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German-Japanese Cooperation in the Japanese Telecommunication Industry : The Case of Siemens, Fuji Electric and Fujitsu

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German-Japanese Cooperation in the Japanese Telecommunication Industry —The Case of Siemens, Fuji Electric and Fujitsu—

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1. INTRODUCTION

Many new communication technologies and services, such as fax, Internet and e-mail rely on the comparatively old technology of the telephone. Internet connections and many of the so-called multimedia services, for example, are transmitted mostly via telephone lines, which are either ordinary copper wires or advanced high-speed glass fiber lines. The telephone network, once part of the general infrastructure, is becoming the fundamental infrastructure of the new information society and for future economic growth. Since the merging of semiconductor, data processing and communication technology at the end of the 1960s, the speed, quantity and quality of telecommunication has grown exponentially, reshaping work and social patterns.

However, the beginning of modern telecommunications by electrical devices dates back to the Meiji and Taishō period, when the infrastructure for the telephone was created. Many of the companies that were involved in the manufacturing of telecommunication equipment at that time are still in the business today. In Germany, the primary example is Siemens, the giant electro-technical company, while in Japan, it is Fujitsu, which is today one of the largest Japanese high-tech companies in data processing, telecommunications and semiconductors. Indeed, Fujitsu was established by Siemens in cooperation with Furukawa. Fujitsu is one of the examples of how the origins of Japanese telecommunication equipment manufacturing are related to foreign technology and foreign investments during the first decades of this century.

This paper focuses on the beginning of the telephone manufacturing industry in Japan. It analyzes the development of this industry and investigates more particularly the cooperation of Siemens and Furukawa in creating the telecommunication equipment manufacturing company Fuji Denki, which later became Fujitsu and which stands as an example of foreign and Japanese cooperation in this industry. This discussion will conclude with an evaluation of Fujitsu's technological resources of telecommunication equipment manufacturing before World War II as a base for the further development into electronic data processing after the war.

2. THE DEVELOPMENT OF THE TELEGRAPH AND TELEPHONE BUSINESS IN GERMANY AND JAPAN

Previous to the telephone, the telegraph was the device for electrical telecommunication. With the establishment of the "Telegraphen-Bauanstalt von Siemens und Halske" in Berlin in 1847, the world's oldest still existing electrical company was founded. Werner Siemens (1816-1892), a former Prussian military officer, developed a prototype British telegraph into a working communication device in the 1840s; he followed this with the landmark discovery in 1864 of the electromagnetism principle by James Clerk Maxwell, which provided the decisive impulse towards the efficient conversion of mechanical energy into electrical energy and vice versa [WILHELMS 1982: 59]. Siemens' electrical research and its applications drew worldwide attention; for example, the company's 11,000 kilometer-long Indo-European Telegraph-Line connecting Calcutta and London, which was constructed between 1868 and 1870.

Siemens' business expanded rapidly, and by World War I, the firm had become the world's largest electro-technical company [SIEMENS 1987: 11-14]. While Germany struggled to become a leading economic and military power among European nations, Japan still lacked the institutions and the political regime for industrialization in 1861, when the first Siemens telegraph arrived with the Prussian East Asia Expedition. After the 1868 Meiji Restoration, small efforts by the former domains to create modern industries were accelerated by a new central government, willing to undertake any necessary sacrifice to modernize and industrialize the country. One of the measures to modernize the country was to establish a nationwide communication infrastructure with British assistance. In 1869, thirty years after Siemens installed the first telegraph connection in Germany between Frankfurt am Main and Berlin, the first public telegraph service was installed in Japan, connecting Tokyo with Yokohama. Siemens Brothers (London) delivered sixty telegraphs for the new service [RAIBLE 1987: 20]. By 1880 telegraphy connected all major Japanese cities [PAUER 1983: 63].

The telephone was introduced in Japan quite soon after its invention by Alexander Graham Bell in 1876. Less than twenty months later, it was brought to Japan by the Ministry of Industry (*Kōbushō*) and put into use by the Osaka Police

Department. Soon, principal government ministries operated phones for limited purposes [MASON 1990: 176]. In 1890, ten years after the first German public phone service had been installed in Berlin, a public telephone service was inaugurated in Japan. Initially, the service had only 240 subscribers, but by 1900 the number reached 19,000. The expansion of the telephone and its availability had been increased by a national program in 1896, creating a limited phone system for use by public officials, important companies and some wealthy individuals [MASON 1990: 177, 179]. Still it should be noticed that in spite of the rapidly developing telephone, the telegraph remained the main form of electrical telecommunication until World War I.

As in many other fields, the Japanese government had to decide among several general strategies for the developing telegraph and telephone services to follow. While for example these services were operated by the private sector in the United States, in Germany, as in many other European countries, information transmission was seen as a natural monopoly of the state. The Japanese government chose to follow the German example, and the operation of telegraph and telephone services became a quasi state monopoly in 1889; it was finally stipulated as a state monopoly in 1900 by the Telegraph Law (*Denshin-hō*) and the Wireless Telegraph Law (*Musen-denshin-hō*) (1915). Public wire and wireless communication services remained a state monopoly for one hundred years in Japan, ending with the liberalization of the telecommunications market in 1985.

3. SIEMENS AND THE JAPANESE MARKET BEFORE WORLD WAR I

After exporting to Japan through a German trading company, Siemens sent its first business representative to Japan in 1887. Although Siemens exported many types of electrical machinery and devices to Japan, its main business was in heavy electrical machinery.¹⁾ At that time the Japanese electric industry was developing at a remarkable speed. For example, in 1873 the first telegraphs were manufactured, in 1883 the first generator for industrial purposes was built, and in 1890 electric bulbs were produced by Hakunetsu-sha (renamed Tokyo Denki in 1899). While Japanese companies could meet some of the demand for telegraph communication devices, the production of telephones proved far more difficult. Until 1885, Japanese government workers produced a total of 252 telephone sets based on imported models. Private companies like Oki Company (Meikōsha, later Oki Denki) began to manufacture telephones but they too were initially unable to meet the demand and to equal the quality of imported phones [MASON 1990: 176]. Although telephone technology diffused rapidly in Japan, foreign imports were necessary in order to keep up with the developing telephone technology.

1) Heavy electric technology is the generating, distribution and utilization of electrical energy. Light electrical technology is the creation, transmission, processing and storage of messages in the form of electrical signals.

Most of the imports were from the U.S., especially from Western Electric, the manufacturing branch of Bell (i.e., AT & T). In 1899, Western Electric formed the first-ever joint venture in Japan by joining with Sumitomo to create Nippon Denki (NEC) for the purpose of manufacturing telephones. Another American company, General Electric, invested in Tokyo Denki (1905) and in Shibaura Seisakusho (1910).²⁾ NEC received many government orders, especially during the Second Telephone Expansion Program (1907–1912). Oki, a wholly Japanese manufacturer, tried to compete against NEC in the telephone business, but it lacked the research and development capabilities to keep abreast of the rapid changes in telephone technology [CHOKKI 1990: 207].

In the first decade of the twentieth century, the Japanese electro-technical industry did gain the ability to compete with Western companies in such low technology products as light bulbs and small-scale generators [TAKENAKA 1992: 142–143]. But as in other key industries, Japan remained in need of technology and know-how from abroad for more advanced products.³⁾ This was especially true for the electrical machinery industry, where Siemens built a leading position. Siemens' first major business successes in Japan were contracts in 1887 with Furukawa Ichibei, one of the many major Japanese entrepreneurs at that time, for electrification of his Ashio mining complex. Siemens steadily expanded its business; in 1905, it formed Siemens Schuckert Denki K. K. (SSDKK), which gained a major share of the power generating machine business until the World War I [TAKENAKA 1989: 337]. Although it exported light electrical products to Japan, Siemens was outperformed in the telephone and telegraph business by American companies, such as Western Electric and their Japanese branch NEC or local Japanese companies like Oki. Nonetheless, time and again Siemens was able to acquire orders for telecommunication equipment, such as those of the Japanese Navy in 1912/13 [SIEMENS 1987: 25].

Japanese sales were vital to Siemens' East Asia business, amounting to more than 50% to the company's exports to this region in the last years before World War I. SSDKK in Japan also oversaw Siemens' business in China and gave technical support for operations in neighboring countries [TAKENAKA 1989: 336–337].

In the last years before World War I, competition in the Japanese market for electro-technical products became so fierce that Siemens began searching for a Japanese partner to start local production. For various reasons, the company declined a joint venture offer from its old business partner, Furukawa, in 1907. Talks with Sumitomo were finally terminated in 1913, when the disclosure of the

2) Later in 1939, Tokyo Denki and Shibaura Seisakusho merged into Tokyo Shibaura Denki, or Toshiba.

3) Rapid progress was made especially in switching systems, based on the invention of Almon B. Strowger in 1891. Electromechanical switching shortened the time for connecting phone calls.

company's extensive gifts to Japanese naval officers for business orders led to the "Siemens Scandal," which discredited the Japanese government and finally caused the cabinet to resign.

This scandal damaged not only severely the reputation of Siemens in Japan, but contributed also to the installment of a pro-British government and thus was partially responsible for Japan joining the Allies at the outbreak of World War I. Siemens' business activities in Japan during the war were quickly hampered, and indeed they concluded in 1917 with the closure of SSDKK.

4. THE INTERWAR PERIOD

The First World War led to a huge expansion of the Japanese industry because Japanese products were used as substitutes for foreign products both in Japan and in neighboring countries. However, the electro-technical industry, like other Japanese industries, was not able to maintain its quality standards of 1914 because it had been cut off from its foreign supply and know-how. After 1918, electrical machines and devices had to be imported again. Furukawa, which had undergone major expansion and diversification, was interested in entering the electrical product market via a foreign partner; in 1919, it again approached its old business partner Siemens.

Siemens was now in a very different position. Like the German electric industry and the German industry in general, it had lost all its foreign investments and its foreign patents. In addition, it faced a shortage of raw materials, closed foreign markets and restrictions mandated by the Treaty of Versailles, which limited the production of military goods. Still, Siemens enjoyed a sound technology base and the market leader position in Germany. Besides reopening its Japanese branch SSDKK in 1919, it decided to start local production. Negotiations between Furukawa and Siemens lasted for almost three years until a final agreement was achieved to set up a joint-venture production company for heavy and light electrical products. This delay was partly caused by Furukawa's financial difficulties and its decision to purchase patents from Western Electric for telephone manufacturing. At the same time, Furukawa created Furukawa Denki Kōgyō K. K. in 1920, which was to manufacture cables and heavy electric machinery.

On 1 June 1921, a contract between Siemens and Furukawa was concluded for a joint production and retail company for all types of electrical machinery and appliances. However, the Siemens negotiating delegation in Japan did not know that the German head office had reached a cartel agreement with Western Electric on the same day. This cartel restricted Siemens' activities in the Japanese telephone market, giving Western Electric a 90% share in the Japanese telecommunication equipment market; Siemens was left with a 10% share and with restrictions on direct local investment in telephone equipment production.

The Siemens-Western cartel, basically a renewal of the prewar international cartel, was set to expire in 1935. The agreement left no opportunity for production

of telephone equipment by a Furukawa-Siemens joint venture, which Furukawa was very much interested in [KUDŌ 1992: 177]. Complicated consultations between both companies led finally to a revised agreement in March 1922 for establishing a joint venture for the production, assembling and sales of engines, generators, and telegraphs. Siemens was to provide technology, patents, research results and manufacturing technology to the new company. The chairman of the board and the managing directors were to be delegated from Furukawa, while the technical directors and factory managers would be sent by Siemens. Siemens was given exclusive rights to the Chinese market [FTSKK 1964: 7].

Siemens evaded the stipulations of the cartel agreement with Western Electric for two reasons; first, the telephone equipment was imported from Siemens and only retailed by the new company, and also the German company held only a 30% capital share in the new company. Thus, legally the firm was not a fully fledged subsidiary but rather an affiliated company [KUDŌ 1992: 180]; Siemens was a minority shareholder and restricted to the technical aspect of the business of Fuji Denki through the provision of engineers and technology. Still, Siemens exerted great influence because the venture relied entirely on the importation and distribution of its technically advanced products.

The name Fuji was chosen as an acronym of *fu* (Furukawa) and *ji* or *si* (Siemens). By tragic misfortune, Fuji Denki Seizō K. K. began its operation on 1 September 1923, the day of the Great Kanto Earthquake. All of the Siemens' imported machinery and production equipment waiting in the port of Yokohama for the Fuji Denki factory in Kawasaki was destroyed, as was the Furukawa Denki factory itself. The earthquake delayed the company's full operation until April 1925. Furukawa Denki transferred production of telephones completely to Fuji Denki, and SSDKK shifted all of its telephone retail functions to the new company [KUDŌ 1992: 193].

The Great Kanto Earthquake had also seriously damaged the Japanese telephone infrastructure. Since 1900 telephone subscriptions had risen enormously, and a telephone infrastructure had expanded throughout the country. Still, the Japanese telephone network lacked sophisticated automatic dial systems, which had already been installed in countries like the U.S. and Germany. The Japanese Ministry of Communications (*Teishinshō*) therefore used the post-earthquake rebuilding opportunity to modernize and extend the telephone communications network. This created huge opportunities for the telephone equipment makers in Japan, especially for Fuji Denki and NEC. Both companies were able to import automatic dial switchboards from their foreign shareholders, Siemens and Western Electric. Purely Japanese makers such as Oki still lacked the production and technical knowledge, as well as the licenses and patents, to produce such advanced equipment.

Fuji Denki, however, could only partially capitalize on these new business opportunities in the Japanese telephone market. From 1926 to 1936, it ranked third in the market, increasing its market share from 2.4% to 11.9%, but it still

lagged behind NEC (whose share fell from 68.4% to 54.5%) and Oki (from 22.3% to 16.8%). Oki's share was remarkable for a Japanese company that relied only on its own technological resources. Still, in the market for switchboards, Fuji Denki mainly competed with its imported Siemens HDS-systems against NEC's Strowger-type systems imported from Western Electric. Although the Siemens system was technically superior, its higher prices were not competitive with the Strowger models. This created some friction between Siemens and Furukawa, which demanded cheaper local production of the Siemens' product. This tension increased when NEC received government subsidies in 1927 for domestic production of smaller automated switchboards, and when Oki started to import General Electric switchboards in 1929.

In 1932 Siemens finally approved local production of its switchboards to begin the following year. This decision was prompted by the new policy of the Teishinshō to substitute imports by local production. In 1931 Fuji Denki was warned by the ministry that the company would be barred from public orders if the production of automatic switchboards was not localized [WADA 1957]. Furukawa used this to demand a halt to Siemens' imports, but Siemens refused, stating that the company was obliged to import Siemens' products [KUDŌ 1992: 199]. However, the ministry's pressure and the demands of Furukawa and Fuji Denki itself to localize production did soon lead to a sharp decline in the share of Siemens' products in the Fuji Denki sales from 93.6% in 1923 to only 17.7% in 1935. The declining importance of retailing Siemens' products made Fuji Denki more and more independent as a producer. From the mid-1930s, Siemens' role was more or less limited to providing Fuji Denki with technical assistance (licenses and manufacturing techniques).

Relations between Siemens and Furukawa had also worsened because of the more general negative performance of Fuji Denki. The company posted losses for most years until 1932, especially during the economic depression beginning in the late 1920s, when orders from the ministry declined. The number of highly paid German engineers was slashed from 29 to 8, and in 1930 Fuji Denki laid off 16% of its workforce [FDSKK 1957: 29-31]. As in other industries, Japanese companies, especially Oki, were able to step up their technological level by acquiring foreign patents and gains in manufacturing know-how, thereby stiffening competition against higher-priced imports. Fuji Denki did finally improve its sales and profitability when orders from the Teishinshō start to rise again in 1932, reflecting new state expenditures. From 1928, the government had also encouraged cartels in various industries to decrease competition between Japanese companies [JOHNSON 1982: 101-104], and Siemens encouraged Fuji Denki's participation in various cartels. The German company itself also participated in various international and national cartels [FELDENKIRCHEN 1988: 27-28]. After Fuji Denki started local production of the automatic switching systems in 1933, the company concluded an agreement with NEC in 1935 to divide the market for this equipment and related devices. NEC received a 70% share, reflecting the company's

dominance in the market. Fuji Denki and NEC divided the market in a way which was similar to the cartel between Siemens and Western Electric of 1921 [KUDŌ 1992: 217-219].

Another reason for Siemens' declining position in the Japanese telecommunication market was the establishment of Fuji Denki Tsūshinki Seizō (Fujitsu) as a corporate subsidiary of Fuji Denki in 1935. The new company was created through an agreement between Fuji Denki and Tokyo Denki to create separate subsidiaries. Fuji Denki's Fujitsu was restricted to the production and retail of wire communication equipment, while Tokyo Denki's subsidiary, Tokyo Musen Denki, was limited to wireless communication equipment. Both companies agreed to exchange 20% of the capital of the new companies and to refrain from entering each other's business field. This led to a manufacturing division of heavy electrical machinery, remaining with Fuji Denki, and light electrical machinery and communication equipment, handled by the new subsidiary Fujitsu.

In spite of its fears that the new company would cut into its own exports to other countries, Siemens agreed to this plan. The company's reasons are still unclear. In part, it seems that the German company could not intervene against the division of Fuji Denki, which reflected Siemens' own divided structure in Germany.⁴⁾ However, the establishment of Fujitsu demonstrated the dominance of Furukawa and Fuji Denki itself which had convinced Siemens of the proposal. Siemens sent only one engineer to the new company, while Fujitsu benefited from Siemens' technology and the patents of its parent company, Fuji Denki. In June 1935, Fuji Denki transferred 700 employees and all communication equipment manufacturing facilities to Fujitsu.

The company was successful from the beginning. Government ministry orders, resulting from its telephone infrastructure expansion program, surpassed the company's production capacity in its first year of business, and Fujitsu increased its production rapidly [FTSKK 1964: 29-35]. Fujitsu-produced Siemens automatic switchboards amounted to about half of its sales in its first few years. In 1937, the Teishinshō ended competitive bidding for public orders and established Nippon Denshin Denwa Kōji K. K., a state-run consortium representing nineteen major telecommunication equipment manufacturers including Fujitsu. The new company received all public orders, which it coordinated and distributed to its member companies [FTSKK 1964: 46]. Siemens' technological influence on Fujitsu was also diminished by the protectionist and nationalistic policy of the Teishinshō in the second half of the 1930s, which reflected the general political climate in Japan. The policy of import substitution from 1928 had led to a local production of telephone equipment in foreign tie-up companies such as NEC, Tokyo Denki, and Fuji Denki, which gave the telecommunication and electrical manufacturing industry in Japan a solid base of manufacturing know-how. Japanese companies

4) Siemens was divided into Siemens Schuckert Werke (heavy electrical technology) and Siemens & Halske (light electrical technology).

such as Oki had also achieved a high technological level, thus giving the industry generally an independence from foreign technology.

The progress of the electrical manufacturing industry enabled the Japanese authorities to pressure the American majority shareholders in NEC and Tokyo Denki to decrease their capital share below 50% in the 1930s. The growing influence of the Japanese military, which was eager to expel foreign capital and participation in all strategic industries, also affected Fuji Denki, which was ordered to consider expelling all of the Siemens engineers in its factories [KUDŌ 1992: 209]. By the middle of the 1930s, the Japanese telecommunication equipment industry had achieved a technological level sufficient for the start of its own research and development activities, which were supported by the Teishinshō to reduce the dependency on foreign patents and technology. In 1935, the ministry started a research program for an automatic switching system to replace the American Strowger-type and the German Siemens-type. Fujitsu participated in this and other cooperative research projects of the ministry and other Japanese manufacturers, which were successfully concluded by the beginning of the Pacific War [FTSKK 1964: 37–38, 60]. By 1940, contacts between Siemens and Fujitsu had been reduced to Fujitsu's utilization of Siemens patents; retailing of imports from the German company represented only 20% of Fujitsu and Fuji Denki sales. Fujitsu did try repeatedly to acquire new technology from the German company, such as vacuum tube technology in 1939, but the contacts were finally reduced to a minimum by World War II,⁵⁾ leaving Fujitsu to its own devices.

5. POST-WORLD WAR II DEVELOPMENTS

Siemens' operations were terminated by the Allies after World War II, and all of its investments, including those in Fuji Denki, were confiscated. Allied Occupation policy also led to the dissolution of the Furukawa zaibatsu, which included Fuji Denki and Fujitsu. Both became independent public shareholder companies in 1949; Fuji Denki held only 15% of Fujitsu shares [FDSKK 1957: 119–120; FTSKK 1964: 94–99, 181].

Fujitsu had expanded during the wartime into a company of about 5,000 workers and had engaged in a broad range of communication equipment manufacturing as well as in mechanical calculators and cypher machines. It had become a leading telecommunications company in Japan, although it still lacked the scale of NEC or Oki. About 55% of the Japanese telephone infrastructure had been destroyed by the war, and the remaining network was in very poor condition [FTSKK 1964: 84]. While other telecommunication equipment manufacturers had also been seriously damaged by the war, Fujitsu's factories remained almost

5) A last effort to gain technology from Germany failed when two Fuji Denki and Fujitsu engineers died on their way to Germany on board a Japanese submarine, which was sunk by the Allies off the French coast in 1944 [FTSKK 1964: 77–78].

completely unaffected. The company could therefore enjoy a considerable advantage in attracting orders for the rebuilding of the Japanese communication infrastructure. In 1952, the government created a public corporation, Denden-kōsha (Nippon Telegraph and Telephone Public Corporation), to handle all Japanese public telecommunication, which had been previously controlled directly by government bodies.

Denden-kōsha immediately faced the problem of different technical standards in Japanese telecommunications, which had been caused by the licensed production of so much different foreign equipment before World War II. It also had to address the relatively poor quality of the Japanese telecommunication equipment caused by bad maintenance during the war and occupation period. Lacking manufacturing facilities, Denden-kōsha decided that the four major equipment manufacturers in Japan, NEC, Oki, Hitachi Seisakusho, and Fujitsu, should become Denden-kōsha's exclusive suppliers, thus opting for the American model of cooperation between AT & T and Western Electric [KAWADA 1991: 95]. This arrangement resulted in a strictly regulated telecommunication market closed to foreign competition until market liberalization in 1985, shaping also the telecommunication equipment industry. While Denden-kōsha overcharged its customers in order to finance the rapid extension of the telecommunication infrastructure, the equipment manufacturers could rely on stable and lucrative orders from Denden-kōsha in addition to participating in Denden-kōsha's publicly funded research and development projects.

The creation of Denden-kōsha had also a negative impact on the intended revival of cooperation between Fujitsu and Siemens in the early 1950s. At that time, competitors like NEC had renewed contacts with their prewar American partners in order to import their advanced technology. Fuji Denki and Fujitsu therefore turned again to Siemens in 1950. Siemens' facilities had been heavily damaged during the war, but its technological level was still competitive. However, the German company lost for the second time all of its direct overseas investments and patents. Siemens therefore responded quite cautiously to opportunities for direct investments abroad in the immediate postwar decade. Still, renewed contacts with the two Japanese companies offered the chance for greater representation in the Japanese market.⁶⁾ In 1952, license agreements were concluded between Siemens, Fuji Denki, and Fujitsu. While the cooperation of Siemens and Fuji Denki in heavy electric technology did very well (Siemens also built up a share of capital in Fuji Denki by license fees), the Siemens-Fujitsu license agreement (which targeted automatic switching systems,

6) Taihei-Yōkō K. K. (太平洋行) represented Siemens officially in Japan from 1947. The company imported Siemens products and maintained Siemens equipment in Japan. The first wholly owned Siemens subsidiary, Siemens Japan Ltd., was established in 1965. This company merged with Taihei-Yōkō in 1970, thus creating Nippon Siemens K. K., which was renamed Siemens K. K. in 1979 [SIEMENS 1987].

wireless communication technology, vacuum tubes and semiconductors) failed. Denden-kōsha opted in 1953 for the American crossbar-switching system of Western Electric in order to standardize the Japanese switching network, thus leaving no market for the Siemens system. The agreement on vacuum tubes and semiconductors failed because of Fujitsu's cooperation with Kōbe Kōgyō, a successful vacuum tube manufacturer, which held semiconductor and transistor technology acquired from the American RCA (Radio Corporation of America).⁷⁾

Thus, only wireless communication technology remained as a minor business field for cooperation between Fujitsu and Siemens. The technology transfer from Siemens to Fujitsu in prewar times must have had an enormous impact on the future development of the Japanese company. Based on the electromechanical relay technology for automatic switching boards acquired from Siemens in the 1930s, Fujitsu already produced mechanical calculators for the Japanese military during World War II. The company proceeded with research and development in this field in the early 1950s and managed to build the first mechanical computers in Japan. In 1956, the company also produced the first Japanese computer for commercial purposes that was based entirely on relay technology [KASHIWABARA 1992: 54–56; KOBAYASHI 1983: 45–46]. Although these computers were inferior to the more advanced IBM electronic computers, they did give the company experience in the new field of computer technology. This led to its decision at the end of the 1950s to enter seriously the computer and semiconductor business. This was just as these industries were declared key industries by the Japanese government. Fujitsu also realized that the computer and semiconductor sectors were future growth opportunities that evaded the Denden-kōsha-regulated telecommunication equipment market, in which Fujitsu ranked third behind NEC and Oki [KASHIWABARA 1992: 43].

In the computer and semiconductor industries, American companies were leading from the beginning. Thus Fujitsu turned its attention especially to IBM, the worldwide market leader in computers. In contrast to other companies, like NEC, Oki, and Hitachi, which were cooperating with American companies, Fujitsu could not find a foreign partner; it decided instead to rely on its own technological creativity and cooperative Japanese research and development projects in the computer field, while also acquiring American technology in the semiconductor field. From 1960 to 1970, Fujitsu's computer business increased tremendously, and reached 46% to the company's total sales in 1970. In telecommunication equipment, Fujitsu still enjoyed a strong market position and participated in Denden-kōsha's projects for applications of computers in telecommunications and data communication [FTSKK 1964]. In 1979 Fujitsu became the first company in the world to overtake IBM in computer sales in any country, and in 1990 it achieved the position of the second largest computer company in the world.

7) Fujitsu acquired 20% of Kobe Kōgyō in 1958, and bought the company outright in 1968.

The success of Fujitsu was also reflected in a reversal in its relations with Siemens. In 1965, Siemens began importing Fujitsu numerical machine controls, leading to an original equipment manufacturing contract in 1971, whereby Siemens retailed this machinery under its own brand name [RAIBLE 1987: 26]. Since 1978, Siemens has had a similar agreement for Fujitsu mainframe computers, indicating an even sharper reversal in the relative positions of the two companies. The student has become the teacher.

6. CONCLUSION

Technological development in telephone equipment manufacturing since the introduction of the telephone to Japan was mainly influenced by American companies, especially Western Electric and General Electric. These companies also invested in Japan by setting up companies such as NEC in cooperation with Japanese firms. Purely Japanese companies such as Oki also entered this market although they lacked the technological resources to produce advanced telephone equipment. While Siemens was doing business in the Japanese electro-mechanical market from the end of the nineteenth century, it engaged in the telecommunication equipment manufacturing only by establishing Fuji Denki in cooperation with Furukawa in 1923. Siemens' influence on Fuji Denki was limited to the technical aspects of Fuji Denki's business.

Due to political and economic factors, Fuji Denki substituted imports from Siemens with domestic production in the 1930s. Other foreign tie-up companies such as NEC also substituted imports by local production thus gaining manufacturing know-how, besides having access to patents and licenses owned by their foreign shareholders. In the 1930s, the Japanese manufacturers of telephone equipment became technologically independent in various fields from their foreign partners, while the government pressured foreign shareholders to diminish their capital in those companies. By barring foreign participation in the Japanese telecommunication industry and thus outside influence on the Japanese telecommunication infrastructure in the late 1930s, Japan gained early independence in these sectors. As the example of Fujitsu proves, Japan was also developing the technology fundamentals for entering the next generation of communication technology in data processing. Improving technological know-how that it originally acquired from Siemens, Fujitsu was able to take its first step into data processing in the early 1950s.

Competition in the Japanese telecommunication equipment market was terminated by the government in 1937, when public orders were distributed through a consortium that represented all major Japanese manufacturers. After the war, the state-owned Denden-kōsha assumed all responsibility for public telecommunication. Denden-kōsha chose preferred suppliers, thus further barring foreign companies from the market, and exerting a major influence on the shape of the telecommunication infrastructure and equipment manufacturing.

More than ten years after the liberalization of the Japanese telecommunications market, debate on further deregulation and foreign access to the market still continues, indicating the depth of the difficulties in overcoming old structures. A wider opening of the Japanese market could lead to a more active foreign participation similar to the prewar period.

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