds., *Foreign Business in Japan before World War II: Proceedings of The Fuji Conference* (Tokyo, 1990); and Gaimusho tokubetsu shiryobu, *Nihon ni okeru gaikoku shihon* (Tokyo, 1948).

⁸ On the global expansion of Siemens, see Wilfried Feldenkirchen, *Siemens: From Workshop to Global Player* (Munich, 2000). For a recent article on a contrasting multinational experience, see María Fernández-Moya, “Creating Knowledge Networks: Spanish Multinational Publishers in Mexico,” *Business History Review* 86, no. 1 (Spring 2012): 69–98.

⁹ Sachio Imakubo, “Ekkyo suru kyodai kigyo—shimensu to AEG,” in *Yoroppa no hakken—chūkishi no naka no kokkyo to shijo*, ed. Hisashi Watanabe (Tokyo, 2000), 235–39.

¹⁰ Akira Kudo, *Japanese-German Business Relations: Cooperation and Rivalry in the Interwar Period* (London, 1998).

¹¹ Siemens K.K., *100 Jahre Siemens in Japan* (Tokyo, 1987); Toru Takenaka, *Jiimensu to meiji nihon* (Tokyo, 1991); Toru Takenaka, “Business Activities of Siemens in Japan: A Case Study of German-Japanese Economic Relationships before the First World War,” in *Japan and Germany: Two Latecomers to the World Stage, 1890–1945*, vol. 1, ed. Akira Kudo, Nobuo Tajima, and Erich Pauer (Kent, 2009), 114–49, and *Chronology of Siemens-Schuckert D.K.K., Tokyo, 1944*, Siemens Corporate Archives, Munich (hereafter SCA), 7912.

devices and appliances to the army, the administration, and private companies. At first, it exported its products through trading companies, subsequently arranging for representation in Japan by sending Hermann Kessler, an engineer born in Liechtenstein in 1860 and trained in mechanics and electricity in Zurich and at the Stuttgart Polytechnicum before entering Siemens in 1883.¹² He opened an office in Tokyo in 1887.¹³ The company was officially registered under the name of Siemens Schuckert Electric Co. in 1905 (thereafter Siemens Japan). Even though it favored exports and did not make any direct investments in production, Siemens played a key role in technology transfer towards Japan, through the German and Japanese engineers who installed and maintained its equipment. In 1898, Siemens Japan employed eight persons, six of whom were Japanese.¹⁴ However, the main feature of the strategy adopted by Siemens in Japan before 1945 was the realization of a large direct investment after World War I, with the creation of the joint venture company Fuji Electric (*Fuji denki*) together with the *zaibatsu* Furukawa in 1923, a new firm to which Siemens gradually transferred its production during the interwar years.¹⁵

Yet most research carried out on Siemens in Japan during the first part of the twentieth century failed to consider the case of X-ray machines, a sector that also led in 1933 to a second joint venture with a Japanese trading company that specialized in medical goods, Goto Fuundo. In 1948, the Ministry of Foreign Affairs briefly mentioned this joint venture in its analysis of foreign direct investment (FDI), which is, incidentally, the main source used by historians who focused on FDI in Japan before World War II.¹⁶ The only two scholars who mention the existence of Goto Fuundo are Kudo Akira, in his work on German business in Japan, and Udagawa Masaru, in an article on foreign direct investment in Japan before World War II.¹⁷ Yet no historian has taken this company as a case study. The unique path of medical business within the Siemens group can also explain this historiographic gap. Originally integrated within the enterprise Siemens & Halske, the X-ray machine division was spun off into a new company and merged with Reiniger, Gebbert & Schall to become Siemens-Reiniger-Veifa GmbH (SRV) in 1925.¹⁸ Since then, this new firm based at Erlangen has been

¹²Toru Takenaka, *Siemens in Japan* (Frankfurt, 1996), 56.

¹³Siemens K.K., *100 Jahre Siemens in Japan*, 17.

¹⁴*Chronology of Siemens-Schuckert D.K.K.*, Tokyo, 1944, SCA, 5, 7912.

¹⁵Hisashi Watanabe, "A History of the Process Leading to the Formation of Fuji Electric," *Japanese Yearbook on Business History* 1 (1984): 47–71.

¹⁶Gaimusho, *Nihon ni okeru gaikoku shihon*, 99.

¹⁷Kudo, *Japanese-German Business Relations*, 28; and Udagawa, "Senzen Nihon no kigyo keiei to gaishikei kigyo," 19.

¹⁸Wilfried Feldenkirchen, *Siemens, 1918–1945* (Columbus, Oh., 1999), 311–15.

responsible for the production of medical devices within the Siemens conglomerate (currently Siemens Healthcare). It still has its own archive center there, while the documents usually used by historians working on Siemens are kept in another Munich-based institution (Siemens-Archiv-Akt, SAA). This institutional compartmentalization of archives is no doubt why business historians have not yet considered Siemens' activities with regard to X-ray machines.

One should also mention that the business of medical devices—essentially X-ray machines—was only a sideline in comparison with other traditional sectors of Siemens (telegraphs, turbines, power stations, and electrical appliances). It was, however, instrumental in modernizing medical equipment and turning medicine into a business in Japan. The involvement of Siemens in the business of X-ray machines in Japan is approached hereafter in four parts, which look at the firm's strategic choices in favor of export, licensing, and direct investment against the background of the changing economic and technological environment.

A Monopoly of German Manufacturers (1900–1914)

Up until World War I, the market of X-ray machines for medical use in Japan consisted only of imports with the exception of a few machines assembled with imported parts from 1908 onwards by Shimadzu Works, a manufacturer of scientific instruments.¹⁹ As we lack foreign trade statistics for these machines, it is not possible to determine the various market shares for individual countries. However, a qualitative approach brings out the virtual monopoly exercised by German manufacturers, mainly Siemens & Halske, Reiniger, Gebbert & Schall AG (RGS), and Veifa. The book on Japanese radiology that Goto Goro published in 1969 does not mention the acquisition of foreign X-ray machines that were not German prior to 1914.²⁰

In December 1898, the Japanese Imperial Army had ordered from Siemens one of the first radiology devices installed in Japan for its school of medicine.²¹ The company Siemens Japan received its first order from the army in 1901 for “a great many Siemens-Roentgen apparatuses.”²² The army and the navy were the first customers of the German firm at the beginning of the twentieth century. The portable X-ray machines that the German army had used on the battlefield during the

¹⁹ Goro Goto, *Nihon hoshasen igakushiko*, vol. 1 (Tokyo, 1969), 64.

²⁰ *Ibid.*

²¹ *Ibid.*, 22.

²² *Chronology of Siemens-Schuckert D.K.K., Tokyo, 1944*, SCA, 6, 7912.

Boxer War impressed Japanese officers, and they decided to acquire some.²³ In 1904, in connection with the war against Russia, the Imperial Army ordered some new X-ray equipment from Siemens, especially for its garrison hospitals of Hiroshima and Matsuyama.²⁴ After the war, the army and the navy decided to equip all their hospitals with Siemens X-ray machines in 1906.²⁵

As the volume of orders rose, Siemens Japan adopted a strategy to develop this business actively, notably in civilian medical circles. In 1909, it launched new machines, and two years later it opened a separate division for medical devices that employed four persons, all Japanese citizens, including a doctor, to develop a communication policy aimed at increasing recognition for its products among civilian doctors.²⁶ In 1903, Siemens had already presented an X-ray machine at the Fifth National Industrial Exhibition of Osaka that had impressed the public.²⁷ But the overall goal of such an event was to stress the technological superiority of Siemens as a whole. Opening the medical division in 1911 had a more practical aim: increasing sales of X-ray machines and penetrating the private medicine market. Thus, in 1910, a Siemens engineer displayed some devices at a conference of the Japanese Medical Society (*Nihon igakkai*).²⁸ This strategy of diversification towards the private sector was successful. In the years leading up to World War I, Siemens of course continued its shipments to the army but extended in parallel its activities targeting universities and some of the most renowned private hospitals (Hayashi Hospital, Juzen Hospital, Ogata Hospital, Tamura Hospital).²⁹ In 1913, Siemens delivered scores of X-ray machines, especially to the navy and to several prefecture hospitals (Aichi, Gifu, Hiroshima, Yamaguchi), that is, benchmark medical institutions in their regions.

Two factors can explain the virtual monopoly that German manufacturers, particularly Siemens, had over the Japanese market for X-ray machines: the relative weakness of American and British manufacturers until 1914 and the fascination of the Japanese scientific and medical world for German medicine. At the time, Germany and the other German-speaking countries (Austria and part of Switzerland) were the favorite destination of Japanese doctors who trained abroad in the late

²³ *Ibid.*, 6.

²⁴ *Ibid.*, 7.

²⁵ Goto, *Nihon hoshasen igakushiko*, vol. 1, 55.

²⁶ *Ibid.*, 69.

²⁷ *Chronology of Siemens-Schuckert D.K.K., Tokyo*, 1944, SCA, 7, 7912.

²⁸ Goto, *Nihon hoshasen igakushiko*, vol. 1, 75.

²⁹ *Die Tätigkeit des Haus Siemens in Japan auf das Gebiet der elektromedizinischen Technik*, 31 May 1958, unmarked folder, Med-Archiv Erlangen (hereafter MAE).

nineteenth century.³⁰ Moreover, when the Faculty of Medicine of the University of Tokyo was founded in 1871, its chairs were entrusted first to German doctors, then in the next generation to Japanese doctors trained in Germany, mainly at the University of Berlin.³¹ Of special note is the case of Julius Scriba (1848–1905), a professor of surgery at the University of Tokyo who trained many Japanese surgeons. In February 1898, he brought back an X-ray machine from Germany and set it up in his department.³² The social networks of medicine appeared to have been a decisive channel for the supply of X-ray equipment in Japan until 1914.

Towards a Competitive Market (1914–1930)

World War I was a double breakdown on both the political and technological levels, ending Siemens's hegemony on the Japanese market for X-ray machines. On the one hand, as occurred in other sectors of the economy, the war interrupted economic relations with Germany.³³ Not only were imports of German goods stopped overnight, but Japanese authorities seized holdings of German companies, especially patents. In the case of X-ray machines, the abrupt disappearance of German firms, which had totally controlled this market until 1914, made it possible for rival companies to launch into this activity. This was notably the case with other foreign manufacturers, such as the American company Victor X-Ray Corporation, close to General Electric. With the war, the Japanese importers and distributors launched non-German X-ray machines and sometimes tried to engage in production. For example, the trading house Iwashiyama Iwamoto Tokichi marketed X-ray machines made by the British firm Watson and the American company Victor, delivering around ten to hospitals in 1915.³⁴ In addition, it set up a radiology division that the company Tokyo Medical Electric Co. (*Tokyo igaku denki*), founded in 1916, absorbed after the war.³⁵ As for the company Goto Fuundo, which went on to partner with Siemens in the mid-1920s, it redirected its sourcing from Germany to France, the United States, and the United Kingdom.³⁶ Moreover, some domestic

³⁰ Pierre-Yves Donzé, "Studies Abroad by Japanese Doctors: A Prosopographic Analysis of the Nameless Practitioners, 1862–1912," *Social History of Medicine* 23, no. 2 (2010): 244–60.

³¹ Tokyo daigaku igakubu hyakunenshi henshūinkai, *Tokyo daigaku igakubu hyakunenshi* (Tokyo, 1967), 123–34.

³² Goto, *Nihon hoshasen igakushiko*, vol. 1, 22.

³³ On the relationships between Japan and Germany, see Kudo, Tajima, and Pauer, *Japan and Germany*.

³⁴ Goto, *Nihon hoshasen igakushiko*, vol. 1, 126.

³⁵ *Ibid.*, 160.

³⁶ *Ibid.*, 126.

producers, such as Shimadzu, Tokyo Electric Medical Care (*Tokyo iryo denki*), and Akiyama, began at the time to produce their own devices.³⁷ For example, in 1915 Shimadzu marketed its first serially produced X-ray machine for medical purposes, the A model.³⁸ These Japanese producers also took advantage of the absence of German manufacturers to export their goods during the war, mainly to Russia, India, China, and Australia.³⁹ In the first half of the 1920s, numerous small companies brought machines onto the market. By 1923, the following companies were marketing some X-ray devices: Shimadzu, Dainihon Roentgen, Okura Roentgen, Morikawa Works, Akiyama Works, and Goto Fuundo, not to mention distributors of foreign machines.⁴⁰

Noteworthy is a major technological breakthrough in the United States at the laboratory of the multinational General Electric Co. (GE)—the development of the Coolidge X-ray tube (1913).⁴¹ The particularities of this tube (high vacuum, tungsten spiral filaments for heating) enabled an easy control of the dosage of rays by delinking their volume (current) from their penetrative power (voltage). This innovation made possible an excellent application of radiology to medicine, largely contributing to its rapid diffusion. In Japan, from 1920 onwards, this technology was controlled by Tokyo Electric Co., a GE-affiliate founded in 1905 that enjoyed a monopoly on imports and sales of Coolidge tubes in Japan and subsequently their manufacturing.⁴² Yet until the early 1930s, GE did not produce complete X-ray appliances but only tubes, which it sold to appliance makers. The American multinational was, however, not the sole tube producer, even if its tubes were the best quality. GE's main rivals were German companies, namely Müller and Phoenix, which were producing in the 1920s respectively for the Dutch company Philips and Siemens. In Japan, there were also several manufacturers producing lower-quality copies (Kanazawa Medical Appliances Co., Shibuya Roentgen Co.).⁴³ But until the beginning of the 1930s, both GE and Tokyo Electric produced only X-ray tubes, which they supplied to X-ray machine manufacturers, especially Shimadzu. The latter indeed approached Tokyo Electric and used Coolidge tubes for its

³⁷Rokurouta Momotani, *Future Prospects in Japan with Special Consideration of the Siemens & Halske Business*, Nov. 1919, SCA, 15 Ln 376.

³⁸Goto, *Nihon hoshasen igakushiko*, vol. 1, 126.

³⁹Momotani, *Future Prospects in Japan*.

⁴⁰Goto, *Nihon hoshasen igakushiko*, vol. 1, 223–24.

⁴¹Siemens, *History of the House of Siemens*, vol. 2, 79–80. On the Coolidge tube, see Robert G. Arns, "The High-Vacuum X-Ray Tube: Technological Change in Social Context," *Technology and Culture* 38, no. 4 (1997): 852–90.

⁴²Tokyo shibaura denki, *Tokyo shibaura denki kabushiki kaisha 85 nen shi* (Tokyo, 1963), 474.

⁴³Goto, *Nihon hoshasen igakushiko*, vol. 1–2.

machines from 1917 onwards.⁴⁴ The two firms signed an agreement in 1922, thereby securing Shimadzu's supply.⁴⁵

In the early 1920s, when Siemens was planning to come back onto the Japanese market for X-ray machines, the structure of this market had changed radically. Although its main rivals on the global scale, namely General Electric and Westinghouse Electric, did not take the opportunity to engage into this business, despite a favorable commercial flow between 1914 and 1918, some local newcomers had emerged and established themselves as dominant actors. Shimadzu especially benefited from GE technology and adopted a particularly active strategy of promotion of its machines within medical circles. The new competitiveness of this market throughout the world led Siemens to restructure this division, both on a global scale and in Japan.

New Organization of Siemens. The German industry for X-ray machines underwent a broad concentration wave in the 1920s that benefited Siemens.⁴⁶ This rationalization of the means of production, made necessary by the financial difficulties many manufacturers faced after World War I, enabled this sector of German industry to recover its pre-war competitiveness. The main merger that occurred at the time was the takeover in 1924 of the company Reiniger, Gebbert & Schall AG (RGS) by Siemens & Halske. Founded at Erlangen in 1886, RGS was a maker of electrical devices for medicine that embarked in 1896 on the production of X-ray machines for Wilhelm Roentgen.⁴⁷ After becoming a joint stock company in 1906, it opted for a strategy of growth based on the acquisition of small rival firms, for example the Frankfurt-based manufacturer of X-ray machines Veifa Werke (1916), subsequently setting up a holding company, Industrieunternehmungen AG (Inag), in 1921. Bringing together some twenty small and medium-sized firms involved in the production of medical appliances and materials, including the X-ray machine makers RGS, Veifa, Sanitas, and Polyphos, this holding aimed at centralizing distribution in order to compete with big enterprises like Siemens. However, this strategy was not financially viable, resulting in the takeover of RGS and Inag by Siemens & Halske in 1924. Siemens then merged RGS with its own X-ray machines division into a new enterprise, SRV, subsequently renamed Siemens-Reiniger-Werke AG (SRW) in 1927. This rationalization of production in Germany in

⁴⁴Ibid., 148.

⁴⁵*Shimadzu Seisakujo shi*, 45. According to Goto, *Nihon hoshasen igakushiko*, vol. 1, 179, the year was 1920.

⁴⁶Georg Siemens, *History of the House of Siemens*, vol. 2 (Freiburg, 1957), 81–85; Feldenkirchen, *Siemens*, 312–13; and *Chronology of Siemens-Schuckert D.K.K.*, Tokyo, 1944, SCA, 4.

⁴⁷Siemens, *History of the House of Siemens*, vol. 1, 280.

1924 also provided an occasion to restructure the import and distribution of X-ray equipment in Japan. For Siemens, this business was secondary in comparison with other key sectors such as telecommunication and energy. In the report on business opportunities in Japan that he wrote in November 1919, Momotani R., an employee of Siemens Japan, did not pay so much attention to X-ray machines and tubes.⁴⁸ In 1923, Siemens & Halske and the *zaibatsu* Furukawa set up the joint venture Fuji Electric and organized a medical division employing six persons.⁴⁹ However, according to the corporate history published by Fuji Electric, it only imported products and was not involved in production.⁵⁰ Yet this division showed growth during the months following the Great Kanto Earthquake on September 1, 1923. Many hospitals and clinics used the reconstruction as an opportunity to reorganize themselves into modern medical institutions. Between September 1923 and June 1926, Siemens delivered to medical establishments, mainly based in the Tokyo area, a total of 101 X-ray machines, twenty X-ray tubes, and thirty-two various medical devices, such as electrocardiograms and diathermy devices (machines used for heating tissues for therapeutic purposes).⁵¹

After 1924, Otto Kresta, a German engineer sent by Siemens & Halske, headed this division. A holder of a PhD in physics who specialized in X-ray devices, Kresta played a key role in the reactivation and the development of the medical networks of Siemens.⁵² Indeed, he participated actively in events organized by the Japan Roentgen Association (*Nihon rentogen gakkai*) from 1924 onwards. He was the only foreigner to attend regularly up until World War II, and he gave papers in German on X-ray machines, their operation and their use, which appeared in the journal of the Association (*Nihon rentogen gakkai zasshi*). In the 1920s and 1930s, the main rival companies of SRW (Shimadzu, Tokyo Electric) also used this strategy of communication aimed at scientific circles.⁵³ Its objective was to strengthen the scientific image of the firm within the medical world and also to make its own new machine known. After 1926, Kresta continued his activities inside the company Goto Fuundo, the medical goods trading company with which SRW signed an agreement. He was, however, the only German engineer dispatched to Japan by SRW until the war, so it is hard to emphasize here an active

⁴⁸ Momotani, *Future Prospects in Japan*.

⁴⁹ *Chronology of Siemens-Schuckert D.K.K., Tokyo, 1944*, SCA, 2.

⁵⁰ *Fuji denki shashi* (Tokyo, 1957), 281.

⁵¹ *Die Tätigkeit des Hauses Siemens in Japan auf das Gebiet der elektromedizinischen Technik*, 31 May 1958, unmarked folder, MAE.

⁵² Rokurouta Momotani, *Nihon ni okeru shimensu no jigyo to sono keiken reki* (Tokyo, 1955), 42.

⁵³ See, for example, *Shimadzu Seisakujo shi*.

strategy of technology transfer of the German multinational through its engineers, as also seen in the case of American multinationals.⁵⁴

A Successful Newcomer: Shimadzu Works. SRW was not the only X-ray machine producer to take up a specific communication strategy towards the medical world in Japan. Indeed, the policy introduced through Kresta's engagement within Japanese medical networks since 1924 appears as an attempt to react to the establishment of a competitive newcomer, namely the company Shimadzu Works (*Shimadzu seisakujo*), which was then challenging the dominant position of SRW. Founded at Kyoto in 1875 as a scientific instrument maker, this family firm also engaged in the production of an X-ray device for medical purposes in 1908, successfully launching its first serial-produced machine in 1915. It then built its organizational capabilities in the development of an X-ray machine in the 1920s on the hiring of university-graduated engineers and the subcontracting of R&D to outside research centers.⁵⁵ It also adopted a very active marketing strategy towards medical networks, which supported its expansion from the 1920s onwards.⁵⁶

As the gross sales of the X-ray machine division of Shimadzu are unknown before 1935, it is difficult to consider the growing competitiveness of this firm towards Siemens. According to the corporate history published by Shimadzu, the sale of X-ray devices amounted to only one or two machines each year at the beginning of the 1910s. It grew to about one hundred machines and a value of 700,000 yen in 1924, and then to 250 machines in 1926 for a value estimated at 1.7 million yen.⁵⁷ In comparison to this growing importance, the export of X-ray machines by SRW to Japan was less than 300,000 yen in both 1924 and 1926.⁵⁸ In the first part of the 1920s a domestic competitor who had adopted an active marketing strategy of accessing a growing medical market had overcome Siemens.

The Agreement with Goto Fuundo (1926). In reaction to the loss of its market share, in 1926 SRW entered into an alliance with a small trading firm that specialized in the sale and the distribution of drugs and medical goods, Goto Fuundo. Founded at Tokyo in 1886 by Goto Setuzo, a young graduate of the Faculty of Pharmacology of the

⁵⁴ Uchida Hoshimi, "Western Big Business and the Adoption of New Technologies in Japan: The Electrical Equipment and Chemical Industries, 1890–1920," in *Development and Diffusion of Technology: Electrical and Chemical Industries. Proceedings of the Fuji Conference*, ed. Akio Okochi and Hoshimi Uchida (Tokyo, 1980), 145–72.

⁵⁵ *Shimadzu Seisakujo shi*.

⁵⁶ Donzé, "Making Medicine a Business in Japan."

⁵⁷ *Shimadzu Seisakujo shi*, 353 and 356.

⁵⁸ *Unser Export nach Japan und unsere zukünftigen Aussichten*, 20 Oct. 1934, 770-2, MAE.

University of Tokyo (1883), this company originally manufactured and distributed medicine, then subsequently diversified into the trade and production of medical instruments and machines.⁵⁹ Besides his involvement in the medicine business, Goto Setuzo soon launched into the import and distribution of surgical instruments and equipment for hospitals, including X-ray machines.⁶⁰ In 1908, he obtained the exclusive importation and distribution rights for Japan for the X-ray machines from the firms Hirschman and RGS.⁶¹ Moreover, he began to do business with Siemens, from which he ordered several medical appliances in 1912.⁶² Finally, Goto Fuundo adopted an active strategy of communication targeting medical circles early on. In April 1908, for example, it organized a demonstration of the practical use of X-ray machines at a meeting of the Japanese Digestive Organs Diseases Association (*Nihon shokakibyō gakkai*).⁶³

In order to maintain and repair the medical appliances and X-ray machines sold to the hospitals and clinics, Goto Fuundo was obliged to internalize some technical know-how, which subsequently helped it launch into production. In 1915, it engaged an engineer, Watanabe Motomu, who graduated that same year from the Electric Department of Tokyo Industrial College.⁶⁴ Watanabe subsequently served on the board of directors until after the war.⁶⁵ A second engineer, Kawamura Kosaku, joined the company around 1917. He graduated from the same department as Watanabe and became chief engineer of Goto Fuundo around 1921.⁶⁶ Finally, Goto Fuundo tried to start producing X-ray machines in 1918. It founded a subsidiary that year, Tokyo Electric Industry (*Tokyo denki kogyō*), whose purpose was to manufacture electrical appliances and particularly X-ray machines.⁶⁷ To do so, it relied on top-flight researchers. Goto Fuundo entrusted the technical direction of the new firm to Iwayama, an engineering graduate; the firm hired as consultants professor Fujinami and professor Torikata Uichi, who held a PhD in electrical engineering from the University of Tokyo and was at the time director of the Electrotechnical Laboratory of the Ministry of Communication.⁶⁸ Despite such excellent knowledge resources, this new firm

⁵⁹ Goto, *Nihon hoshasen igakushiko*, vol. 1, 42.

⁶⁰ Setuzo Goto, *Surgical Instruments and Appliances* (Tokyo, 1906).

⁶¹ Goto, *Nihon hoshasen igakushiko*, vol. 1, 64.

⁶² Lieferübersichten, 8 June 1935, SCA, 7912.

⁶³ Goto, *Nihon hoshasen igakushiko*, vol. 1, 64.

⁶⁴ *Ibid.*, 128.

⁶⁵ Goto Fuundo, *Eigyō hokokusho* (Tokyo, 1950).

⁶⁶ *Nikkan kogyō shimbun*, *Nihon gijutsuka soran* (Tokyo, 1934), 201; Goto, *Nihon hoshasen igakushiko*, vol. 1, 194.

⁶⁷ Goto, *Nihon hoshasen igakushiko*, vol. 1, 160.

⁶⁸ *Ibid.*; Kuro Iseki, ed., *Dainihon hakushi roku*, vol. 5 (Tokyo, 1930), 250.

seems to have quickly given up its activities, and Goto Fuundo took over in 1919.⁶⁹

Goto Fuundo was a major dealer in medical appliances in the 1920s. During that decade, it signed many exclusive import and distribution contracts with various foreign medical equipment manufacturers, mainly German, such as the companies Mayer & Rotzler in 1923 and Veifa-Werke, Phoenix, and RGS in 1924, all part of the holding company Inag.⁷⁰ In return, Inag received 50,000 yen of the capital of Goto Fuundo (that is, 9.1 percent), a share that went to Siemens after it took over Inag. In 1926 Siemens signed other similar contracts; in 1928 it signed contracts with Adam Schneider, the German manufacturer of devices for dentists, and with Schaerer, the Swiss producer of hospital equipment.⁷¹

For Siemens, the takeover of Reiniger, Gebbert & Schall AG (RGS) led to the restructuring of the distribution of medical goods on the Japanese market and the signature of an exclusivity contract with Goto Fuundo, which evidently possessed better networks with medical circles than Fuji Electric. In 1926, Goto Fuundo signed two contracts, one with Siemens-Reiniger-Werke (SRW), giving it exclusive rights to distribute its products on the Japanese market, and the second with Fuji Electric, concerning the sale in Japan of the possible production of medical appliances by this company.⁷² The 1926 contract between SRW and Goto Fuundo was extended in 1931 and then again in 1934 for four years.⁷³ In this context, in 1926, Goto Fuundo engaged Otto Kresta, head of the medical division of Fuji Electric from 1924 onwards.⁷⁴ He became a member of the board of directors and played a key role as a technical consultant until World War II.⁷⁵ However, no relocation of production facilities or any other form of technology transfer was envisaged at the time. Siemens was still giving priority to export strategy, and the contracts signed with Goto Fuundo should be understood as a means of boosting sales.

For SRW, the commercial consequences of this agreement with Goto Fuundo were however disappointing, as it did not enable it to overcome the competitiveness of Shimadzu and put an end to a growing loss of market share (see Figure 1). While the 1926 contract mentioned

⁶⁹ *Nihon kogyo yokan*, 1936, 127.

⁷⁰ Contracts between Goto Fuundo and various foreign firms, unmarked folder, MAE.

⁷¹ *Ibid.*

⁷² "Vertretung des UB Med und seiner Vorgänger in Japan, 1887–1979," 1979, SCA, 4, 7912.

⁷³ Contracts between SRW and Goto Fuundo, 12 Nov. 1931 and 1 Jan. 1934, 770-2, MAE.

⁷⁴ Momotani, *Nihon ni okeru shimensu no jigyo*, 53–54.

⁷⁵ Memo, 2 Oct. 1946, CPC 41470, National Diet Library, Tokyo, Archives of the Supreme Commander of the Allied Powers (hereafter SCAP).

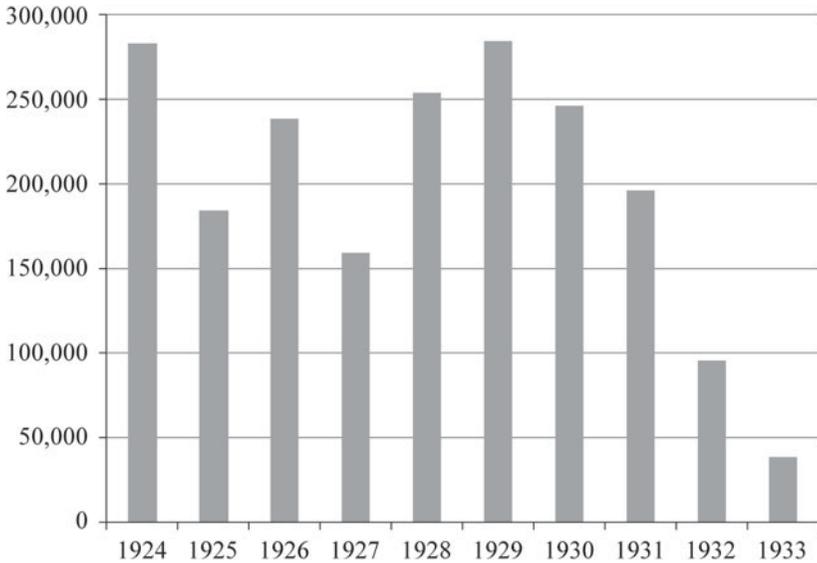


Figure 1. Sales from SRW to Goto Fuundo, in yen, 1924–1933. Note: Unknown before 1924. (Source: Siemens Corporate Archives, Med-Archiv Erlangen, 770-2; Unser Export nach Japan und unsere zukünftigen Aussichten, 20 Oct. 1934.)

the guarantee of annual orders for at least 250,000 yen, this sum was reached only three times by 1933, including for a year before the signature of the contract.⁷⁶ Between 1926 and 1931, Goto Fuundo's orders from SRW averaged only 229,701 yen. Afterwards, the 30-percent devaluation of the Japanese yen in December 1931 made German products more expensive and largely explained the drop in orders, which plummeted from 95,550 yen in 1932 to 35,500 in 1933. However, SRW was still competitive with other foreign multinational enterprises. According to an SRW internal document, the German firm exported X-ray machines to Japan to the tune of 77,000 marks in 1933, that is, more than the official value of the German foreign trade statistics (76,000 marks).⁷⁷ Obviously, Siemens had no German rival in Japan. Moreover, American exports of X-ray machines amounted to a paltry 7,100 marks that same year.⁷⁸ However, SRW's real competition appeared on the domestic market in the early 1930s, with the growth of Tokyo Electric and Shimadzu. The position of Goto Fuundo in the market of medical devices

⁷⁶ Contract between SRW and Goto Fuundo, 1926, unmarked folder, MAE.

⁷⁷ Gegenwärtiger Stand des SRW-Geschäfts in Japan, 4 Jan. 1939, unmarked folder, MAE.

⁷⁸ Ibid.

was indeed weakening in the first half of the 1930s, with a dividend rate that dropped from 10 percent in 1927 to at least 7 percent in 1930, 5 percent in 1931 and 4 percent in 1935.⁷⁹

Producing in Japan (1930–1945)

SRW's decision to transfer production of X-ray machines to Japan was a consequence of the new competitiveness of this market, following the launch of General Electric (GE) in the production of complete X-ray equipment.⁸⁰ The upcoming end of the validity of GE's patent on the Coolidge X-ray tube in the mid-1930s and the development of German multinationals in this business led GE to become involved in the business of complete X-ray machines, a high-growth market in the 1930s.

For Siemens, the issue was not the technology but rather the market. At a very early stage, it controlled its supply of Coolidge-type high vacuum X-ray tubes. Even though its rival Allgemeine Elektrizitätsgesellschaft (AEG) obtained manufacturing rights for the European market for the GE patent shortly before World War I broke out, Siemens held some patents for Germany related to tungsten anti-cathodes necessary to the production of Coolidge X-ray tubes. Thus, the two German multinationals signed an agreement, whereby AEG could use the Siemens patents but undertook in exchange to produce a determined quantity of X-ray tubes for it.⁸¹ Until the end of the 1920s, Siemens had no problems supplying tubes. Besides, two independent manufacturers emerged as producers of high-quality X-ray tubes exported throughout the world—the companies C. H. F. Müller and Phoenix Röntgenröhrenfabriken AG. While the Dutch multinational enterprise Philips took over Müller in 1927, SRW bought up Phoenix in 1932.⁸² Founded in 1918, Phoenix above all supplied Veifa with X-ray tubes and worked essentially for Siemens after 1925.⁸³ In fact, its takeover in 1932 reflected Siemens' desire to secure its supply of X-ray tubes.

In reaction to the arrival of GE on the X-ray machines market, SRW tried to establish an international cartel with other European firms (AEG, Philips, Müller, Elema-Schönander) for a share of the world market.⁸⁴ Under this agreement, Japan belonged to the markets attributed mainly to Siemens, together with Latin America, Sweden, Norway, Italy,

⁷⁹ Dividendenzahlungen von Goto, 174, MAE.

⁸⁰ General Electric, *The Story of X-Ray* (Milwaukee, 1963), 6.

⁸¹ Siemens, *History of the House of Siemens*, vol. 2, 80.

⁸² Kees, "Tensions within an Industrial Research Laboratory," 82.

⁸³ Siemens, *History of the House of Siemens*, vol. 2, 85.

⁸⁴ Verträge auf dem Arbeitsgebiet der Siemens-Reiniger-Werke AG, around 1932, 753, MAE.

Spain, Yugoslavia, and Switzerland. According to a document dated 1934, Siemens and Philips shared the Japanese market with a relative proportion of 62 percent to 38 percent.⁸⁵ Philips and Müller could thus export in Japan, but gave no priority to their action. It should be underlined here that, unlike other electrical appliance sectors such as telephone equipment, there was no international agreement between American and German multinationals for X-ray machines, probably due to the strong competitiveness of Siemens and GE at the beginning of the 1930s.⁸⁶ Thus, Japan was a privileged area of Siemens's business, due to the European cartel agreement, but this firm faced American and domestic competitors there.

The Japanese market for X-ray machines changed radically in the 1930s when GE's patent for the Coolidge tube expired in July 1934.⁸⁷ Until then, Tokyo Electric, GE's subsidiary in Japan, had limited its involvement in the business of radiology to the import and then the manufacture of tubes, having signed an agreement in 1922 with the main Japanese manufacture of X-ray machines, the company Shimadzu Works.⁸⁸ Anticipating the end of their monopoly, GE and Tokyo Electric had begun to produce complete installations in the 1930s with the launch of the Giba 75 machine in 1932, a standardized X-ray machine that ensured the success of Tokyo Electric in the market.⁸⁹ Moreover, Tokyo Electric also founded a sales company, Nippon Medical Electric (*Nihon iryo denki*), in 1930, whose task was to market the machines imported from GE and produced in Japan by Tokyo Electric.⁹⁰ As for the production of tubes, this market saw the arrival of several newcomers after 1934. Shimadzu in particular managed to secure its supply of high-quality tubes thanks to its cooperation arrangements with the company Japan Quartz Industry Co. (*Nihon sekiei kogyo*), to which it subcontracted R&D.⁹¹

The Japanese market for X-ray machines thus became very competitive in the early 1930s due to the arrival of Tokyo Electric and the strengthening of Shimadzu's organizational capabilities. Already in 1930, the management of Siemens feared the creation of a big Japanese X-ray company based on the rapprochement between Goto Fuundo and

⁸⁵ Letter received from an anonymous correspondent in Berlin by Otto Kresta, 28 July 1934, 770-2, MAE.

⁸⁶ For the case of telephone equipment, see Kudo, *Japanese-German Business Relations*, 165-217.

⁸⁷ *Shimadzu Seisakujo shi*, 378.

⁸⁸ *Ibid.*, 45. Goto, *Nihon hoshasen igakushiko*, vol. 1, 179, cites 1920.

⁸⁹ Tokyo shibaura denki, *Tokyo shibaura denki kabushiki kaisha 85 nen shi* (Tokyo, 1963), 708.

⁹⁰ *21 seiki he no kakehashi* (Tokyo, 1998), 8.

⁹¹ *Shimadzu Seisakujo shi*, 378.

Shimadzu.⁹² In November, the German headquarters explained to Kresta its will to become closer to Goto Fuundo in order to avoid this company drifting from SRW: “We consider correct to tie up now, and for as long as possible, with Goto for production.”⁹³ That was done two years later. Thus, the relocation of part of production to Japan during the first part of the 1930s was not the result of an expansion strategy, but rather a reaction to the emergence of competitive newcomers. As happened with telephone equipment, where production was moved in 1932, an external push factor led Siemens to engage in technology transfer.⁹⁴

The Establishment of Goto Fuundo Manufacturing (1932–1934).

In June 1932, SRW signed a contract with Goto Fuundo in Japan to set up a joint venture, Goto Fuundo Manufacturing (GFM), confirmed by the German management in November 1933.⁹⁵ Afterwards, SRW continued to support the development of Goto Fuundo by participating in various capital increases (July 1938, February 1939, September 1939) and by granting a loan of 50,000 yen (April 1937).⁹⁶

The objective of the new company GFM was, according to its statutes, “to produce electro-medical apparatus, light therapeutic apparatus and Roentgen apparatuses for medical purposes” except “high-vacuum or gas discharge tubes.”⁹⁷ The capital of the new enterprise amounted to 400,000 yen, shared equally between SRW and Goto Fuundo. SRW received its shares in exchange for the free provision of licenses and know-how. It undertook to give GFM the necessary patents and blueprints for its devices, as well as practical assistance through some engineers.⁹⁸ GFM obtained the exclusive and free license for the production in Japan of SRW’s X-ray machines. As for Goto Fuundo, it obtained its shares against the provision of its factory and some cash. The company GFM was established at the same address as Goto Fuundo and naturally took over its production facilities.

The management of GFM depended rather on Japanese managers linked to Goto Fuundo. Its board of directors was composed of three members, two of whom were designated by Goto Fuundo and one by

⁹² Letter from SRW to Otto Kresta, 4 Nov. 1930, unmarked folder, MAE.

⁹³ Ibid.

⁹⁴ In the case of telephone equipment, this push factor was the intervention of the Ministry of Communications, which decided at that point to give priority to products made in Japan rather than imports. Kudo, *Japanese-German Business Relations*, 215–17.

⁹⁵ Agreement between Goto Fuundo and SRW, 30 June 1932–25 Nov. 1933, unmarked folder, MAE. The agreement was signed in 1932 in Japan and countersigned in Germany in 1933.

⁹⁶ Various financial statistics on Goto, 1935–1943 and *Verzinsung des Darlehns*, 1935–1944, 174, MAE.

⁹⁷ Agreement between Goto Fuundo and SRW, 30 June 1932–25 Nov. 1933, art. 3.

⁹⁸ Ibid., art. 4.

SRW, as well as a Japanese citizen inspector appointed by SRW.⁹⁹ Goto Fuundo was in charge of the management of GFM and undertook to pay a minimum dividend of 6 percent and guaranteed Siemens 10 percent royalties on the sales and minimum annual orders for 300,000 yen, instead of 200,000 yen.¹⁰⁰

However, SRW was not only looking for an agreement that could ensure good financial results. Its concern was above all to control—and limit—technology transfer. In particular, the German multinational wanted to control potential innovations realized within GFM as well as possible cooperation arrangements with other firms. The 1932 agreement on the joint venture included a long article on innovation, which mentioned notably that “inventions and other propositions for improvements proceeding from the supervisors or employees shall be communicated by [the] Factory to SRW immediately, at the latest by the time when the protection rights for such inventions or improvements are applied for in Japan. To utilize such inventions and improvements and to acquire protection rights outside of Japan, SRW is authorized exclusively.” Moreover, it planned that the “Factory shall not acquire the rights of other inventions and protection rights unless SRW explicitly agrees to each such case. In case SRW expresses its agreement, it will advise [the] Factory as to the acquisition. [The] Factory shall do its best to help SRW acquire these rights for utilization outside of Japan under at least the same advantageous conditions. It depends on the decision of SRW whether or not it accepts the conditions.”¹⁰¹

The prudence of SRW can also be observed in the transfer of production, limited as much as possible. The GFM production site was the workshop that Goto Fuundo had possessed in the Tokyo area since 1919, where it produced spare parts for X-ray machines and other medical devices.¹⁰² After 1934, this factory was not only the production center of SRW products in Japan, but also the place where Goto Fuundo continued to manufacture appliances and instruments on its own, an ambiguous situation that led to problems between Goto Fuundo and Siemens after World War II. When Kresta came to Berlin in December 1933, he spoke with two SRW representatives about launching a first production program in Japan, for a value of some 100,000 marks and a limited volume of machines (thirty small X-ray machines, ten heliophos X-ray generators, twenty diathermy machines, and various other appliances).¹⁰³ The discussions showed that the transfer of production was restricted to a

⁹⁹ *Ibid.*, art. 12.

¹⁰⁰ *Ibid.*, art. 11.

¹⁰¹ *Ibid.*, art. 16.

¹⁰² Letter from Goto Fuundo to an unknown recipient, 13 June 1949, CPC 41476, SCAP.

¹⁰³ Protokoll über eine Besprechung—Fabrikation in Japan, 7 Dec. 1933, unmarked folder,

maximum, that is, to machines whose import to Japan was no longer competitive. These smaller devices, which were meant for the army, the navy, and private hospitals, had a high-growth potential due to increasing demand, but imported products were too expensive because of the high exchange rate and the cost of foreign currencies after the devaluation, combined with the cheap labor in Japan. Siemens then decided to assemble these machines in the GFM factory with some parts imported from Germany and others produced there. However, the company postponed the launch of production for about a year due to some negotiations with Tokyo Electric/GE. Rather than expanding the transfer of technology and production towards Japan, the management of Siemens attached great importance to international agreement, as in other sectors of the electrical-appliances business. GE was not a member of the international cartel led by Siemens and AEG, and the negotiations engaged with Tokyo Electric reflect a desire to reach an agreement on controlling the spread of the technology and the possible emergence of competitors.

At the same time that the production program within GFM was launched, the SRW management began negotiations with Tokyo Electric in early 1934. The director of Tokyo Electric, Yamaguchi, approached Siemens in the spring of 1934 on the occasion of a trip to Berlin. He proposed to take over the production in Japan of SRW's medical devices.¹⁰⁴ Kresta proposed to his German management to found a new joint venture company with Tokyo Electric and Goto Fuundo, endowed with a capital of 2.7 million yen, split between Tokyo Electric (44.4 percent), in charge of production, Goto Fuundo (29.7 percent), responsible for marketing, and SRW (25.9 percent), which would supply patents and brands.¹⁰⁵ However, Yamaguchi set some conditions to this agreement: he wanted to centralize all production at Tokyo Electric's factory and transfer Goto Fuundo's workshop there.¹⁰⁶ Both partners did not accept these conditions. On the one hand, SRW claimed a negotiation with GE on the global scale and a general agreement between both multinationals. Goto Fuundo, on the other hand, would not agree to give up its production facilities.¹⁰⁷ The impossibility of reaching a satisfactory agreement finally led SRW to envisage transferring production in Japan within GFM.

The Growth of Production in Japan (1935–1940). The production of SRW machines under license really got underway in 1935.

¹⁰⁴ Letter from Sehmer (SRW Berlin) to Otto Kresta, 9 May 1934, 770-2, MAE.

¹⁰⁵ Letter from unknown correspondent (Berlin) to Otto Kresta, 28 July 1934, 770-2, MAE.

¹⁰⁶ Letter from Otto Kresta to SRW, 28 July 1934, 770-2, MAE.

¹⁰⁷ Letter from unknown correspondent to SRW, 28 Aug. 1934, 770-2, MAE.

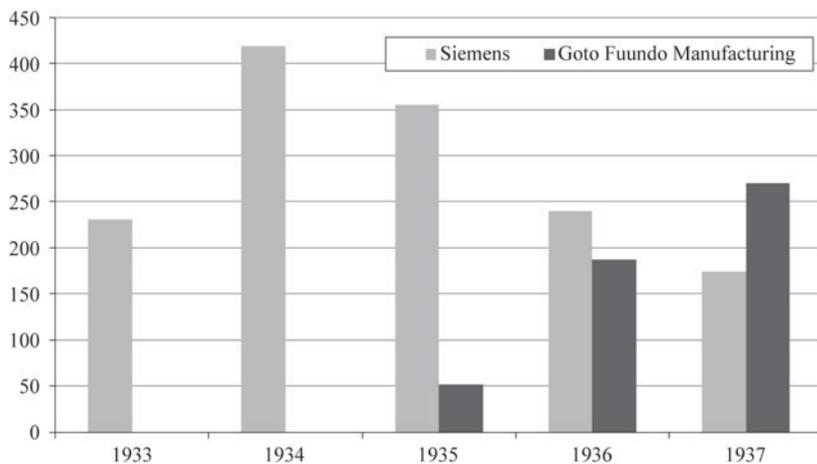


Figure 2. Gross sales of Goto Fuundo by origin of products, in thousands of yen, 1933–1937. Note: Unknown after 1937. (Source: Siemens Corporate Archives, Med-Archiv Erlangen, un-marked folder, Gegenwärtiger Stand des SRW-Geschäfts in Japan, 4 Jan. 1939.)

According to a document on the GFM origin of products between 1933 and 1937, no production took place in Japan in 1933 and 1934 (see Figure 2). However, once SRW decided to produce X-ray machines in Japan, the transfer was quick, as it was observed in the case of Fuji Electric since the mid-1920s.¹⁰⁸ The value of products imported from Germany and sold by Goto Fuundo declined steadily from 1934 onwards, dropping from 419,000 yen in 1934 to 174,000 yen in 1937, while the value of in-house production increased sharply, from a mere 52,000 yen in 1935 to 270,000 yen in 1937. In relative numbers, the share of domestic production went from 12.8 percent in 1935 to 43.8 percent in 1936 and 60.8 percent in 1937.

Moreover, together with this growth of manufacturing in Japan, the increase of machines, whose production GFM took over, also characterized the transfer of production. The evolution of the production programs between 1935 and 1938 shed a light on this phenomenon (see Table 1 below). In 1935, GFM produced little more than orthoscopes (one among the complete sets of radiology equipment marketed by Siemens). From the following year onwards, however, the variety increased, not only different kinds of X-ray machines but also diathermy devices. Thus, a real technology transfer, after volume of parts sent by SRW stagnated after 1934, accompanied the transfer of production. The

¹⁰⁸ Udagawa, “Senzen Nihon no kigyo keiei to gaishikei kigyo,” 25. See also Watanabe, “A History of the Process Leading to the Formation of Fuji Electric.”

Table 1
Number and Kinds of Machines Produced by GFM, 1935–1938

	1935	1936	1937 (second semester)	1938 (first semester)
Ultratherm (diathermy device)	—	17	18	15
Heliolox 300 mA 60 kV (X-ray machine)	—	—	—	3
Heliodor Duplex (surgery appliance)	—	4	—	—
Tuto Heliophos (X-ray machine)	1	5	2	3
Orthoscope (X-ray machine)	22	17	—	4
Pantoscope (X-ray machine)	—	1	6	5
Tele-Pleoscope (X-ray machine)	—	1	—	2
Tele-Pantoscope (X-ray machine)	—	4	7	4

Source: Siemens Corporate Archives, Med-Archiv Erlangen, unmarked folder, Gegenwärtiger Stand des SRW-Geschäfts in Japan, 4 Jan. 1939.

value of the parts supplied to GFM rose to 35,800 marks in 1935, 22,600 in 1936, and 33,000 in 1937.¹⁰⁹ Together with the growth of production, GFM did not strengthen its dependency on SRW but rather internalized some resources.

However, despite this collaboration and the production in Japan, SRW and Goto Fuundo registered only a very small number of patents, although the products were used in Japan. For the years 1900–1945, their main rivals Shimadzu (thirty-seven patents registered in the field of X-ray machines) and Tokyo Electric (seventy-one patents) made frenzied use of legal protection for their technologies in Japan. In the same period SRW registered only six, all between 1926 and 1933, and its partner Goto Fuundo only two, one in 1927 and one in 1939.¹¹⁰ This feature of SRW can be surprising, as Siemens in other cases relied heavily on the patent system.¹¹¹ As a result, it was thus legally possible to copy most of SRW's X-ray machines in Japan. For SRW, this strategy embodied the technological competitiveness Siemens enjoyed in the field of X-ray machines and stemmed from a desire to dominate the market by the excellence of the products: as it transferred the production and assembly of consistently the best quality X-ray machines to GFM, SRW would thus prevent their copy by domestic manufacturers

¹⁰⁹Gegenwärtiger Stand des SRW-Geschäfts in Japan, 4 Jan. 1939, unmarked folder, MAE.

¹¹⁰Database of the Industrial Property Digital Library, www.ipdl.inpit.go.jp/homepg.ipdl (accessed Feb. and Mar. 2010) and Japan Patent Office 1958.

¹¹¹Rudolf Boch, ed., *Patentschutz und Innovation in Geschichte und Gegenwart* (Frankfurt am Main, 1999).

that did not have the necessary organizational capabilities to develop such equipment. According to a report by the Tripartite Commission dated 1954, this was a deliberate strategy of SRW: "It might have been the intention of SRW to keep Goto Factory in possession of devices always new and up-to-date as a precautionary measure to prevent competing companies from imitating devices."¹¹² The testimony of Goto Fuundo's board of directors runs along the same lines. In a letter sent to the Ministry of Finance in February 1954, they wrote:

Our Company could manufacture and sell [the] newest SRW type apparatuses by copying at the factory those equipments which were imported as goods from SRW under the terms of [the] sales agreement. Our Company took pride in the novelty and superiority of our products as compared with articles of other makers. This was acknowledged by all persons interested in this line of business, whereby Our Company was placed in a position to compete with any other maker at a margin sufficient to pay for the license fee.¹¹³

Despite the development of its technological facilities, GFM still depended on SRW for some parts of the production process, probably with regard to practical know-how and tacit knowledge.¹¹⁴ It tried to register some patents for copies of SRW machines in Japan but never succeeded: "The application has always been rejected on the ground that the said equipment was a fact widely known to the public."¹¹⁵ Besides, Goto Fuundo was not able after 1945 to successfully develop its own machines without the support of SRW.

A look at gross sales for GFM between 1936 and 1945 shows two distinct phases in the development of the firm (see Figure 3 below). First, the years 1936–1940 are characterized by the transfer of production and of technology from SRW, with gross sales that rose from 137,000 yen in 1936 to 326,000 yen in 1939. The stagnation observed in 1940 resulted quite obviously from the severance of commercial relations with SRW due to the war in Europe. Indeed, the last delivery of X-ray machines and parts from Germany occurred in September 1940.¹¹⁶ Despite the military and political alliance between Germany and Japan, the conflict weakened commercial relations between both countries, and strong rivalry continued between the firms of both countries.¹¹⁷

¹¹² Disposition of vested interests formerly owned by Siemens-Reiniger-Werk AG under license agreement with K.K. Goto Fuundo, 5 Mar. 1954, CPC 34029, SCAP.

¹¹³ Letter from Goto Fuundo to the Minister of Finance, 5 Feb. 1954, CPC 34029, SCAP.

¹¹⁴ This can also be observed in the chemical industry, for example. Kudo, *Japanese-German Business Relations*.

¹¹⁵ Letter from Goto Fuundo to an unknown recipient, 13 June 1949, CPC 41476, SCAP.

¹¹⁶ Letter from Goto Fuundo to the Minister of Finance, 5 Feb. 1954.

¹¹⁷ Kudo, Tajima, and Pauer, eds., *Japan and Germany*.

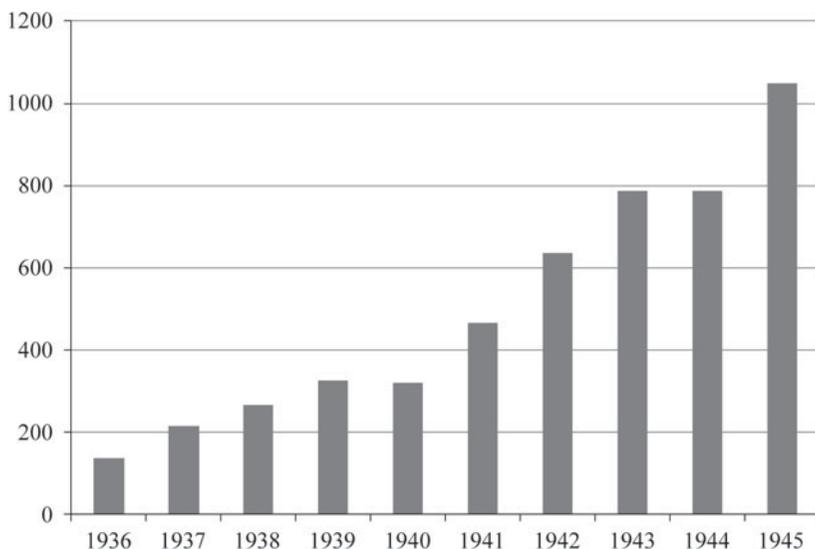


Figure 3. GFM gross sales, in thousands of yen, 1936–1945. Note: The values are different from those given in SRW document used for Figure 2 but the trend and the order of magnitude are similar. (Source: National Diet Library, Tokyo, Archives of the Supreme Commander of the Allied Powers, CPC 41474, Siemens-Reiniger-Werke, Cost Accounting, no date.)

These four years of cooperation with SRW, 1936–40, had a positive impact on Goto Fuundo's ability to compete, which was marketing GFM production. While its dividend rate was dropping in the years 1930 to 1934, it entered a new period of growth (5 percent in 1937, 7 percent in 1938, and 8 percent since 1940).¹¹⁸ However, in comparison with its main rival on the Japanese market, Shimadzu, GFM's growth was limited. While Shimadzu saw gross sales for its X-ray machines division go up from 1.7 million yen to 2.5 million yen in 1937, sales by Goto Fuundo of SRW products only rose from 407,000 yen to 444,000 yen over the same period.¹¹⁹ These numbers apparently include only SRW products (imported from Germany and manufactured by GFM). Overall gross sales of Goto Fuundo, consisting as well of products made in-house and goods supplied by firms other than SRW, must have been higher, but there are no supporting documents. However, for SRW, which distributed all its production in Japan through Goto Fuundo, this comparison with Shimadzu reveals a situation on the Japanese X-ray machines

¹¹⁸ Dividendenzahlungen von Goto, 1927–1943, 174, MAE.

¹¹⁹ Interview with Shimadzu Manufacturing Co. Ltd, 26 Oct. 1945, USB-12, M1654-7, SCAP; Gegenwärtiger Stand des SRW-Geschäfts in Japan, 4 Jan. 1939, unmarked folder, MAE.

market that was completely different to what it was before World War I: between 1914 and 1935, SRW moved from a virtual monopoly to a second-rank competitor.

For Goto Fuundo, the end of commercial relations with SRW in 1940 did not put an end to the growth of the firm, which continued during the war thanks to strong demand for X-ray equipment from the army and the navy. GFM's gross sales increased steadily despite the cut-off of supplies of German parts and machines, peaking at one million yen in 1945. The value of Goto Fuundo's gross sales during these years is not known, but this firm continued to pay a dividend of 8 percent, which shows that it enjoyed good business conditions.¹²⁰ However, this development could not reverse the balance of power with Shimadzu: gross sales for its X-ray machines division amounted to 6.7 million yen in 1943 and 6.2 million yen in 1944.¹²¹

Conclusion

The involvement of Siemens in the Japanese market for X-ray machines highlights an evolution characterized by both the firm's global strategy and the particular conditions of the Japanese market. The case study analyzed here confirms Kudo Akira's point of view that German enterprises favored an export strategy "as far as they were able."¹²² The comparison with the telephone-equipment business, in which Siemens was also involved, is striking. In both cases, despite the realization of a direct investment in Japan, Siemens tried to escape as much as possible the transfer of technology, giving preference to cartel arrangements. For both telephones and X-ray machines, even if demand was growing apace after the Great Kanto Earthquake of September 1923, the German multinational did not seize this opportunity to relocate production facilities and benefit from this boom. The desire to control the market and to limit the spread of technology through cartel agreements was an important factor. When facing the emergence of domestic competitors in the case of X-ray machines, Siemens tried to reach an agreement with GE, even after it officially founded a joint venture for manufacturing.

Another aspect is the relative low importance of the Japanese market for Siemens. Indeed, sales in Japan amounted to only 0.2 percent of SRW's gross sales in 1925 and 0.7 percent in 1933.¹²³ The German firm enjoyed a dominant position on the European market, where

¹²⁰ Dividendenzahlungen von Goto, 1927–1943, MAE.

¹²¹ Interview with Shimadzu Manufacturing Co. Ltd., 26 Oct. 1945.

¹²² Kudo, *Japanese-German Business Relations*, 218.

¹²³ Umsatz und Bestelleingang (Mappe 1), SCA, 18500.

it was able to sell large amounts of X-ray machines, as a result of which the German managers may have viewed the Japanese market as secondary. In this sense, it did not appear particularly risky for Siemens to keep a strict position regarding technology transfer towards Japan for X-ray machines. In any case, Japan was a very small market, and Siemens felt no reasonable justification for giving technology to local manufacturers.

Last but not least, Siemens did not understand, or minimized, the potential for growth of the Japanese medical market, which can explain the lack of commitment in terms of marketing. The particular conditions of the Japanese health-care system undoubtedly had a key influence on the growth of domestic competitors. Unlike the Western countries, the Japanese health-care system has been based, since the 1880s, on an extremely dense network of small private hospitals.¹²⁴ This particular structure exerted two influences on the medical-appliances market. First, the keen competition between health-care institutions obviously favored the diffusion of new technologies that could have been used as distinguishing features and comparative advantages. Second, the high number of health centers ensured important outlets for medical-appliance makers due to the high absorption capacity of the health-care system. In 1960, there were a total of 6,094 hospitals—of which 74.2 percent were private—with 113 beds on average, together with 59,008 clinics—nearly all private—with 3 beds on average.¹²⁵ At the time, 90.1 percent of hospitals and 56.6 percent of clinics were equipped with X-ray installations.¹²⁶ Thus, viewed from a German perspective, Japan was probably considered an emerging market in the beginning of the twentieth century. But it had a fast-growing capacity owing to the structure of the medical system. This made it possible for local manufacturers like Shimadzu to establish themselves and grow on the domestic market without any relationship with the electric-appliance industry's multinational enterprises (MNEs). Finally, after World War II, it helped Japan become the country with the highest density of medical-imaging devices in the world.¹²⁷

Beyond Siemens, the case analyzed here sheds a new light on the difficulties encountered by MNEs in Japan during the interwar period. While scholars tend to stress the impact of institutional factors that

¹²⁴ Ikai, *Byoin no seiki no riron*.

¹²⁵ Akira Sugaya, *Nihon no byoin: Sono ayumi to mondaiten* (Tokyo, 1981). According to the definition established in 1948 by the Ministry of Health, hospitals (*byoin*) are health centers with twenty or more beds, while clinics (*shinryujo*) have fewer than twenty beds.

¹²⁶ Ministry of Health, *Iryo setsubi chosa* (Tokyo, 1960).

¹²⁷ Masao Onishi, *Hoshasen iryo: CT shindan kara kanwa kea made* (Tokyo, 2009),

Japanese authorities set up in the 1930s against foreign firms, like the various industrial laws restricting the activities of MNEs, this classical approach cannot explain the incapacity of Siemens to establish itself on the Japanese market for X-ray equipment.¹²⁸ Except for raising custom duties, which was a worldwide phenomenon after World War I, Japan adopted no particular protectionist measures to support domestic X-ray machine makers against foreign competitors. The story exposed in this article is closer to the perspective recently proposed by Takeo Kikkawa.¹²⁹ Citing the example of Western oil companies in Japan during the 1930s, he emphasized MNEs' lack of knowledge regarding the Japanese market and their inability to react properly to its changes. During the inter-war years, Japan was among the fastest-growing emerging markets of the world. The global technological advantage of a multinational like Siemens was not sufficient; understanding the structure and functioning of Japan's markets was more crucial for an MNE to be successful.

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¹²⁸ Mason, *American Multinationals and Japan*, 1992.

¹²⁹ Takeo Kikkawa, *Senzen nihon no sekiyu kobosen* (Tokyo, 2012).