NEC Corporation
1899–1999

A Century of
"Better Products,
Better Services"

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Preface

President Koji Nishigaki and Chairman Hajime Sasaki

On July 17, 1899, revisions to the unequal treaties between Japan and the Western powers finally came into effect. In line with the revisions, it became possible for foreign companies to participate with equity in Japanese companies. On that same day, Nippon Electric Company, Limited, known today as NEC Corporation, was established in the Mita section of Tokyo. Kunihiko Iwadare, the founder of NEC, possessed a strong entrepreneurial spirit and joined with Western Electric Company of Illinois, a company that recognized the future potential of Japan as a telephone market, to establish NEC Corporation as Japan's first foreign-affiliated joint venture. Over the subsequent 100 years, NEC met and overcame—based on its founding motto of "Better Products, Better Services"—countless trials and tribulations. In July 1999 the company successfully celebrated its centennial anniversary.

One hundred years of successful business could not have been possible without the support of our customers, stockholders, and others in Japan and overseas. Nor would it have been possible without the enthusiasm and untiring efforts of generations of dedicated managers and other employees inside NEC. We take this opportunity to express our appreciation to those many persons.

When NEC was established in 1899, telephones were already being widely used in the advanced Western nations. The company's first business was thus the import and sale of telephone sets made by its joint venture partner. The company grew rapidly afterward as the information and communications industries developed in Japan.

In 1977, well ahead of other companies, NEC introduced the concept of the integration of computers and communications (C&C), thus entering the business domains that comprise today's Internet age. At present, as an Internet solution provider with an unequivocal customer orientation, NEC has expanded to become a global corporation. It would please us greatly if this English history were to provide its readers with a better understanding of our company, its people, products, and services.

Professor Yoshitaka Suzuki of Hitotsubashi University wrote this history, and Mr. Thomas I. Elliott undertook the translation, in cooperation with the Japan Business History Institute. We wish to express our sincere appreciation here for their fine efforts in the publication of this history.

December 2002

Hajime Sasaki

Hajime Sasaki
Chairman of the Board

Koji Nishigaki

Koji Nishigaki
President

Pictorial Retrospect of NEC's First Century

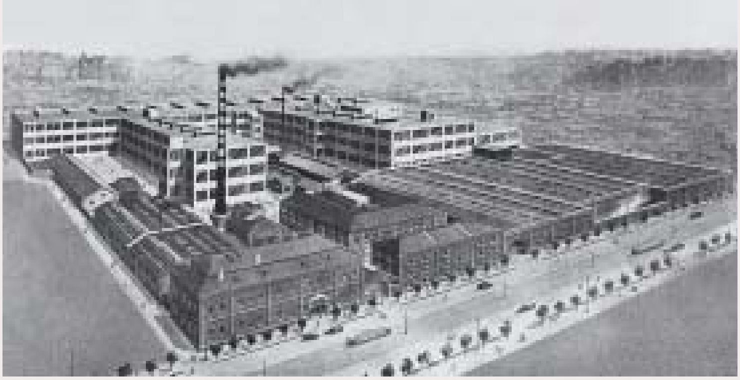
1899
The first plant of Nippon Electric Company, Limited was the former plant of Miyoshi Electric Works. It was one of few in Japan at the time producing electrical machinery.

1901
The Ministry of Communications presented this Delville telephone set to the Imperial Household. Bell Telephone Manufacturing produced this telephone. Nippon Electric imported it and delivered it to the Ministry.

1909
This photo was taken at the start of the New Year in 1909. Sitting from left to right, starting with the second person, are: W. Kameyama (chief plant manager), I. Nakayama (chief engineer), K. Iwadare (managing director), R. C. Dodd (director and plant manager), F. H. Leggett (former director), T. Maeda (auditor), and M. Matsushiro (Osaka branch manager).

1912

In its third year of business, Nippon Electric began publishing an in-house newsletter titled *Nippon Denki Geppo* (Nippon Electric Monthly), an innovative approach to public relations at the time. The August 1912 issue of *Western Electric News* on the right introduced the June 1911 issue of *Nippon Denki Geppo*.



1922

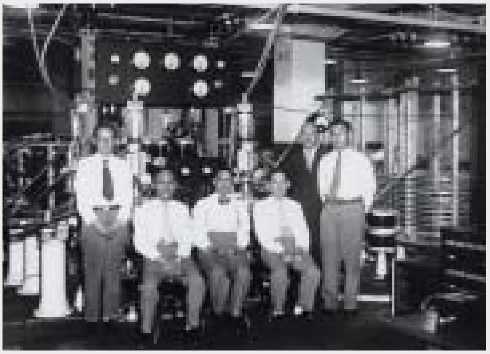
Nippon Electric expanded the Mita Plant several times after its original construction in 1902. This photo shows the plant, modeled after Western Electric's Hawthorne Works, after it was expanded to have 28,000 square meters of floor space.

1922

Nippon Electric received guidance from Western Electric from its establishment, and moved forward with domestic production of telephone sets and switching systems. This photo shows final adjustments being made to magneto-type switches.

1928
Y. Niwa (left) and M. Kobayashi standing behind NE-type photo-telegraphic equipment that Nippon Electric developed with original technology. In November 1928, this equipment transmitted scenes of the Imperial Accession Ceremony of Emperor Hirohito held in Kyoto more clearly and faster than foreign-made equipment, thus demonstrating its superior qualities.

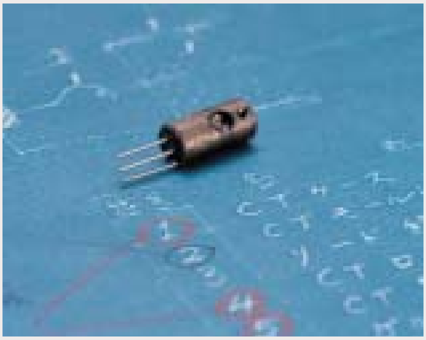
1934
This photo shows Nippon Electric engineers standing in front of the 120kW cooling tower used with the broadcasting equipment of the Hsinking (today's Changchun) Broadcasting Station in Manchuria.



1942
During the war, the Ikuta Research Laboratory became the company's focal point of research on radio-wave weapons, centered on radar. This photo commemorates a visit to Ikuta by Higashikuni Naruhiko, head of a former Imperial Branch Family, and later the first postwar prime minister.

1946
W. S. Magil of GHQ's Civil Communications Section, and his successor, H. M. Sarasohn, lectured on the method of statistical quality control. Magil is seated in the center with K. Kobayashi on his right and Sarasohn on his left. H. Nishio is standing behind Kobayashi.

1951
Nippon Electric introduced a belt conveyor system called the "Tact System" to mass-produce the No. 4 type telephone set (below). The photo shows an assembly line in the Mita Plant.



1951
Nippon Electric obtained a sample point contact transistor from Bell Telephone Laboratories in 1950. The company then began tackling research into transistors. A year later, Nippon Electric successfully completed its first prototype transistor, a germanium point contact transistor.

1958
Nippon Electric delivered its first commercial digital computer, the NEAC-1102, to Tohoku University. Christened the SENAC after delivery, the computer began operating from November 1958.

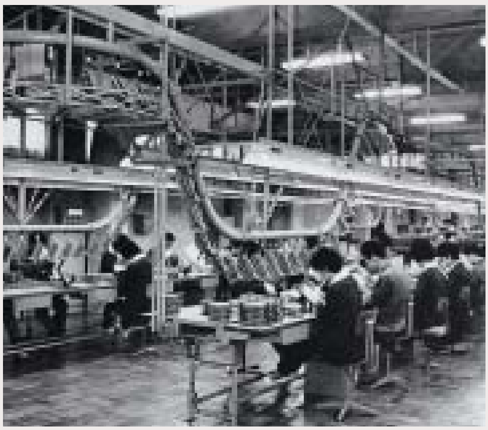
1958
Nippon Electric built Japan's first dedicated transistor production plant inside the Tamagawa Plant and established a mass-production system.

1959
After completing development of the fully transistorized NEAC-2201 computer in 1958, Nippon Electric exhibited and operated it at the UNESCO AUTOMATH Show in Paris, marking the first time for any company to operate an actual model of a fully transistorized computer in a public venue.

1963
In a move to raise capital to meet its increasing need for funds, and to raise the level of familiarity of the company's name, Nippon Electric issued American Depositary Receipts. The photo shows Executive Vice President Y. Makino (center) signing the ADR agreement papers with First Boston and Daiwa Securities representatives in New York.

1963
Nippon Electric provided a high-sensitivity receiver system to KDD's Ibaraki Space Communications Test Center, Japan's first satellite communications earth station. The first experimental television broadcast between Japan and the U.S. conducted later in the month carried the first satellite-relayed images—the assassination of President John F. Kennedy.

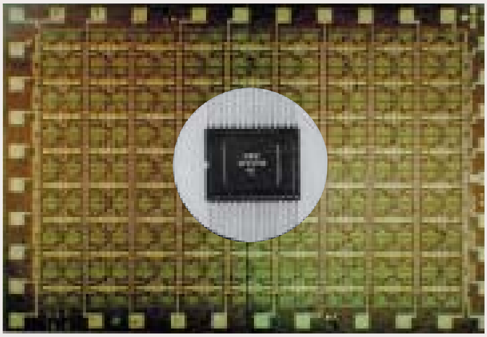
1965
After construction of the Sagamihara Plant was completed, the plant began mass-producing crossbar switches. The various production processes were connected to the parts warehouses via an overhead conveyor.



1965
Nippon Electric introduced five models in the NEAC-Series 2200, the first domestic-made computer family based on the "one-machine concept." This photo is of the Model 200, the medium-size computer in the series.

1968
Nippon Electric established its first overseas plant, NEC de Mexico S. A. de C. V., a wholly owned subsidiary, in cooperation with the localization policy of the government of Mexico.

1968
Nippon Electric successfully developed the high-speed 144-bit MOS memory, the μPB391.



1972
Prime Minister Tanaka of Japan visited Beijing to normalize Sino-Japanese relations. In order to televise that historic event, Nippon Electric air-freighted a transportable earth station to Beijing. The photo shows the earth station under construction near Beijing Capital International Airport.

1974
Nippon Electric and Toshiba Corporation jointly introduced a new series of computers called the ACOS Series 77, oriented toward online and distributed processing. The first models introduced were the ACOS System 200, 300, and 400. This photo is of the System 400.

1976
As a step toward expanding its microcomputer sales, NEC marketed the TK-80, an assembly training kit for microcomputers. This photo was taken at Nippon Electric's Bit-INN service center in the Akihabara section of Tokyo. Visitors are watching a TK-80 being used to control operation of a model train.

1977
Chairman Kobayashi gave a keynote address at INTELCOM 77 in Atlanta, Georgia, on October 10, 1977. His speech marked the first public mention of the coming integration of computers and communications. It also marked the origins of NEC's subsequent C&C strategy.

1977
NASDA awarded NEC the contract for producing the Himawari, Japan's first geostationary meteorological satellite. The photo shows the Himawari under construction at NEC's Yokohama Plant. Using a NASA Delta Rocket, the Himawari was successfully launched in 1977.

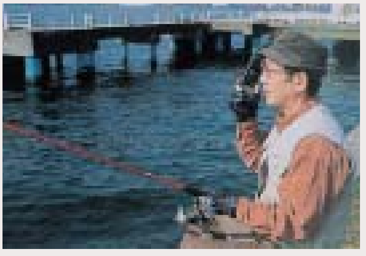
1979
NEC's transportable earth station was used as Intelsat's standard B-type earth station. Using this earth station, NHK and KDD successfully televised images from the Antarctic, a world's first.

1982
This is the first model in the PC-98 Series, the PC-9801. The PC-98 Series enabled NEC to win an overwhelming share of the domestic personal computer market.

1983
NEC Semiconductors (UK) had a particularly auspicious beginning with Her Majesty Queen Elizabeth II as the guest of honor at the ceremony marking the start of LSI production operations. Her Majesty wore dust-free clothes to tour the plant.

1983
The International Telecommunication Union staged TELECOM 83 in Geneva, Switzerland. NEC's exhibit drew large crowds to watch demonstrations of C&C systems, including a research model of an automatic interpretation system.

1985
NEC began providing VAN services by using a dedicated high-speed digital line and ultra-large computers. The system was called the "C&C-VAN."



1993
When NTT began personal digital cellular phone service, NEC developed the first-generation Digital Mova N for delivery to NTT.

1993
When NEC unveiled the world's first prototype 256Mbit DRAM, its compactness and low power consumption made it ideal for use for computer main memory and portable electronic equipment.

1994
NEC hosted the NEC Multimedia Conference for Children around the World, linking children in Australia, Japan, the U.K., and the U.S. The participating children discussed the main theme, "Our Earth." This experiment emphasized how computers can be used for international communication.

1995
NEC research bases in Japan and the U.S. cooperated to develop the Express5800 Series of high-performance servers addressing the market for small open servers. The photo is of the Express5800/160.

1996
This photo is an artist's rendition of the permanent manned space station proposed by the U.S. NEC participated in building a Japanese Experimental Module and was awarded the contract for developing the JEM's operating & control system and inter-satellite communications system.

1997
NEC developed the M terminal, a very small mobile unit, for use with the Inmarsat-M system. This photo shows members of the international NGO "Save Africa" using an M terminal.

1997
This photo shows a 42-inch color plasma display panel (PDP) that provided images of superior contrast on a par with CRTs. The development of large-size PDPs featuring thin panels, light weight, and low power consumption led to the diffusion of large-size television sets, including those used in homes.

1997
NEC's SX-5 Series of supercomputers provided a maximum vector performance of 4 teraflops, the world's fastest at the time. In the late 1990s, the Science and Technology Agency awarded NEC a contract to provide the basic design for an ultracomputer with a maximum performance of over 32 teraflops for use in its Earth Simulator Program.

Contents

Chapter 1

Foundation of NEC: 1899 – 1913

1. Start of Telephone Business in Japan

Start of Telephone Business

Nippon Electric Company, Limited (today's NEC Corporation), was founded in 1899 as the nation's first joint venture with foreign capital. The principal investors were Western Electric Company of Illinois (WE, renamed Western Electric Company, Incorporated, in 1915) in the United States and Kunihiko Iwadare and others in Japan. During its first 100 years, NEC developed to become one of the world's foremost companies in the main sectors of the information and communications industries. The company's primary businesses when it was founded were the import of telephone apparatus and electric equipment, and their manufacture and sale in Japan.

The telephone business started in Japan in 1890, about 10 years before establishment of Nippon Electric Company. Since that was only about 10 years later than the start of the telephone business in the U.S. and the main countries of Europe, the business met various difficulties in Japan. The telegraph business, on the other hand, had started in Japan as early as January 1870, barely two years following establishment of the new Meiji government in January 1868. It thus began earlier than other businesses. Such businesses as postal services, railroads, electric power, and related industries soon followed.

Under its direct guidance, the Meiji government continuously promoted a policy of introducing Western technologies and systems. During the 15 years from when it was established in 1870 until it was abolished in 1885, the Ministry of Industry played the central role in promoting the government's policy of increasing production and promoting industry, expended large amounts of funds, and mobilized a large number of personnel. The communications industry was one of the most important of the industries being promoted. As it was promoted, a number of specialized schools were established, such as Tokyo College of Postal and Telegraph, for teaching communications technology. Also, the electrical equipment production division of the Ministry of Industry was concerned mainly with producing prototype electric equipment and conducting experiments. Some persons active in that division, and later also active in the manufacture of telephones and switchboards, were K. Oki, I. Kawaguchi, W. Kameyama, and S. Miyoshi. Although companies in the electric power supply business were privately operated, such businesses as the telegraph, postal services, and railroads began as state-run businesses. Plans for establishing the telephone business began somewhat later than those for other businesses, because it took time to decide whether to start it as a state-run or private business.

The first telephone sets were brought to Japan in 1877, the year after Alexander Graham Bell invented his telephone. As early as 1878, the Ministry of Industry's production division successfully reproduced Bell telephones. Before long, telephones were being used mainly in government, police, and railroad offices.

In 1883, a report was prepared on the telephone exchange system in use in Shanghai, and the Ministry of Industry formulated a plan for establishing a telephone exchange business in Japan. The Ministry of Industry wanted to promote the telephone business as a state-run business. At the time, however, the Meiji government faced fiscal difficulties and serious inflation. As well, its commerce and industry policy was approaching a point of transition. It was around this same time, moreover, that the government sold off the state-run coal mining, shipbuilding, cement, and other industries to private interests. It was thus not enthusiastic about establishing a new business as large as the telephone exchange business, and ordered a survey concerning the feasibility of establishing a privately run telephone business. The Ministry of Industry tried twice more, in 1884 and 1885, to promote a plan for establishing the telephone business as a state-run industry, but both times the administration opposed it. The Ministry of Industry was abolished in 1885, and the Ministry of Communications assumed its duties.

A group of businessmen, meanwhile, comprising mainly leading entrepreneurs and others, began moving to establish the telephone business as a private-sector business. Centered on Eiichi Shibusawa and other businessmen, the group presented a plan to the Ministry of Industry in 1885 and to the Ministry of Communications in 1886 for establishing a privately managed telephone business. Neither Ministry, however, approved the plan. In these ways, while the government opposed plans by the Ministry of Industry to establish a state-run telephone business, the Ministry of Industry and then the Ministry of Communications, each only a ministry of the government, disapproved plans by private businessmen to establish the telephone business under private management.

In 1889, the government finally decided to establish the telephone exchange business as a state-run business. The main reasons the Ministry of Communications cited at that time for establishing it as a state-run business were the public nature of telephones and the fact that huge investments were required. Also not overlooked were national security and the maintenance of public order.

Japan's first telephone exchange services began in December 1890 in and between Tokyo and Yokohama. Initially there were only 197 subscribers, 155 in Tokyo and 42 in Yokohama. In the background of the favorable economic situation brought about by the Sino-Japanese War that ended in 1895, however, the number of applicants for telephones increased so rapidly that service capabilities and government investment could not keep up. To appreciate the situation better, it should also be noted that between 1896 and 1899 Japan experienced its first boom in the setting up of companies. As a result, corporate expansion was greater during that period than at any time in the past, particularly in the textile, banking, railroad, and other leading industries. The favorable economic situation and the corporate expansion combined to lead to rapid growth in the demand for telephones. During the six years from 1890 to 1895, the government invested as much as 540,000 yen in the telephone business. Although this amount was only half that of investments made during the same period in establishing a telegraph network (excluding expenses related to laying submarine cables), investments in the telephone business in later years far exceeded those in the telegraph business.

First and Second Telephone Expansion Plans

In 1896, the year following the end of the Sino-Japanese War, the government began viewing the telephone business as an important undertaking for satisfying the great increase in demand for telephone service. That year marked introduction by the Ministry of Communications of the First Telephone Expansion Plan, a seven-year plan. The main part of the plan called for 12.8 million yen worth of investment in the telephone business, more than 20 times greater than those made up to then. The plan included the building of new telephone offices in 40 cities throughout the country, the laying of a total length of 60,000 kilometers of long-distance telephone lines, and an increase of 22,800 new subscribers. The funds required to implement the plan would be raised through the issuing of government bonds. At any rate, at the start of the plan the outlook was not good for obtaining the materials required to complete a plan of that scale, nor did the government have the capability to install that many telephones.

In the end, the Ministry added an extra year to the plan, for a total of eight years. By the time the plan ended in 1903, the entire 12.8 million yen had been invested. Although only 11,000 kilometers of long-distance lines were laid, far below the target figure, the number of new subscribers was over 32,000 (total subscribers were 35,000 in 1903), exceeding the original plan. Over 21,000 more subscription applications were left pending. When telephone service first began, inter-city calls could only be made between limited areas, such as between Tokyo and Yokohama, and Osaka and Kobe. In 1899, however, long-distance lines were opened to serve the 550 kilometers between Tokyo and Osaka.

Despite the expanded demand, the government could not establish a new telephone expansion plan at the end of the first plan in 1903. That was because Japan was at war with Russia from 1904 to 1906, and long-distance lines for military use took precedence over other demand. After the war ended, the Ministry of Communications introduced its Second Telephone Expansion Plan to respond to the demand for telephones. This was a six-year plan, started in 1907. Besides increasing the number of cities with telephone offices from the current 80, principally large cities, to more than 400, including provincial cities and other areas, the main content of the plan included a target of 138,000 subscribers at the end of 1912 (an increase of 95,000) and the laying of 48,000 kilometers of long-distance telephone lines.

A total of 20 million yen was required to implement the plan, a far larger budget than for the first plan. To realize a rapid increase in the number of subscribers, the government introduced new systems whereby persons benefiting from newly installed telephones bore some of the cost burden through donations and extra charges.

By the time the second expansion plan ended in 1912, about 26 million yen had been invested during the period of six years, over 900 new telephone offices were built, the number of subscribers increased to over 180,000 from 43,000 in 1906, and over 80,000 kilometers of long-distance telephone lines were laid. All these figures greatly exceeded the original plan.

Bell telephones and Edison telephone receivers were manufactured from early on in the Ministry of Industry's production division. Among the men who gained technical competence there were Kibataro Oki, who later independently established Meikosha Ltd. Until 1890, when the telephone exchange business started, Meikosha manufactured telephones and switchboards for the government. The company's name was later changed to Oki Shokai (today's Oki Electric Industry Co., Ltd.). When the Ministry of Communications started the telephone business, it introduced the WE telephone switching system. Oki Shokai began assembling and supplying telephone equipment imported from WE.

2. Nippon Electric Limited Partnership

Thayer's Visit to Japan, and Negotiations with Oki

In 1896, after hearing about Japan's First Telephone Expansion Plan from Ryuji Nakayama, an engineer in the Ministry of Communications who visited the U.S., WE sent its New York Branch Manager, H. B. Thayer (later, chairman of AT&T), and an engineer named Hovey, to Japan. Thayer conducted a survey of the Japanese telephone market, also meeting with Saitaro Oi, another engineer in the Ministry of Communications, and Kunihiko Iwadare, WE's agent in Japan. Thayer had previously met both men in the U.S.

He exchanged opinions with Iwadare and Oi about WE possibly entering the Japanese telephone equipment manufacturing industry and he asked Oi to participate in the undertaking. The discussions at that time, however, did not proceed very far. Based on his survey, Thayer recommended to his head office that WE should enter the telephone equipment manufacturing industry in Japan and do so in the form of a joint venture. The joint venture format in Japan would differ from the wholly owned subsidiary format that WE preferred in developing its overseas businesses in Europe and elsewhere. Hovey's role was to provide technical guidance to engineers in the Ministry of Communications and to make necessary adjustments to the switchboards imported from WE.

In 1897, WE sent W. T. Carleton, a secretary to H. B. Thayer, to Japan as the company's representative. With Iwadare acting as the intermediary, Carleton moved to establish a new company jointly capitalized by WE and Oki Shokai. In negotiations with Kibataro Oki that continued from late 1897 into 1898, Carleton proposed several conditions as the basis for conducting joint business operations in Japan. WE would invest in the new company but Oki would handle management; WE would provide the new company with the patents and expertise held by WE and AT&T, the parent company of WE; WE technicians would be sent to Japan and Oki Shokai technicians would be sent to WE for training to establish the new company's technology and production system; and WE and its affiliated worldwide companies would provide the new company with the equipment and materials it required to conduct its business.

In response to the several conditions, Oki emphasized that Oki Shokai was the only company in Japan able to manufacture telephone equipment and that it had reached its current high level of competence completely on its own. During negotiations, Oki repeatedly requested that the proposed percentages in the division of profits be revised in his favor. Although at one point the parties reached an agreement, the talks collapsed in June 1898 because Oki felt strongly that he did not want the company to be under the control of foreign capital. For his part, Carleton was not pleased with Oki's negotiating methods and, in the context of consecutive demands from Oki for revising the profit percentages in his favor, he felt he could not continue the discussions.

Iwadare and Nippon Electric Limited Partnership

Kunihiko Iwadare was constantly available for advice during the negotiations between Carleton and Oki. Iwadare was an engineer, graduating in 1882 from the faculty of telegraph of the Imperial College of Engineering (today's Faculty of Engineering in the University of Tokyo). He joined the Ministry of Industry immediately after graduation and was placed in charge of telephone maintenance. Four years later, after resigning his position with the ministry, he used personal funds and traveled to the U.S. to join Edison Machine Works (later integrated into General Electric Company) as an assistant engineer. He returned to Japan in 1888 to assume the position of chief engineer in Osaka Dento (Osaka Lighting Company), a company just being established. Before leaving the U.S., Iwadare purchased electrical generators and other machinery and equipment that Osaka Dento would need. Unlike the direct current (DC)-based electrical equipment Edison was insisting on at that time, Iwadare purchased alternating current (AC) generators from Thompson-Houston, a rival manufacturer of Edison. As a result, Edison severed its relations with Iwadare. Later, after realizing that Iwadare's decision that using the AC system would be favorable in the electric power supply business was correct, Edison appointed Osaka Dento the sales agent of General Electric (GE) in Japan. In 1895, Iwadare resigned from Osaka Dento and began independently importing electric machinery in Osaka. Edison then appointed Iwadare GE's sales agent. Not long afterward Iwadare was also appointed the sales agent of WE. It was in that context that Iwadare was asked to act as mediator when Carleton and Oki negotiated.

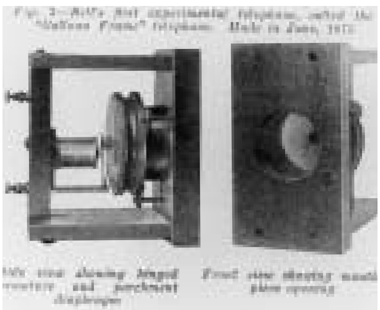
After the talks between WE and Oki broke down, Iwadare approached the terribly frustrated Carleton and proposed that Iwadare himself enter into a partnership with WE in establishing a new company. WE subsequently changed its policy in effect up to that point and began moving toward setting up a new company in Japan with Iwadare as its partner. Although Iwadare had an engineering background, he was mainly involved at the time in importing and selling electrical equipment in Osaka. WE felt that in working with Iwadare it could introduce U.S. production methods rather than use Japanese production methods.

Iwadare, meanwhile, invited Takeshiro Maeda to participate in the new venture. Like Iwadare, Maeda believed that the AC system was most appropriate for the electric power supply business. Also like Iwadare, Maeda was a successful businessman, importing and selling electrical equipment and machinery in

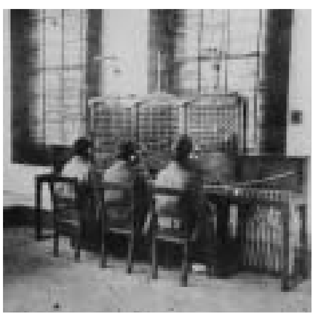
Kunihiko Iwadare (1857-1941)
Iwadare was managing director from July 1899 to December 1926, and chairman from December 1926 to September 1929. In a conversation with W. T. Carleton of WE in early June 1898 he expressed his wish to participate in a joint venture. "Shall I buy the Miyoshi Works," he said, "and run it in connection with Western Electric?"

Takeshiro Maeda (1867-1931)
Maeda was pleased when Iwadare agreed to the name Nippon Electric Limited Partnership for the company they established because he had previously owned a company named "Nippon Electric Trading."

W. T. Carleton (1867-1900)
Carleton contributed greatly to Nippon Electric's establishment and to guiding the company through its initial difficult period. He left Japan with his wife and their newborn son in May 1900 but became seriously ill two months later and died at the young age of 33.

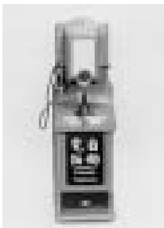


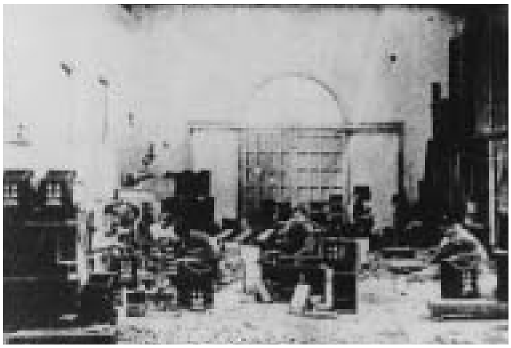
Alexander Graham Bell successfully transmitted a voice message using electric signals in June 1875. In another experiment, on March 10, 1876, Bell said into his telephone, "Watson, come here, I want you." Thomas Watson came running from the next room yelling, "I heard you, Mr. Bell. I heard you."



Three telephone switchboards, manufactured in Japan based on the standard switching system of Western Electric (WE), were installed in the Tokyo Telephone Office in 1890 to serve 155 telephone customers.
(Photo courtesy of Teishin General Museum-Communications Museum)

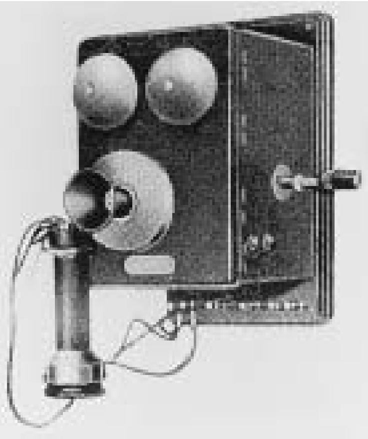
Construction of Nippon Electric's new Head Office and plant was completed in 1902. Made of red brick, the buildings occupied the same land on which today's Head Office stands.



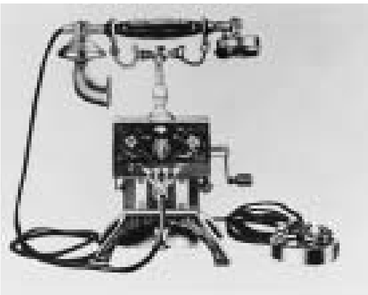


The Ministry of Communications began installing public telephones, called "automatic" telephones, in 1900 (left photo above). An oyakata ("boss") supervised production of these telephones in Nippon Electric.

WE management systems were introduced in Nippon Electric from 1908. Time recorders, imported from WE, were used for strict control of working hours. Also, a piece-work-rate system replaced the oyakata system in 1910 and the company began paying workers by output.



The Ministry of Communications used solid-back telephone sets—magneto-telephones—as its standard equipment, along with Delville telephones.



Nippon Electric began producing domestic-made telephone sets not long after its founding. It used various designs, such as this metal Delville-type telephone.

Telephone operators work with parallel duplex switching systems at the Naniwa Branch Telephone Office in Tokyo.
(Photo courtesy of Teishin General Museum)

Not long after the Ministry of Communications decided to use common-battery switching systems, Nippon Electric imported the first system from WE and installed it in the Shiba Branch Telephone Office in Tokyo in 1909.
(Photo courtesy of Teishin General Museum)

Tokyo. He thus had to think carefully about Iwadare's proposal: accepting it meant he would have to close his business. Because of Iwadare's enthusiasm, however, and his own expectations concerning involvement in a larger business undertaking, Maeda accepted Iwadare's proposal to work together.

As a first step, Iwadare and Maeda established Nippon Electric Limited Partnership in September 1898. Total capital was 50,000 yen, with Iwadare investing 80 percent and Maeda 20 percent. As they waited for the treaty revisions with the Western nations scheduled for July 1899 that would make foreign capital participation possible in Japan, Iwadare and WE moved forward with planning to establish a joint venture with WE. Because the new company would represent emerging Japan in the area of electrical machinery, Iwadare selected the name Nippon Electric for it. The suggestion for the name came from Maeda.

Before establishing the new company, Iwadare bought out Miyoshi Electric Works, a company located in the Mita part of Tokyo, thus securing a production base. Together with Oki Shokai, Miyoshi Electric Works was one of the principal companies in the earliest stage of Japan's electrical machinery industry. Its plant in Mita was one of few such plants in Japan at that time. Although Miyoshi had been successfully manufacturing generators and other electrical machinery, it fell on hard times during the recession following the Sino-Japanese War of 1894–95, became burdened with a huge amount of debt, and was on the brink of bankruptcy. After Maeda, who once worked for Miyoshi, told Iwadare about Miyoshi's predicament, Iwadare then successfully negotiated with Miyoshi and bought the plant, its lathes and other machine tools, and all the company's other machinery, including steam engines, for 40,000 yen.

The new company took over the agency rights and sales channels that Iwadare and Maeda had developed in their separate businesses up to then. It also retained some former employees of both companies and had them conduct the bookkeeping, sales, and other duties of the new company. Some engineers and skilled workers from Miyoshi Electric Works were employed on the manufacturing side, and other engineers joined the new company from mining and electric power companies. Carleton remained in Japan nominally in charge of importing products from WE, and involving himself in the preparations for establishing the new company as a joint venture and putting its production system in order.

Even as it pressed forward with production preparations, Nippon Electric Limited Partnership began immediately after its establishment to import and sell machinery and equipment. Among the imported products were telephones and switchboards from WE, electric appliances from GE, rubber-insulated copper wire from Simplex, and so on. The company's principal customer was the Ministry of Communications. Other important customers were electric power companies and railroad companies around Japan and many companies in Tokyo. Because the company was established during the period of the First Telephone Expansion Plan, sales of WE products were particularly favorable.

As well, although the company began its business mainly with the sale of imports, it quickly had to begin the assembly of telephones, the manufacture of some components, and service and maintenance of products. And before long the company began manufacturing telephones. Although the plant purchased from Miyoshi was quite large for the time, it was far from being modernized. A reporter wrote about the plant as follows in *Denki no Tomo*, an electric industry publication of the time.

> The plant was dimly lit, the dirt floor was uneven, the roof leaked, and there were puddles of water everywhere. All types of lathes, small and large, blackened by oil and dust, were lying where they were knocked over. At one end of the plant were a 25hp lateral-type steam engine and a DC generator called an engine dynamo. Belts about 15 inches wide led from the steam engine and powered the various machines through a main shaft running along the ceiling.

The first products manufactured at this plant were magneto-telephones (Delville telephones, and solid-back telephones). Maeda wrote in his memoirs that the first production batch of telephones had many mechanical defects. The machinery and other equipment needed for manufacture were not yet available and there were not enough machinists who could make telephones. The products were not at the quality level of Oki Shokai's products.

Ichitaro Kawaguchi, manager of the production division of the Ministry of Communications, was a production consultant for Nippon Electric Limited Partnership when its plant began operating. Kawaguchi was a competent engineer who had been involved in the efforts to build Japanese-made telephones and switchboards in the Ministry's production division. Through his introduction, Wazo Kameyama, an engineer of that division, joined Nippon Electric Limited Partnership soon after it started operation. He was appointed chief manager of the plant, in overall charge of manufacturing. Maeda, meanwhile, was responsible for sales. Under the slogan of "Better Products, Better Services," Maeda demanded a high level of quality for the products the company was delivering. He required especially strict quality inspections for the products manufactured in the plant and refused to accept products that did not meet the company's quality standards. He also ordered his subordinates to pay particularly close attention to installation and servicing, no matter what the size was of a customer's order.

3. Nippon Electric Company, Limited, Established

Nippon Electric Company

On July 17, 1899, Nippon Electric Company, Limited (hereinafter "Nippon Electric"), was established, a year after Nippon Electric Limited Partnership was established. That was the same day that revisions to treaties with the Western powers took effect and Japanese laws were revised to permit foreign entities to invest in Japanese companies. WE acquired 54 percent of the stock of the company, and W. T. Carleton of WE and E. W. Clement, an American residing in Japan, joined with Iwadare, Maeda, and three other Japanese to become promoters of the company. Nippon Electric was the first foreign-affiliated company in Japan, and for many years was one of very few such companies.

WE's policy from the preparations stage in establishing Nippon Electric Limited Partnership was to participate only in Nippon Electric. After establishing Nippon Electric Limited Partnership, Carleton remained in Japan and WE provided help to the company. After WE became the principal shareholder of Nippon Electric, Carleton and Clement—who opened a mission school in Tokyo—became directors. Iwadare became managing director, and Maeda and Koreteru Fujii—another promoter of the company—became auditors. Maeda was also in charge of sales. Clement, meanwhile, was an external director, and thus was not directly involved in the company's management. Nippon Electric's management was thus left to Iwadare, Maeda, and Carleton. The company's initial capital was 200,000 yen (400 shares), with 150,000 yen paid in. Nippon Electric took over the business of Nippon Electric Limited Partnership, and began business operations on September 1, 1899.

Early-Stage Management

An organization chart dated April 1, 1900, shows the company's organization in the very early stages. Iwadare is listed as managing director, with Takeshiro Maeda under him in charge of sales and W. Kameyama in charge of the plant. The position of chief engineer was also set up to assist the plant manager; Ichiro Nakayama assumed that position after leaving the Ministry of Communications. Departments included under the sales branch were general affairs, sales, and accounting. The plant included the technology and manufacturing departments. The company's business affairs, of course, were performed while maintaining a close relationship with WE. Carleton not only handled communications with WE but also provided management guidance, including working closely with Iwadare to put the plant into order and prepare the production system. L. E. Sperry replaced Carleton in Tokyo after the new company's operation began proceeding smoothly, and Carleton returned to the U.S. in May 1900. Very unfortunately, two months later he died suddenly at his home in Haverhill, Massachusetts.

Nippon Electric set a goal from the start of operation to increase its manufacture of telephones. Aiming for early manufacture of 10,000 telephones, the company made special efforts to manufacture products in-house. The mainstay items contributing to sales, however, were products imported from WE, with imports accounting for more than 70 percent of overall sales. Maeda placed a priority on selling ever more outstanding products, and WE products played an important role in achieving that goal. In order to accomplish Iwadare's goal of increasing the manufacture of in-house products and Maeda's goal of improving product quality, it soon became an urgent matter to expand and modernize the plant. It was thus decided in August 1900 to relocate the plant. Not only was there no further room for expanding the existing plant but fire insurance companies refused to raise the amount of insurance on the plant because of the many wooden structures around it. By coincidence, the Mitsui Bank and related persons owned land not far from the existing plant, and the company gradually purchased some of that land. In fact, the land purchased at that time is today the site of NEC's head office.

Two plant buildings and a warehouse made of red brick and roofed with slate were constructed on the newly acquired land. L. E. Sperry, Carleton's replacement as the WE director residing in Japan, oversaw the plant's construction, completed in 1902. Operations began after production was moved to the new plant. In January 1903, the head office was also moved there. The plant was fitted with state-of-the-art machinery and equipment, including automatic lathes, all imported from WE. This plant was later named the Mita Plant.

Even after the plant began operating, the equipment was continuously improved. In 1906, the fourth year after moving to the new plant, additional land was acquired and the plant was expanded in order to have production keep up with the increase in demand linked to the Second Telephone Expansion Plan of the Ministry of Communications. The first structure built on the new land was a three-story second warehouse. A second production plant was built in 1907. Not long afterward, WE sent the engineer R. W. Patterson to Japan. Under Patterson's guidance, another production plant, the third one, was built in 1908. Automatic screw machines and other modern equipment were installed at that time, as were a 100kW generator and a steam engine for generating electricity. The power source was thus switched to electricity.

All these moves resulted in giving the plant a completely new appearance. An especially noticeable addition was an earthquake-resistant chimney 1.8 meters in diameter and 40 meters tall built in the center of the plant. Up to then, shafts from the steam engine, the sole source of power, had stretched through the plant, and belts had run from the shafts to provide motive power to the various machines. Together with electrification, however, these shafts were no longer needed and were taken down. As well, switches were fitted to each machine, allowing them to be operated independently. From 1910, the company carried out still another plant expansion and equipment improvement program. In 1913, it built its first ferro-concrete structure, the two-story sixth production plant.

4. Transfer of WE Systems

Management of WE

Until 1918, when International Western Electric (IWE) was established, WE's International Division directly oversaw all overseas operations. The format in which the company conducted its overseas operations differed according to the importance and nature of the particular market. In the early 1900s, WE already had about a dozen overseas subsidiaries, and owned most of them outright. The company sent personnel to reside overseas and serve as directors in the overseas subsidiaries and affiliates. Other personnel were sent to oversee technology, accounting, import operations, and procurement of materials. Although Nippon Electric was not a wholly owned subsidiary, WE used the same management methods with them as with its own subsidiaries. Iwadare sent a regular Monthly Report to WE, for example, that included information on the company's monthly business performance. Sometimes he sent detailed information on the political and economic situation in Japan.

Based on the information it received, WE prepared an international business strategy. And when WE thought it was necessary, it provided Nippon Electric with instructions. At times the instructions were too detailed and forceful, as shown by Iwadare's complaints in the following letter to WE.

> As you know, Nippon Electric, unlike WE's affiliates in places like London and Antwerp, is a joint venture, and Japanese are included among its principal shareholders. If there is a valid reason, the Japanese shareholders are prepared to listen to anything WE has to say. It is not very pleasant, however, for us to be prevented, on the one hand, from having the opportunity to express our opinions, while, on the other hand, we receive letters written in the imperative mode. The resident WE manager in Japan ignores the Japanese situation and issues overly detailed instructions that place the company in a disadvantageous position. Most people are motivated and feel pride when they are able to judge situations correctly, but they lose interest when there is outside interference even in minute details.

WE Systems Take Root

The principal feature of WE's management of its overseas operations was not only that it provided instructions, such as the above, directly from the head office in the U.S. but that it attempted to transplant to its overseas operations the same systems of control it used for managing its domestic operations. From the viewpoint of Nippon Electric this was interpreted to mean that WE management methods were to be introduced and aggressively learned. The management methods of WE were generally divided into cost accounting and other quantitative types of management, and production control used inside the plants. In addition, however, they also included work methods for daily affairs, such as receiving product orders and issuing purchase orders, and even clerical systems in the office.

At the end of every month, the company checked the cash on hand, the ledgers, and vouchers, and conducted a detailed inventory of products. The ledgers and vouchers were all prepared in the same format as those used by WE. Everything was printed in English, with Japanese translations.

WE supplied its subsidiaries and affiliates not only with telephone equipment it manufactured but also with ledgers vouchers, catalogs, and other office supplies. When ordering supplies, therefore, Nippon Electric used order vouchers identical to those WE used. The clerk in charge of placing such orders conducted his business by sending telegrams to WE's Supply Business Department.

It is not clear when Nippon Electric first began using WE's cost accounting system. Among the oldest records on file in Nippon Electric are instructions from WE dated 1902 and addressed to WE's subsidiaries in England. For Nippon Electric, P. K. Condict was sent from WE in 1907 to oversee improvements in the plant operations, including the cost accounting system. Condict became a Nippon Electric director in 1908; in later years, he was a vice president in IWE and eventually became president of International Standard Electric (ISE). His visit is said to have marked the beginning of a comprehensive cost accounting system in Nippon Electric. In 1915, Eizaburo Hata of Nippon Electric was sent to WE and later prepared a detailed report concerning the cost accounting system in the Hawthorne Plant. Concerning the loading rate for indirect production cost, Nippon Electric was using the labor loading system. The Hawthorne Plant, however, used the machine loading system. Hata felt that the labor loading system was more appropriate for Nippon Electric, but also felt a need to improve the system. WE used a system of standard cost accounting at its Hawthorne Plant, and Hata recommended that the same system be used at the Nippon Electric plant in Tokyo.

Production in the early years in Nippon Electric's plant was carried out under an internal subcontracting system. In this system, an oyakata ("boss") was responsible for each series of processes, such as wood processing, lathe processing, assembly, painting, and so forth. The oyakata recruited teams of workers to do the work inside the plant. As the plant expanded, however, the number of parts and types of machines and work units increased, leading to problems with the oyakata system. As well, the workers were often dissatisfied with the money the oyakata paid them. As the work became more detailed, moreover, the standards for paying daily wages became more complicated; it also became more difficult to adjust for differences among the subcontracted units. In order to introduce the comprehensive accounting system from WE, therefore, it was necessary to hold down labor costs. Condict pointed out problems with the oyakata system not long after he arrived in Japan from WE.

In October 1906, before Condict was sent to Japan, Iwadare visited WE in the U.S., his first visit since Nippon Electric was established. Iwadare had been in the U.S. before but was astonished by the plant management system he saw at WE. Two engineers from Nippon Electric were studying telephone equipment production technology at the Hawthorne Plant at the time—Saburo Nosaka and Chikashi Ebashi. After viewing operations at the Hawthorne Plant, however, Iwadare convinced WE to have their training schedules changed. Nosaka then began to study the plant's accounting system, and Ebashi its production control system. Following this visit to WE's Hawthorne Plant, Iwadare came to have stronger doubts concerning the oyakata labor subcontracting system. As soon as Nosaka and Ebashi returned to Japan in 1908, a move began to reform the systems in the plant.

Iwadare discontinued the oyakata subcontracting system in

1910. A new system of individual responsibility was introduced in which all factory workers contracted with the company and were paid according to their productivity. The switch away from the former subcontracting system, however, was not easy. It took about two years to abolish the old system and put a new system into effect. First, to make certain the daily wages paid to the workers were calculated fairly, a record-keeper was assigned to each oyakata, a record was kept of work operations, and standards called "piece-work-rate" were set for each operation of every part for calculating the daily output of each worker. Also, employees called "tracers" were placed in the plant to control the progress of work operations, based on the schedule agreed upon with the oyakata. Reports from the tracers enabled discovery of factors blocking smooth production. Also, inspections were introduced into each work process, and limits were set on the allowable disparity between blueprint specifications and actual work piece dimensions. In these ways, Nippon Electric's management and control systems moved a step closer to those being used in WE's plant. The system of individual responsibility was tied directly to wages paid for individual work efficiency, and the switch to that system is said to have resulted in a 15 to 20 percent increase in the wages of general workers in Nippon Electric. As a result, the wages of those workers became 50 percent higher than those of other workers in the private sector, and were on a par with the wages of workers in state-run plants. Wages were high in Nippon Electric, but control was strict. Time recorders sent from WE were placed at the entrance to the plant, and employees were required to punch in for work five minutes before the start of operations.

Managers sent to Japan from the U.S. led the transfer of management methods from WE to Nippon Electric. For its part, meanwhile, Nippon Electric sent engineers and other personnel to WE to undergo training in technology and management methods. Nippon Electric instituted a system of overseas education in 1905 and sent students to WE. The first two students were Nosaka and Ebashi, mentioned earlier. Most of the students were trained at WE's Hawthorne Plant. Their training was in either a one- or two-year program, and they returned home after receiving technical training regarding telephones, the manufacture of cable, and so forth. Some students, such as Nosaka and Ebashi, studied WE's accounting and production control systems.

5. Establishment of Management Foundation, and New Technology

Introduction of Common-Battery Switching System

The government's Second Telephone Expansion Plan, introduced in 1907, brought with it a rapid increase in the number of subscribers and central telephone offices, and major technical changes. One of the principal changes was a new telephone switching system: the common-battery switching system replaced magneto-type switches. The earlier magneto-type telephone system had to have its own battery for each telephone, together with the battery for the switchboard in the telephone office. In the new common-battery telephone system, it was necessary only for the telephone office to have a battery to supply electricity commonly to the switchboards in the office and to each telephone in the area. This new technology made it possible to produce smaller telephones, and made the telephone's operation much easier. Although use of the common-battery telephone system spread quickly in the U.S. from 1896, the first common-battery switchboard in Japan, imported from WE through Nippon Electric, was installed in the Kyoto telephone office in 1903. The common-battery telephone system required a large-capacity battery, causing problems such as reduced insulation efficiency of the switchboard cables in telephone offices. For that reason, and because it is so humid in Japan, the Ministry of Communications was not aggressive at first in using the new switchboard. This drawback was resolved, however, after the Ministry of Communications developed enameled cable that replaced the former silk-covered cable.

The all-out use of the common-battery telephone system dates from its installation in the Shiba Telephone Office in Tokyo in 1909. The Ministry of Communications began ordering enameled cable from WE. Also, during the first stage, the Ministry of Communications installed common-battery switchboards imported from WE. Because magneto-type switchboards continued to be used in Japan, however, it was necessary that the common-battery switchboards be compatible with them. Nippon Electric resolved this problem by developing connecting equipment.

It was not long before Nippon Electric began manufacturing common-battery telephone sets on its own. With guidance from WE, it also began manufacturing common-battery switchboards. In these ways, the introduction of the common-battery telephone system presented Nippon Electric with a new business opportunity. Taking advantage of this opportunity, the company first imported and sold common-battery switchboards made by WE and then later began supplying the market with products it manufactured in-house.

When Nippon Electric was founded, it had a total of 92 employees, comprising 19 clerical workers and 73 factory workers. In 1907, the year the government introduced its Second Telephone Expansion Plan, there were 85 clerical workers and 341 factory workers, 426 in total. By 1912, when the Second Telephone Expansion Plan ended, these numbers had increased, respectively, to 115 and 581, a total of 696. Most of the managers among these employees were engineers with experience in the Ministry of Communications who later joined Nippon Electric. In contrast, up to 1914 there were very few employees who had received technical education at some sort of educational institution. The increase in the number of such employees came in the next stage of the company's growth.

Expanded Sales, and Increased Capital

The principal customer for Nippon Electric's telephones and switchboards was the Ministry of Communications. There was also a strong military demand for communications equipment.

The demand from these two areas alone accounted in 1907 for about one-third of total sales. In 1912, that demand jumped to over 50 percent of total sales. In contrast, the demand from the private sector for electric lighting products and power-related products continuously accounted for over half of Nippon Electric's sales. These were products made overseas and imported mainly from WE and GE. For handling sales of telephones and switchboards, Nippon Electric established a dedicated Ministry of Communications Sales Department. For handling sales of products aimed at the private sector, it established a General Sales Department. Because the telephone equipment business depended on the government's budget, it was not an entirely stable market. Sales to the private sector, meanwhile, were depended on to support any drop in demand from the government. Besides the sales departments in the head office, the company opened an Osaka Branch Office in 1906. That office handled the expansion in demand in western Japan for telephone installations and sales to the private sector. The head of the Osaka Branch Office was Matsunosuke Matsushiro, an engineer from the Ministry of Communications who Iwadare invited to join Nippon Electric. Overseas offices, meanwhile, were opened in Seoul in 1908 and Dalian, China, in 1909. These two offices handled the increased telephone business in Korea and China.

The assembly of imported components and the manufacture of products began at approximately the same time in the plant Nippon Electric acquired when it was founded. The challenge of management was how successfully WE technology could be applied to domestically manufactured products. The company categorized its sales at this time into Nippon Electric products made in-house, WE products imported, non-WE products imported, and non-Nippon Electric products made domestically. According to this categorization, in 1907 the sales of Nippon Electric products—28 percent of total sales—were about equal to sales of WE's products. This situation continued for several years until 1911, when sales of Nippon Electric products accounted for about one-third of the company's total sales. In 1912, however, the sales of Nippon Electric products far exceeded those accounted for by WE's products, 43 percent versus 27 percent. And in 1914, the sales of Nippon Electric products exceeded 50 percent of the company's total sales for the first time.

Sales around this time were 943,000 yen in fiscal 1900 (December 1899—November 1900). In fiscal 1907, however, the first year of the Second Telephone Expansion Plan, sales were 1,632,000 yen, 1.7 times those in 1900. In 1912, the final year of that plan, sales were 3,251,000 yen, 3.4 times those in 1900.

During the period from 1899 when the company was established to 1914, Nippon Electric's paid-in capital increased ten-fold, from 150,000 yen to 1.5 million yen. The composition of the shareholders during that period, however, remained basically the same as at the company's founding. Whenever the company increased its capital, it allocated new shares according to the number of old shares a shareholder held. When capital was increased in 1906 for the first time, 200,000 yen of the total increase of 300,000 yen was transferred to the capital account to be used to pay special dividends. When the capital was increased the second time, in 1909, about 180,000 yen of the total increase of 500,000 yen was used to pay special dividends. Capital was increased again in 1912 for paid-in capital of 500,000 yen. This increase was made by payments from shareholders.

Chapter 2

Technology Takes Root, and Business Develops: 1914 – 1932

1. Changing Business Opportunities

First World War and Telephone Business

During the roughly 10 years following the outbreak of the First World War in July 1914, the business environment surrounding Nippon Electric underwent bewildering change. One reason was significant changes in the government's plans related to the telephone business; another was the effect the First World War had on the international environment and on the Japanese economy. On the one hand, while the government's telephone business expansion plans temporarily ended with completion of the second plan in 1912, an economic boom accompanying the First World War started in 1915. And from 1916 the government began implementing its Third Telephone Expansion Plan. For some time even after the end of the war, the economic boom and expansion of the government telephone plan continued. Before long, however, a period of recession set in.

When the Second Telephone Expansion Plan ended in 1912, the government temporarily suspended the special expenditures related to its telephone business. During the six-year life of the Second Telephone Expansion Plan, the government had invested 26 million yen and enrolled 140,000 new telephone subscribers. Despite the large number of new subscribers, the increase in demand was at an even faster rate than the growth in accommodating capacity. In fact, applications for new telephone installations did not slow down, and in 1912, the year the Second Telephone Expansion Plan ended, there were about 120,000 applications wait-listed. The government did not implement its Third Telephone Expansion Plan immediately after the second plan because of the tight fiscal policy it introduced to combat the poor business situation.

Nippon Electric's principal market around this time was the government sector. Contrary to popular belief, the demand from this sector was not entirely stable. Shifts in government spending policies influenced it strongly, giving it an unstable aspect. The fluctuations were reflected in Nippon Electric's total sales. In 1912, for example, sales reached a peak of over 3.2 million yen. But they fell in 1913 to 2 million yen, less than two-thirds of the 1912 figure. Sales then continued sluggish until 1916, the year the government introduced its Third Telephone Expansion Plan. The reduced expenditures in the telephone business by the Ministry of Communications tied directly to a decrease in Nippon Electric's sales. The company's profits were also affected, with a loss of 4,692 yen in 1913. The drop in sales of products Nippon Electric made in-house was especially severe, and operation losses at the plant increased. For the first time since its founding, the company had to carry out a thorough downsizing. For each of the three years from 1913 it reduced the number of factory workers by 20 percent while maintaining the number of clerical workers at their peak level.

Although sales decreased across all product areas, business from sales of Western Electric (WE) products directly linked to the telephone business dropped especially sharply. In contrast, no such sharp drop was seen in the amount of business handled of either non-WE imported products or products made by other companies in Japan. This was because Nippon Electric had developed business in sectors other than telephone equipment, especially lighting products, power supplies, and home electric appliances. It focused on the expansion of sales in products made by Japanese as well as overseas companies. The percentage of profit from these products was low but their sales contributed toward halting a drop in overall sales and tied to providing work for the clerical staff. Sales of products made in-house by Nippon Electric, meanwhile, dropped sharply from 1.4 million yen in 1912 to 800,000 yen in 1913, the year after the Second Telephone Expansion Plan ended. Not long after the First World War started, however, sales of Nippon Electric's in-house products moved toward recovery. Contributing especially noticeably to this sales growth during the First World War were orders from Russia for military-use telephones.

The strongest positive influence of the First World War on overall Japanese industry started to take effect in 1915. Although Japan had been importing a wide variety of industrial products from the United States and countries of Europe, the war halted all such imports. Rather than hurting Japan, however, the situation had a positive influence on the promotion of Japanese industry as companies turned to domestic manufacturers for their supply of industrial products. Large companies subsequently emerged in almost all industrial sectors. The war also severely affected Nippon Electric. The value of WE products the company handled dropped further from the low level marked after the Second Telephone Expansion Plan ended. The value of products from other foreign companies Nippon Electric was handling also dropped after the war started. In that situation, the company covered for the imported products from the U.S. and Europe it had previously depended on by expanding the range of in-house products it was manufacturing. The manufacture of lead-covered paper cable took on particular importance.

Third Telephone Expansion Plan and Nippon Electric

The market recovery that followed the outbreak of the First World War, and the new business opportunities presented to Nippon

Electric, continued with the start in 1916 of the government's Third Telephone Expansion Plan. In the initial stage, this plan was not especially large: it had scheduled annual investments of 4.5 million yen, and 14,000 new installations per year. The government, however, revised the plan three times between 1916 and 1920, expanding it greatly each time. In the end, total investments were four times those originally planned. In that background, Nippon Electric's sales results in 1917 marked a new all-time high of 3.57 million yen; profits also reached a new high. Worth special note is the overwhelming percentage of total sales accounted for by sales of products manufactured in-house. Except from the period after the Great Kanto Earthquake of 1923 when automatic switching systems were introduced, products manufactured in-house continued to account for the largest relative share of Nippon Electric's total sales.

The favorable business situation in Japan accompanying the First World War ended the year after the war ended, in 1920. The subsequent recessionary period was long and serious. It was so bad, in fact, that the central bank had to provide relief to Japan's mainstay industries, such as textiles, steel, and shipbuilding.

The business environment surrounding Nippon Electric during the period from 1912 to 1920 thus saw bewildering change, whether related to the government's telephone expansion plans or to changes in the Japanese economy tied to changes in the international environment. Even as Nippon Electric was influenced by the ups and downs in telephone-related business from the government, it gradually absorbed technology from WE and moved steadily toward independence.

2. Expansion of Business

Plant Expansion

During the period of change following the First World War, Nippon Electric expanded its business in three principal directions: first, it expanded and improved its plant; second, based on the improved and expanded plant, it began manufacturing cable; and third, it entered the market in China. It was also during this period that Nippon Electric began cooperating with the Mitsui and Sumitomo groups.

Regarding the expansion and improvement of its plant, Nippon Electric had modernized the plant in 1902 and gradually afterward purchased additional land in the neighboring area, expanding the plant each time. The company temporarily halted new construction in 1913 with completion of the No. 6 Plant, but began a new phase of construction in 1919. The plant's original buildings were made of brick and were either two-storied with hipped roofs or one-storied with saw-shaped roofs. The No. 6 Plant, built in 1913, was the first two-storied building made of reinforced concrete. The trend toward building this type of structure—multi-structured and made of reinforced concrete—continued even after the new construction phase began in 1919. The new buildings were large, and floor space was usually three times that of previous buildings. One point of special interest is that while the general trend in Western countries in building state-of-the-art plants was to move away from multi-story and toward single-story buildings the trend in Japan with Nippon Electric was just the opposite. WE introduced the subcontractor for constructing reinforced concrete buildings, American Trading Company. At any rate, the plant's area was gradually increased until in 1922 it reached a total floor space of 28,000 square meters, 10 times the size of the original plant. And to reflect Japan's unique situation, emphasis was placed on making the buildings earthquake resistant.

The plant's expansion continued in step with the company's expanded scale of production. During this period of active plant expansion, the value of sales reached 9.6 million yen in 1922, a level 14 times the size of the average annual sales recorded for the first five years after the company was founded. In 1922, sales of in-house products rose to 5.05 million yen, accounting for 52.7 percent of total sales. And although the number of plant workers decreased between 1912 and 1915, it began increasing again from

1916. In 1921, the total number of plant workers was over 1,500.

Expanding Business to Include Cable

Since its founding, the principal products Nippon Electric handled were in the communications field—telephones and switchboards using wire. As early as 1904, the company manufactured prototype lead-covered electrical cable based on WE patents. Not long afterward, other Japanese cable manufacturers, such as Sumitomo Electric Wire and Cable Works (today's Sumitomo Electric Industries, Ltd.), also began producing prototype cable. Still, most of the cable used in Japan at the time was imported from WE, and Nippon Electric handled it. From 1913, lead-covered paper cable for use in telephone communications, which differed technologically from previous cable in that its conductor was encased in paper and covered with lead, was added to the products used in Japan. To head up the technological effort to manufacture that cable, Nippon Electric invited Eizaburo Hata of Yokohama Electric Wire and Cable (today's Furukawa Electric Co., Ltd.), to join the company as plant manager, thus continuing to prepare for its entry into cable manufacturing. Also in 1913, Nippon Electric purchased state-of-the-art automatic lead-encasing presses from WE. Related to that contract, WE sent an engineer named C.D. Hart to provide technical training, and Nippon Electric subsequently began manufacturing lead-covered paper cable.

When Nippon Electric entered this market, three companies were already specializing in the manufacture of wire and cable, including Sumitomo Electric Wire and Cable Works. Two of the companies, Sumitomo Electric Wire and Cable Works and Yokohama Electric Wire and Cable, began manufacturing telephone cable in 1912. Telephone cable, however, was much finer than other cable, and required a higher quality level of insulation. Up to then, it had been normal practice when manufacturing lead-covered cable to cover the cable conductor with cotton and to pass it through lead tubing. In contrast, the automatic lead-encasing presses manufactured telephone cable by automatically covering the cable conductor with paper and encasing it in lead, technology that WE developed. The conductor used for this type of cable was made in Japan. During the First World War, Nippon Electric—based on technology imported from WE—was manufacturing higher-quality products than those of the specialist wire and cable manufacturers. The company held an especially superior position in the area of multipair cable.

Business Expansion into China

Nippon Electric's entry into the market in China began with the advance of Japan into China from the time of the Russo-Japanese War. In 1905, the Korean government signed a treaty with the Japanese government for building a communications network on the Korean peninsula, and Japan had a monopoly in that project. Next, in 1908, the Chinese and Japanese governments signed a treaty for servicing and expanding the communications network Japan built in the southern part of Manchuria (northeastern China) during the Russo-Japanese War. This treaty gave Japan the right to service and expand the network. Japan's advance into Korea and China did not stop there but brought with it the entry of Japanese industry into both countries, expanding still further the demand for telephone equipment.

In that background, Mitsui and Company, Limited won a contract in 1915 from the Chinese government for constructing long-distance telephone lines tying together Hankou and Wuchang. The terms of the contract called for using equipment made in Japan, and Nippon Electric supplied some of the telephone equipment. This marked the first steps taken by Nippon Electric in entering the market in China. Based on that business transaction, Mitsui and Co.—which already had a powerful sales network in the huge Chinese market—and Nippon Electric subsequently signed an agency agreement, and Mitsui Gomei Kaisha, the holding company for the Mitsui zaibatsu, acquired 6.4 percent of Nippon Electric's shares. That made Mitsui Gomei Kaisha the company's third largest shareholder after WE and Iwadare. Masatsugu Fujise of Mitsui and Co. became a director of Nippon Electric.

In 1918, the Chinese government, WE, and Nippon Electric established China Electric Company, Limited (CEC), with the latter two companies each acquiring 25 percent of total equity. The main aims in setting up CEC were to manufacture and sell the machinery, equipment, materials, and components required for the Chinese government's telegraph and telephone businesses. The head office of the new company was in Beijing and a branch office and its plant were in Shanghai. WE had long wanted to enter the Chinese market, and WE's Vice President G. Swope had begun preparations from 1915. The plan was put into effect because of the positive relationship that developed between the Chinese government, on the one hand, and the Japanese government and Nippon Electric, on the other. Nippon Electric and Mitsui and Co. terminated their agency contract in 1918 after CEC was established. Mitsui and Co., however, maintained its position as Nippon Electric's third largest shareholder (at times, second largest) until 1935.

Although Nippon Electric thus gained a foothold in the huge Chinese market through CEC, sales activities did not progress as smoothly as originally planned. Not long after establishment of CEC, Sino-Japanese relations worsened and products made in Japan were driven from the mainland. Although CEC had agreed under the original contract to import products from Nippon Electric, in the developing circumstances CEC imported products only from WE.

Business Ties with Sumitomo

Meanwhile, although Nippon Electric had begun manufacturing cable, it had difficulties securing supplies of copper, and price competition with other manufacturers was severe, making expansion of the cable business difficult. Iwadare thus decided instead to concentrate on manufacturing telephones and related equipment, and in 1920 the company transferred its cable manufacturing, including rights to the use of patents, to Sumitomo Electric Wire and Cable Works.

In July 1919, P. K. Condict, vice-president of International Western Electric (IWE), visited Japan to receive a medal from the

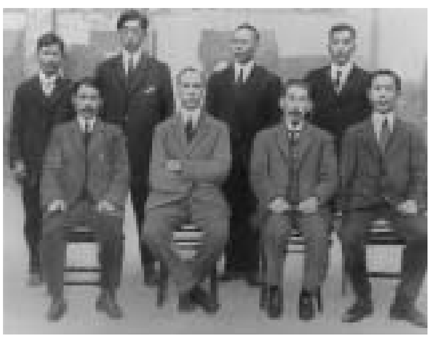
Japanese government. (WE established IWE in 1918 to oversee its international operations, and WE's equity in Nippon Electric was transferred to IWE.) While in Japan, Condict sounded out Iwadare concerning establishment of U.S.-Japan business ties for manufacturing rubber-covered electrical wire. Because of the difficult situation in the cable manufacturing industry, Iwadare discussed the matter with Saitaro Oi, former manager of the Engineering Division of the Ministry of Communications. Without hesitating, Oi recommended Sumitomo Electric Wire and Cable Works as a partner in the project. Not long afterward, Oi joined Nippon Electric as a director, and business talks between Nippon Electric and Sumitomo subsequently moved forward.

At the time, the Ministry of Communications was beginning to use duplex cable for telephones, and Nippon Electric was designated the sole supplier of WE duplex cable products. Iwadare told Sumitomo that if the two companies agreed to business ties, Nippon Electric was prepared to halt its manufacture of cable and to turn over to Sumitomo Electric Wire and Cable Works all the cable production machinery and know-how it had obtained from WE. Even more than the rubber-covered electrical wire technology, Sumitomo was keenly interested in WE's duplex cable manufacturing machinery and know-how. Negotiations with Sumitomo ran into difficulties related to Nippon Electric acquiring a percentage of its shares, but in the end it was Sumitomo's patents on high magnetic intensity steel that proved to be the decisive factor. In October 1920, a contract was signed by Condict, Iwadare, and Kichizaemon Sumitomo. According to the contract: (1) Sumitomo Electric Wire and Cable Works was reorganized into Sumitomo Electric Wire and Cable Works, Limited, and Nippon Electric acquired 25 percent of Sumitomo Electric Wire and Cable Works' shares and Sumitomo Electric Wire and Cable Works acquired 5 percent of Nippon Electric's shares; (2) Iwadare and Oi became directors of Sumitomo Electric Wire and Cable Works, Kinkichi Nakata of Sumitomo Goshi Kaisha (the holding company of the Sumitomo enterprises) became a director of Nippon Electric, and L. W. Tucker of WE became an auditor of Sumitomo

Saitaro Oi (1856-1924)
Oi played a key role in the Ministry of Communications in the early years of Japan's telephone business. An alumnus of the same class with Iwadare, he joined Nippon Electric in 1919 as a director after providing key advice when Nippon Electric and Sumitomo entered into equity ties.

P. K. Condict (1880-1949)
Condict came to Japan in 1907 to introduce WE management methods in Nippon Electric. He subsequently served as a director and contributed substantially to the company's growth for 21 years, until he resigned as president of ISE in 1937.

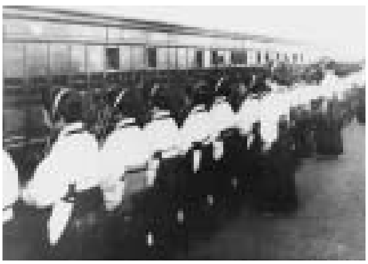
In 1920, Nippon Electric and Sumitomo Electric Wire and Cable Works agreed to equity ties. The October 1921 issue of *Western Electric News* introduced Sumitomo's Osaka Plant with photos of Kunihiko Iwadare (right) and Kichizaemon Sumitomo.



Nippon Electric entered the cable business from 1913. C. D. Hart of WE trained Nippon Electric's cable division engineers. Some are seen here with Hart. S. Kiguchi, sitting far left in front row, later was sent to WE's Hawthorne Works for training.

By 1920 WE's management methods, including work rules and preparation of manuals, took firm root in Nippon Electric. Here, engineers are at work in the engineering and production control division in 1922.

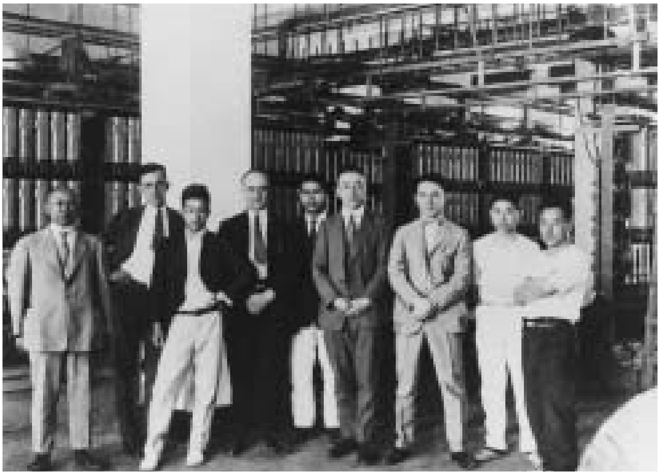
Western and Japanese methods often existed side by side. Here a female clerk in the accounting department checks figures with a Japanese soroban. A Western-style calculator also sits on the desk.



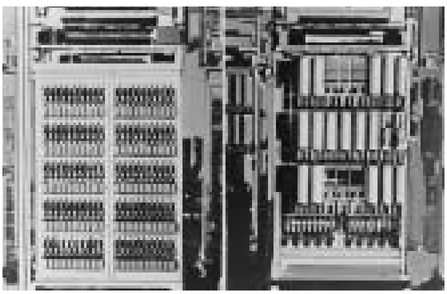
The first large-size common-battery switchboard for long-distance calls was installed in a telephone office opened in Tokyo in 1919 for exclusively handling long-distance calls.
(Photo courtesy of Teishin General Museum)

Common-battery switching systems allowed the production of much simpler telephones. The Type 107 telephone introduced in 1924 was officially called the Type 2 common-battery type desk telephone.

Large volumes of cable were used for switchboards. Most cable production processes were manual. The photo shows a factory scene in the Mita Plant in 1922.



Following the Great Kanto Earthquake, the Ministry of Communications decided to introduce Strowger-type automatic switching systems. Nippon Electric supplied the first of such systems imported from ATM to six telephone offices in Tokyo. These engineers installed the automatic switching system in the Kyobashi Branch Telephone Office.
(Photo courtesy of Teishin General Museum)



Nippon Electric produced Japan's first domestic-made A-type automatic switching system in July 1929 and delivered it to the Nakano Telephone Office in Tokyo. Service began using the switching system in March 1930.

NE-type phototelegraphic equipment developed by Y. Niwa and others in Nippon Electric successfully transmitted clear scenes of the Imperial Accession Ceremony of Emperor Hirohito held in Kyoto in November 1928.

Gen-ichiro Ohata
Ohata was managing director from September 1929 to June 1932. He was in charge of reconstruction work after many buildings in the Mita Plant were destroyed in the Great Kanto Earthquake of September 1, 1923.

The Great Kanto Earthquake struck the Tokyo-Yokohama area in September 1923. Even earthquake resistant buildings in Nippon Electric's plant were destroyed. The second and third stories of 3-story reinforced steel buildings collapsed (top). Workers in silent prayer after initial rescue efforts (right).

Radio Tokyo began Japan's first regular radio broadcasting in July 1925. Nippon Electric decorated its trucks with banners to promote the spread of radio broadcasting.

Electric Wire and Cable Works; (3) WE transferred the rights to Sumitomo Electric Wire and Cable Works to use its duplex cable patents, and Sumitomo assigned the rights to WE to use its high magnetic intensity steel patents; (4) Nippon Electric sold at book value to Sumitomo Electric Wire and Cable Works the machinery it had for manufacturing duplex cable, patent and production information, and raw materials and parts it had in inventory; and (5) an agency agreement was signed between Nippon Electric and Sumitomo Electric Wire and Cable Works.

After joining Nippon Electric as a director prior to the start of negotiations with Sumitomo, until his death in 1924, Saitaro Oi served as an excellent adviser to Iwadare and contributed substantially to Nippon Electric's growth. Condict remained a director of Nippon Electric from 1920 until he left his position as president of ISE (as will be discussed later, IWE became ISE in 1925) to retire in 1937. In that position he continuously provided top management in Nippon Electric with guidance and advice.

3. Management after Great Kanto Earthquake

Great Kanto Earthquake

At the end of over 10 years of tumultuous change in the business environment, starting with the First World War, another calamity struck Nippon Electric in the form of the Great Kanto Earthquake of September 1, 1923. This tremendous natural disaster was ruinous to the Kanto area (Tokyo and its surroundings), and it devastated the company's head office and plant. In the reconstruction period following the earthquake, however, the telephone business in Japan developed rapidly. In particular, the government decided to replace manual switchboards with automatic switching systems. In addition, radio broadcasting began around this time, and Nippon Electric turned quickly to manufacturing the new switching systems and broadcasting equipment. This was actually a period of great upheaval for all of Japanese society, and included a large-scale labor dispute at Nippon Electric in 1924.

The Great Kanto Earthquake that struck on September 1, 1923, and the resultant fires, caused particularly devastating damage in the Tokyo and Yokohama area. An estimated 140,000 persons were killed, and another 3.4 million persons were injured or otherwise affected. At Nippon Electric, all the newly built reinforced concrete buildings were either partly or totally demolished, and 105 employees were killed. Among the dead were W. T. Blume, an engineer sent to Tokyo from WE, and Motoo Takami, manager of the Engineering Department. The only structure left standing at the plant was the red brick building dating from its earliest days. Usable floor space after the earthquake was reduced to half of what it had been. It took about seven months, until March 1924, to rebuild the plant buildings and repair or replace the damaged machines and equipment. Because of the earthquake damage, Nippon Electric recorded a loss of almost 1.4 million yen in its business report for the period ending November 1923. The company covered the loss by using accumulated reserve funds.

The earthquake substantially affected the Japanese communications network. Of the 19 telephone offices in Tokyo, 13 of them, including the Tokyo Central Telephone Office, were completely gutted by fire and another two were heavily damaged. Many telephone lines were cut, and 64 percent of the total of 83,000 telephones in service were destroyed. The situation was much the same in Yokohama: both of the city's central telephone offices were destroyed by fire, and 90 percent of the telephones in service were destroyed. Communications in Japan's capital city were paralyzed for eight days.

To respond quickly to restoring telephone service in the Kanto area, Nippon Electric shifted its manufacturing operations to a wood processing plant in Shibaura. It even set up work processes in the area surrounding the plant. WE also responded quickly. Director A.G. Jillard of WE, who had been sent to Nippon Electric, had by coincidence returned to the U.S. temporarily and was safely away from Tokyo when the earthquake struck. But Vice President Condict of IWE, concurrently a director of Nippon Electric, was in Japan at the time and reported on the terrible situation in Tokyo and Yokohama to both IWE and WE. He cooperated with Iwadare and Plant Manager Hata immediately after the earthquake to assist in Nippon Electric's recovery. It took until June 1924 to return the company's manufacturing division to its pre-earthquake condition. During the time that its manufacturing activities were halted, Nippon Electric supplied nearly 80 percent of the orders it received for telephones by delivering WE products and products of WE-affiliated companies. In other words, Nippon Electric used imports to meet the emergency demand created during the period of restoration following the earthquake.

Nippon Electric decided to construct entirely new buildings on the site of those destroyed in the earthquake, modeling the new buildings after those in the Hawthorne Works of WE. They included three-story, steel-framed, reinforced concrete buildings. The company planned to complete the rebuilding of the plant, covering 40,000 square meters, over seven reporting periods. Reflecting on its experience from the earthquake, the company requested assistance from outside experts from the design stage of construction, and put Director Gen-ichiro Ohata in overall charge. The first construction stage was completed in August 1925.

Automatic Switching System Introduced

The Japanese government placed a top priority on restoration of telephone service in the Kanto area. The basic restoration policy the Ministry of Communications adopted was to take advantage of this opportunity and automate the telephone switching systems. Engineers in the Ministry had already developed a strong interest in automatic switching, and in 1922 a Strowger-type automatic switching system made by Automatic Telephone Manufacturing Co. (ATM) of the U.K. was installed in the Ministry and was being experimented with. The Dalian Central Office in Manchuria had been automated in April 1923 with this same equipment, and was operating successfully. Engineers from Nippon

Electric participated in the installation work in Dalian and their work so impressed ATM that it invited Nippon Electric to become its general sales agent in Japan, taking the agency away from L. J. Healing & Co. Nippon Electric thus came to hold an advantageous position when the Ministry of Communications introduced automatic switching systems.

Besides ATM, other companies manufacturing automatic switching systems at the time included Siemens & Halske and a manufacturer affiliated with WE. In the first phase of changing over to automatic switching systems, the Ministry of Communications called for bids targeted at six telephone offices in Tokyo. In the end, the Ministry decided to use Strowger-type automatic switching systems made by ATM. As the general sales agent for ATM in Japan, Nippon Electric received orders for all the equipment. Since ATM had business ties with WE, in December 1924 Nippon Electric ordered the equipment from Standard Telephone & Cables (STC), one of WE's affiliates in England. STC put itself in charge of general design and manufacture of the cables needed in the automated offices and commissioned ATM to manufacture the automatic switching systems. Nippon Electric received the call indicators, devices used for connecting the automatic and manual switchboards, from WE. The total contract for automatic switching systems for six telephone offices amounted to over 8 million yen, an unprecedented sum. For reasons related to the production capacity of ATM, some components were made in the U.S. and assembled in Nippon Electric with technical guidance from ATM engineers. Engineers also visited Japan from WE to oversee and resolve problems related to installing the call indicators. Based on the experience it gained at this time, Nippon Electric acquired the technology and expertise later needed for localizing the manufacture of automatic switching systems.

Next, in 1926, the second stage of the government's plans to automate its telephone offices was carried out, targeting six telephone offices—four in Tokyo and two in Yokohama. Strowger-type systems were used in Tokyo, as previously, with the equipment manufactured by Automatic Electric, Inc. (AEI), of the U.S.

In Yokohama, however, after bids were received from competing companies, Siemens-type systems were used. Nippon Electric received the order for the four offices in Tokyo; Fuji Electric Co., Ltd., a company affiliated with Siemens, received the contract for the two offices in Yokohama.

Nippon Electric began planning to produce automatic switching systems in-house right from when it decided to import them. The systems it imported and installed were Strowger-type automatic switching systems made by ATM or AEI. In that background, Nippon Electric started in-house production of an automatic telephone switching system in 1926. It completed the first domestically made system in July 1927 and installed it in the Mitsukoshi Department Store in Tokyo as a private automatic branch exchange. After that success, the Ministry of Communications designated Nippon Electric an official supplier of automatic switching systems in 1928. The company installed the first domestically produced central office automatic switching system in the Nakano Telephone Office in Tokyo in 1929. It began operating in March 1930. Automatic switching systems made by Nippon Electric came to be installed widely throughout Japan from 1930. In this way, Nippon Electric established a firm base as Japan's foremost manufacturer of automatic switching systems.

Radio Broadcasting, and Broadcasting Equipment

The Great Kanto Earthquake demonstrated the limitations of wire communications. Together with the restoration of telephone services in the Kanto area, therefore, the Ministry of Communications decided on a new policy of promoting wireless communications. It was at this time, in response to the start of radio broadcasting by the government, that Nippon Electric entered the radio communications field. WE had already opened a radio broadcasting station in the U.S. in 1922, and General Sales Manager Matsunosuke Matsushiro pulled together a proposal in 1924 for Nippon Electric's entry into the radio communications business. Based on that proposal, the company subsequently decided to begin importing and selling radio equipment and to establish a radio experimental lab.

Also in 1924, Nippon Electric purchased 500W broadcasting equipment from WE for use in PR broadcasting.

Radio Tokyo, established in November 1924, began experimental radio broadcasting in March 1925. All-out radio broadcasting began in July 1925 in Tokyo using 1kW broadcasting equipment made by WE that Nippon Electric imported. The first radio broadcasting began at stations in Osaka and Nagoya almost immediately afterward, and these three radio stations were reorganized into Nippon Hoso Kyokai (NHK), established in August 1926. From 1928, radio stations were opened successively in provincial cities. Although Nippon Electric initially responded to calls for bids with broadcasting equipment made by STC, the company moved forward simultaneously with plans to produce broadcasting equipment on its own. When the NHK radio station in Okayama began service in 1931, it used 500W broadcasting equipment made by Nippon Electric.

Management During Great Depression

Nippon Electric's business took a favorable turn after the Great Kanto Earthquake, due mainly to business related to the government's restoration of telephone service in Tokyo and Yokohama and the introduction of automatic switching systems. The government, however, adopted a stringent budget policy, and reduced its telephone expansion plan in 1924 to about half the size of the original plan. Recovering from 1924, Nippon Electric's business results reached a peak in 1926 and afterward began trending downward in both sales and profit. From 1928, in particular, sales and profit both began a noticeable decrease that continued for several years. Sales eventually decreased in 1931 to only 22 percent of what they were at their peak in 1926.

The period until the second half of 1931, when the company's business results turned upward once again, thus comprised a long, difficult period for Nippon Electric. The primary cause of the difficulties was a long-term economic recession called the Showa Recession that brought about reductions in the national budget, especially funds for telephone expansion. Actually, an unfortunate statement by the Finance Minister in March 1927 led to a popular response that later snowballed to become a serious financial crisis. In the U.S., Black Thursday, October 24, 1929, was a preamble to the New York stock market crash. Japan was then caught up in the maelstrom of the World Depression. The Japanese government, nevertheless, introduced a tight fiscal policy and moved to improve the nation's balance of international payments. The Ministry of Communications revised its Third Telephone Expansion Plan—begun in 1916—almost every other year afterward, continuing until 1932. The revisions related mainly to the period covered by the plan and the scale of investments. After 1926, the plan was reduced in scale each time it was revised. As a result, the funds available for implementing the plan fell to 11.9 million yen in 1931, just 24 percent of the peak level of 48.6 million yen reached in 1926. Besides the difficulties related to the reduced government budget, other causes were the emergence of economic nationalism that tied to increased pressure on foreign-affiliated companies, and the policy of the Ministry of Communications to have multiple suppliers for the same type of equipment. Nippon Electric's share of the total business from the Ministry of Communications decreased from 24 percent in 1927 to 16 percent in 1931.

Despite the difficulties the company experienced, however, it moved forward internally to develop independent technology and accumulate technological competence. Out of those moves was formed a unique set of technologies. In later years, those technologies took on important significance for the company's growth and corporate identity.

In 1930, the Ministry of Communications announced regulations for promoting domestic production and, based on them, purchasing regulations. The purchasing regulations included standards for defining domestically manufactured products to put into practice the domestic production promotion policy. They emphasized that products meeting the standards would be purchased on a priority basis, and stipulated that such products would benefit by having the Ministry designate them rather than have them compete in bids. "Purely domestic-made" products were defined roughly as follows: they were products for which the original manufacturer was a company in which Japanese shareholders held 51 percent or more of the equity; they were products not made by companies assembling foreign components; and they were products not manufactured on the basis of foreign patents, imported patents, or patents on which patent fees were being paid to foreign companies. If a product failed to meet even one of these three requirements, the Ministry would not consider it purely domestic made. At the time, a foreign company owned 59 percent of Nippon Electric's shares. Also, most of its products were being manufactured based on WE patents and blueprints. There was thus no way Nippon Electric's products could be considered purely domestic-made. Placed in such a disadvantageous position because of these regulations, the company felt a sense of growing crisis. It responded by moving quickly to locally manufacture automatic switching systems and other products and to promote the development of its own technology.

Government measures to promote domestic production took on an additional aim besides that of encouraging the development of domestic technology: they took on stronger colorings of excluding foreign capital. For example, the government addressed the exclusion of foreign capital control and foreign capital profits by scrutinizing the percentage of foreign capital in a company. Also, the government aimed at freeing Japanese companies from the technological control of foreign companies by emphasizing the matter of foreign patents. These measures related closely to the widely prevailing exclusionary thinking in Japanese society at the time. And Nippon Electric was viewed as a representative company under foreign capital control. In the same industry, Fuji Electric was a joint venture between Furukawa Electric and Siemens Schuckert Werke. Although Fuji Electric was not viewed as being under the control of foreign capital, it was manufacturing its automatic switching systems and other communications equipment based on foreign patents. It thus had to quickly move toward wholly domestic production. In that background, Nippon Electric began reviewing its relationship with foreign capital.

Around the same time that the government began viewing Nippon Electric as a foreign-affiliated company, a major change occurred related to International Western Electric (IWE). In 1925, International Telephone and Telegraph Corporation (ITT) bought out IWE and changed the company's name to International Standard Electric (ISE). ISE subsequently took control of IWE's 10 overseas affiliates, except the subsidiary in Canada. Nippon Electric thus became a subsidiary of ISE. ISE also inherited the directors and employees of IWE, and P. K. Condict, a vice president of IWE and director of Nippon Electric, and A. G. Jillard and Douglas F. G. Eliot, seconded to Nippon Electric from IWE, remained in their positions. Concerning the technical information and the patents Nippon Electric was obtaining from WE through IWE, an agreement for mutual exchange was signed between WE and ITT. Then, in September 1926, ISE and Nippon Electric entered into an agreement regarding the mutual exchange of technical information and patents, and Nippon Electric continued to receive information and patents as before. Also, the system of control over Nippon Electric reverted almost intact from IWE to ISE. Nippon Electric continued to experience budget controls, and filed the Monthly Letter as done previously.

Iwadare Retires, and Ohata Becomes Managing Director

In 1926, the year after Nippon Electric's parent company changed from IWE to ISE, another major event occurred that affected Nippon Electric. In December 1926, Kunihiko Iwadare, managing director of Nippon Electric since its founding, resigned from his position and assumed the newly established position of chairman. It is difficult to express the tremendous contribution Iwadare made by developing the newly established Nippon Electric into becoming Japan's top manufacturer of communications equipment. Nippon Electric was Japan's first joint venture with foreign capital. And when it began manufacturing, it had no examples in Japan to follow. The company promoted a wide spectrum of discussions with WE, one of the world's foremost manufacturers of communications equipment at the time. As a manager who could handle the various problems that emerged, Iwadare was the ideal person with his background of experience in technology and manufacturing in the U.S. As chairman, Iwadare continued even afterward to support the management of Nippon Electric until September 1929 when he resigned the chairman position and left the company.

Iwadare's successor as managing director was Director Genichiro Ohata, in charge of IWE-related business in Nippon Electric. Ohata was formerly an engineer in the Ministry of Communications. He joined Nippon Electric in 1920 as assistant plant manager. After succeeding to Eizaburo Hata's position as plant manager in 1923, Ohata was appointed a director. Following the Great Kanto Earthquake of September 1923, Ohata contributed greatly to the recovery of the company's production activities. The other officers, besides Chairman Iwadare, when Ohata became managing director were Eizaburo Hata, Masajiro Fujise, Matsunosuke Matsushiro, Tsunekichi Asabuki, and Kankichi Yukawa (general manager of Sumitomo; chairman of Sumitomo Electric Wire and Cable Works), and Condict, Jillard, and E. C. Richardson as representatives of ISE. The auditors were Takeshiro Maeda and Tomizo Yajima (from Sumitomo Goshi Kaisha).

4. Technology Takes Root, and In-House Technological Development

Transfer of WE's Technology

Nippon Electric established its original Engineering Department in 1908, with Department Manager Ichiro Nakayama in charge of about 10 persons. The department's two principal duties were the handling of patents and technology from WE. It oversaw the use of WE's patents in Japan, and prepared blueprints and drawings for each production process and component, based on those received from WE. From 1913 to 1923, WE dispatched a number of technical advisers to Japan, including Hart, White, Holstedt, Jessup, Reigle, and Blume. Some were sent at the start-up of manufacturing new products; others were stationed in Japan as advisers to the plant division.

In a few words, the basic policy of the foreign business operations of WE was to install Bell telephone equipment throughout the world. Integral to the company's global strategy was assigning R&D related to telephone equipment to WE's research division. The basic policy was to take the results of the division's R&D, add expertise WE possessed in engineering, manufacturing, and marketing, and have the results realized in the company's overseas subsidiaries. In 1924, WE spun off its R&D division and established Bell Telephone Laboratories. WE's approach says much for the emphasis it placed on R&D. In 1918, moreover, the company established International Western Electric (IWE) and placed it in charge of its overseas subsidiaries. At that time, the R&D policy of WE did not change. The company never considered having its overseas subsidiaries develop products on their own.

From 1914, Nippon Electric began the regular hiring of personnel with engineering backgrounds. Records show the company hired a total of 115 workers with engineering backgrounds between 1914 and 1924, over double the number of clerical personnel hired during the same period. The hiring of workers with engineering backgrounds accounted for most of the college graduates and over half of the graduates of specialized schools the company hired. Most of these new employees were not necessarily assigned to the Engineering Department but to the plant. Some, in fact, were assigned to the head office and the branches. The Engineering Department was gradually expanded, from roughly 10 persons at the start to about 35 persons in 1924. Although a research division was established in the Engineering Department in 1920, the Engineering Department did not expand at the time to where it was developing new products. It played an important role when Nippon Electric began localizing the manufacture of products such as cable and common-battery switchboards.

Expansion of Engineering Department, and New Technologies
In the Great Kanto Earthquake in 1923, Nippon Electric lost the manager of the Engineering Department and suffered tremendous physical damage to its engineering facilities. In 1924, Iwadare moved to strengthen the Engineering Department by inviting Yasujiro Niwa of the Electrotechnical Laboratory of the Ministry of Communications to join the company as a researcher. In viewing the total dependence of Nippon Electric's technology on WE, Niwa emphasized the need for the company to develop original technology. Moves to bolster the Engineering Department along the lines of Niwa's ideas began from 1926, after Niwa returned from a trip to the U.S. and Europe to study the situation in the communications industry there. After becoming manager of the Engineering Department in 1927, Niwa expanded the department to cover 12 technical fields and reorganized it into the Engineering Division. Besides further research into traditional telephone equipment, Niwa wanted the Engineering Division to study long-distance telephone systems and radio, and certain other fields WE was not yet involved in. Two experimental labs—the Apparatus and Circuit Laboratory and Transmission Laboratory—were established in the Research and Development Department of the Engineering Division. Also, as a result of Niwa's policy of aggressively hiring college graduates with engineering backgrounds, many engineers who later played important roles in the company were hired, including Yasujiro Shimazu, Masatsugu Kobayashi, and Koji Kobayashi.

Under this new approach to technological research, various results in original research were achieved. One new product that attracted much attention was NE-type phototelegraphic equipment. WE, Siemens, Belin, and other companies were moving forward with the development of such products, and in the second half of the 1920s had brought them to the stage of practical use. In April 1928, a team in Nippon Electric, headed by Niwa and with cooperation from Masatsugu Kobayashi and others, completed the development of a similar system based on original technology. It just happened that the major newspapers in Japan were preparing at the time to use foreign-made phototelegraphic equipment to transmit scenes of the Imperial Accession Ceremony of Emperor Hirohito scheduled to be held in Kyoto in November 1928. The Tokyo Nichinichi Shimbun (today's Mainichi Shimbun), however, elected to use Nippon Electric's NE-type equipment. That equipment ended up transmitting the clearest photos quickly. Subsequently, the use of Nippon Electric's equipment spread rapidly in the domestic market. Although the original NE-type equipment required wire transmission, the company developed a wireless product in 1929, followed afterward by equipment capable of transmitting photos internationally.

While engineers in the Transmission Laboratory developed the NE-type phototelegraphic equipment, a representative product developed in the Apparatus and Circuit Laboratory, using original technology, was a remote supervisory control system. Yasujiro Shimazu and others finalized this system in 1929, and it came to be used for unattended operations at electric power plants and transformer substations. Later it was used for transmitting from unmanned communications stations.

There was much progress in the development of communications equipment technology during this period, and Nippon Electric quickly assimilated this technology and localized it in domestic production. As already related, after the Ministry of Communications decided to introduce automatic switching systems following the Great Kanto Earthquake, Nippon Electric began studying the in-house production of automatic switching systems.

For technology related to long-distance telephone service, it was mainly necessary to introduce and then refine various components, such as loading coils, vacuum tubes for communication systems, telephone transmission repeaters, and telephone carrier equipment.

A loading coil is a component inserted at regular intervals along a cable route to prevent attenuation of the electric current level that accompanies an increase in the length of telephone lines.

Loading coils came to be used in Japan from the 1920s. The first ones used were made by WE. In 1925, however, Nippon Electric began producing loading coils independently. Afterward, the company focused on downsizing the loading coils and making them lighter. Downsizing depended on advances in magnetic materials used in the cores of coils.

Another technology related to long-distance telephone service was development of a telephone repeater for amplifying signals that attenuate with the increased distance of telephone lines. From among the repeaters developed by WE engineers, in 1925 Nippon Electric began importing and using a triode vacuum tube repeater. Afterward, from 1928, the company began producing various amplifier tubes, including amplifier vacuum tubes for use in repeaters.

Structure of Nippon Electric's Workforce

During the period just prior to and after the First World War, major changes occurred in Japan's social structure and in the social values of the Japanese people. Among the employees of Nippon Electric at the time was a group of workers paid daily wages. The system of paying daily wages was started in 1910, when Nippon Electric established its production control organization. The workers being paid by the day were record-keepers inside the plant. Later, personnel in the inspection processes and the so-called "tracers" were also included among the workers paid daily wages. All of these workers were graduates of technical and other vocational schools, so their educational background differed from that of salaried workers. Because of the type of work they were doing, they were treated as clerical workers. Their income, however, was less than that of salaried clerical workers and also sometimes even less than ordinary factory workers.

At the end of 1923, the clerical workers in Nippon Electric being paid daily wages organized themselves, and in July 1924 they requested that the company improve their treatment. The other factory workers sympathized with the clerical workers paid daily wages, and management entered into negotiations with them. The negotiations broke down, however, and the workers went on strike from August 1. The newly organized nationwide workers federation provided support to the striking workers, and the strike continued for 52 days. The company finally accepted most of the demands of the workers, and the workers accepted the proposal of the chief of the Mita Police Station, who acted as mediator. As part of the agreement, 24 of the clerical workers being paid daily wages and 17 of the factory workers were discharged. This strike at Nippon Electric drew wide attention in Japanese society as a white-collar labor struggle.

In 1921, Nippon Electric had over 1,500 employees. At the end of 1923, the year of the Great Kanto Earthquake, the number decreased to 1,200 employees. Afterward, together with an improvement in the company's business results, the number increased to 1,713 employees. In the background of the severe Showa Recession, however, the number of employees dropped to 1,335 in 1931. Salaried employees accounted for 17 percent of the total workforce in 1926 and 21 percent in 1931. They were assigned mainly to the head office, the Osaka Branch, and the plants. Day-wage employees accounted for about 20 percent of the total workforce, and mainly worked in the plants as inspectors and for preparing blueprints. Factory workers, meanwhile, accounted for 60 percent of the total workforce in 1926 but dropped to 57 percent in 1931.

Chapter 3

Reform of Management Structure: 1932 – 1936

1. Management During Recovery from Great Depression

During the Great Depression, Nippon Electric's business results, both sales and profit, continued to decrease sharply over a long period. By 1931 sales had decreased to only 22 percent of what they were at their peak in 1926. Although afterward the company's overall business results turned toward recovery, sales did not surpass their previous peak—18,584,000 yen in 1926—until 1937.

In the early 1930s, the government began reviewing the retrenched budget for its telephone expansion plan, and from 1932 its policy turned toward expansion. In the course of several upward revisions, although the growth each time was small, the budget gradually moved toward expansion. Finally, in 1936, the budget surpassed the 48.6 million yen of 1926, reaching 69.3 million yen. The subsequent increased demand for communications equipment came not only from the expanded telephone plan of the Ministry of Communications but also from the military. Once into the 1930s, Japan strengthened its military advance into Manchuria on the Chinese mainland. Beginning with reinforcement of the communications network in Manchuria, the economic recovery supported by the demand from the military stimulated the demand for communications equipment. The influence of the military demand affected not only the traditional wired communications industry but also promoted the development of new fields such as radio equipment and vacuum tubes. High-power broadcasting equipment, ultrashort-wave multiplex telephone systems, and other new products were developed for those emerging fields. Radio broadcasting spread widely, and changes began occurring in a market that had depended up to that point only on telephones.

In these ways, new product fields were developed, and the telephone market began turning upward after bottoming out in 1931. Nippon Electric's business results also turned toward recovery. In percentage of total business from the Ministry of Communications, however, the monopolistic position Nippon Electric had held up to then clearly began deteriorating. The company's 23.8 percent share of total procurements of the Ministry of Communications held in 1927 dropped to 15.2 percent in 1931, and finally recovered to only 18.2 percent in 1936. The principal reason for that decrease was the Ministry's shift to a procurement policy of purchasing from multiple vendors, which enabled other communications equipment companies to realize technological growth and manufacture automatic switching systems, a field Nippon Electric had previously monopolized.

2. Entrusting Management to Sumitomo

Entrusting Management to Sumitomo

Kunihiko Iwadare, who left his post as managing director in 1926 to assume the position of chairman, had discussed with related persons his idea of entrusting the company's management to Sumitomo prior to leaving the company for good. Around March 1929, for example, he spoke about the idea with E. C. Richardson, a director of Nippon Electric and International Standard Electric's (ISE) representative in Japan, and Richardson conferred with ISE about the matter. Iwadare also spoke about the idea with Takesaburo Akiyama, managing director of Sumitomo Electric Wire and Cable Works. Akiyama passed on Iwadare's idea to top management in Sumitomo. In that background, representatives of ISE and Sumitomo began negotiating an agreement. In May 1932, ISE signed an agreement with Sumitomo to entrust the management of Nippon Electric to Sumitomo.

ISE understood that the Ministry of Communications did not evaluate Nippon Electric very highly, and was generally concerned about the future of foreign-affiliated companies in Japan. On the other hand, ISE was informed that the government and the general public evaluated Sumitomo highly. The parties agreed that entrusting Nippon Electric's management to Sumitomo would be a solution for adapting to the changes in the external situation.

In May 1932, an agreement was reached between Vice President J. E. Fullam of ISE and Director Akiyama of Sumitomo Goshi Kaisha (concurrently a director of Nippon Electric since December 1930), concerning the following conditions.

1. ISE will transfer 18,032 shares each of fully paid-up and partly paid-up shares it owns of Nippon Electric to Sumitomo Goshi Kaisha, and Sumitomo Goshi Kaisha will transfer an equal number of Sumitomo Electric Wire and Cable Work shares to ISE.

2. Sumitomo Goshi Kaisha will manage Nippon Electric jointly with ISE, with Sumitomo holding the final decision rights on personnel matters. This condition concerning personnel matters will continue for at least 3 years.

3. Sumitomo Goshi Kaisha will have the ultimate responsibility for decisions related to the internal policies of Nippon Electric, and will always keep ISE informed of those policies. Sumitomo will also welcome suggestions and advice from ISE.

4. ISE will provide advice and assistance regarding managerial and technical matters of Nippon Electric.

Following the agreement between the two companies, the decision was made at a special general shareholders meeting of Nippon Electric held in June 1932 to reduce the company's capital by 5 million yen. As a result of the agreement, ISE's holdings of Nippon Electric shares dropped from 59 percent to slightly under 50 percent while Nippon Electric shares held by Sumitomo-related companies, including Sumitomo Goshi Kaisha, increased from 5 percent to over 14 percent. The Sumitomo group, formerly the fourth ranking shareholder, thus became Nippon Electric's second largest shareholder after ISE, moving ahead of Mitsui & Co. and Dairoku Kyodo, Kunihiko Iwadare's holding company.

Changes in Organization and Management

Right after the agreement was signed, Sumitomo sent directors to Nippon Electric's board, and Akiyama served concurrently as the company's chairman. Chief Engineer Fumio Shida of Sumitomo Electric Wire and Cable Works replaced Gen-ichiro Ohata as managing director of Nippon Electric. Besides Ohata, two other directors who had contributed greatly to Nippon Electric's growth, Matsushiro and Hata, also retired from the board. Kunihiko Iwadare left his chairman position in September 1929, and his son Yoshinori Iwadare became a director. Yoshinori Iwadare remained on the board even after the Sumitomo directors were sent in. Also, Itaro Oi (son of Saitaro Oi), who had become an auditor after Takeshiro Maeda died in 1931, continued as an auditor. P. K. Condict and A. G. Jillard also continued as directors from ISE, but J. E. Fullam replaced E. M. Clark, who had replaced Richardson. Yunosuke Yasukawa from Mitsui & Co. and Tsunekichi Asabuki from Daiichi Life Insurance continued as directors. A point worth mention is that Akiyama and Shida, both from Sumitomo, were engineers.

Managing Director Shida introduced structural reforms in October 1932 that greatly reduced the size of Nippon Electric's organization. Up to then, the company had been divided into the head office and plant. Both had gradually expanded until the head office had four and the plant five divisions. Under the new organization, the head office had only the Sales Division and the plant had only the Industry Division. On the management side, a general manager and a chief engineer were placed immediately under the managing director. Takeshi Tsuzuki was brought over from Sumitomo Goshi Kaisha to be the general manager and was assigned to head the Sales Division. Yasujiro Niwa, formerly the head of the Engineering Division, meanwhile, was appointed chief engineer. Shida was concurrently head of the Industry Division. The former four divisions of the head office were reduced in size to departments and two heads of new departments were brought in from Sumitomo Electric Wire and Cable Works. Jinza Satori was appointed assistant manager of the Sales Division and head of the Sales Department, and Kiyoshi Ishikawa was brought in to head the General Affairs Department. Concerning domestic sales activities, the sales offices of Sumitomo Goshi Kaisha were made agencies of Nippon Electric; concerning overseas sales offices, the Seoul liaison office of Nippon Electric was closed soon after the reorganization and its duties were transferred to the Seoul sales office of Sumitomo Goshi Kaisha.

Afterward, as business results improved, the organization was expanded once again. In 1936, for example, there were four divisions—manufacturing, engineering, general affairs, and sales. The activities in the plants and the sales offices came under the responsibility of the head of the Manufacturing Division and the head of the Sales Division, respectively.

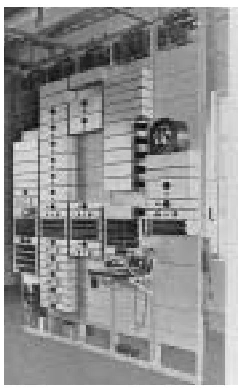
The new structure, with Shida in the center, saw Tsuzuki join the board as a director in 1933 (replaced by Nobuo Yamamoto in 1935). The board increased its seats by adding Niwa in 1934, and Satori (to replace Yasukawa from Mitsui & Co.) in 1936. The Akiyama-Shida leadership structure continued until Akiyama and Shida died suddenly one after the other in 1938.

Fumio Shida (1886-1938) Shida was managing director from June 1932 to April 1938. He was chief engineer at Sumitomo Electric Wire & Cable Works before joining Nippon Electric as a director. Shida developed the radio business into one of Nippon Electric's main businesses.

Takesaburo Akiyama (1873-1938) Akiyama was chairman from June 1932 to March 1938. When Vice President J. E. Fullam of ISE visited Japan to discuss turning over management of Nippon Electric to Sumitomo, Akiyama negotiated with him as a director of Nippon Electric and also representing Sumitomo.

Dr. Irving Langmuir, inventor of the high-vacuum electron tube, visited Japan in 1934 as a guest lecturer under the auspices of the Iwadare Scholarship Fund. Seated with Dr. and Mrs. Langmuir are former Chairman Iwadare (third from left), Managing Director Shida (second from right), and other Nippon Electric managers.

Nippon Electric exported its first domestically produced H-type automatic switching system to Manchuria in 1936. The second H-type system, shown here, was installed in the Hirano Telephone Office in Osaka in 1938.

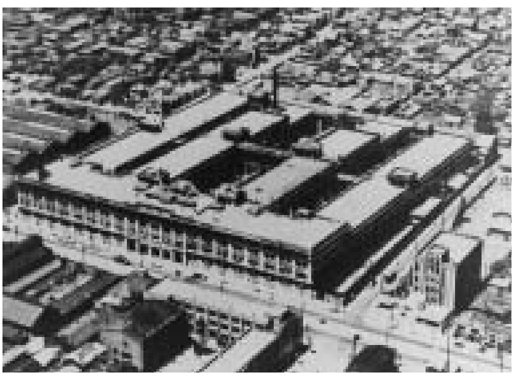


Nippon Electric developed a nonloaded cable carrier transmission system entirely with domestic technology and installed it in 1937 in Manchuria. Shown here is the terminal equipment in the Mukden Telephone Office.

Nippon Electric installed in 1937 50kW short-wave radio broadcasting equipment, the highest power in the world at the time, in the Nasaki Station of International Telephone Co., Ltd.

Nippon Electric was known in the 1930s for its strong men's volleyball team. In 1936, the company's team won the national title.

In order to respond to the increased demand for radio equipment, Nippon Electric built the Tamagawa-mukai Plant in Kawasaki, about 25 miles southwest of Tokyo. The photo shows the plant under construction in 1936.



Reconstruction of the Mita Plant, badly damaged during the Great Kanto Earthquake, was postponed due to the Showa Recession. It was begun again in 1935 and completed in 1938.

3. Promoting Communications Technology, and Entering Radio Field

Switching Systems, and Nonloaded Cable Carrier

Ahead of other companies, Nippon Electric succeeded in 1927 in manufacturing the A-type (ATM-type) automatic switching system in-house. In 1935, the company also began tackling domestic manufacture of the H-type (Siemens-Halske-type) automatic switching system, and produced its first system in 1936. Fuji Electric had been importing and installing H-type automatic switching systems since 1925, and did not begin producing them domestically until 1934. Even in the context of the new multiple vendor policy of the Ministry of Communications, Nippon Electric was only slightly behind Fuji Communication Equipment Manufacturing Co., Ltd. (spun off in 1935 from Fuji Electric; today's Fujitsu Limited) in producing the H-type switching system domestically.

Another particularly notable success around this time was the company's development and practical application of a nonloaded cable carrier transmission system. Shigeyoshi Matsumae, an engineer in the Ministry of Communications, and others proposed this system in 1932. In place of conventional loading coils, the system employed vacuum tube amplifiers to restore the attenuation of signals, to realize long-distance telephone communication. From Nippon Electric, Koji Kobayashi, a researcher, participated in this development project. This nonloaded cable carrier transmission system was developed entirely with domestic technology and installed in March 1937 for telephone communication between Andong (today's Dandong) and Mukden (today's Shenyang) in Manchuria. In 1939, the system enabled the world's longest telephone trunk line at the time, linking Tokyo and Mukden over a distance of 3,000 kilometers.

Entering Radio Field

Nippon Electric entered the radio field when radio broadcasting began in Japan. Based on the aggressive managerial policy of

Managing Director Shida, the company promoted its radio-related business by developing high-power radio broadcasting equipment and the in-house manufacture of vacuum tubes.

Nippon Electric began manufacture of low-power broadcasting equipment in 1930 for use in local broadcasting stations. The equipment was gradually installed during the early 1930s in broadcasting stations around the country. In response to subsequent requests for higher power equipment, Nippon Electric began designing 100kW high-power broadcasting equipment in 1933. Although radio broadcasting was in its earliest stage, the international situation at the time was growing increasingly tense and radio broadcasting was viewed as an important medium in the military's propaganda strategy not only domestically but also aimed at neighboring countries. The 100kW broadcasting equipment was delivered to the Hsinking (today's Changchun) Broadcasting Station of the Manchuria Telegraph and Telephone Corporation in 1934. Afterward as well, rather than for public broadcasting use inside Japan, the high-power broadcasting equipment was manufactured for use in Korea, Taiwan, and in the Imperial Army. This broadcasting equipment required new design of transmission tubes for amplifying power as well as various components. Although technically speaking this was the first time for Nippon Electric's engineers to handle much of this equipment, the company accomplished the necessary design and manufacture and delivered the unit in a relatively short time after receipt of the order.

The situation concerning short-wave broadcasting equipment was the same as that for medium- and long-wave equipment, with an expanding demand for high-power equipment addressed to overseas markets. In Japan, the first short-wave broadcasting service aimed at overseas was begun in 1932 from a broadcasting station of International Telephone Co., Ltd. Nippon Electric installed short-wave broadcasting equipment with 10kW of power in this broadcasting station, but soon afterward International Telephone placed an additional order for 50kW power equipment. No other short-wave radio broadcasting equipment in the world at the time had such high power. After receiving the order, Nippon

Electric's engineers in the radio and vacuum tube division worked exhaustively to design and manufacture the system. They completed it in a little over one year.

Vacuum tubes played an especially significant role as the radio field developed. In the background of the advanced technology it possessed regarding communications equipment and related components, centered on WE's technology, Nippon Electric had been at the very forefront among the companies in Japan in entering new fields. Concerning vacuum tubes for radio systems, however, Tokyo Electric Company Ltd. (today's Toshiba Corporation), a vacuum tube and light bulb manufacturer, was the most advanced manufacturer in Japan and held the majority market share for those products in Japan. Nippon Electric had begun the production of transmitters but had to purchase the vacuum tubes for the transmitters from either WE or Tokyo Electric.

Together with the rapid expansion and technological advances in the radio field, however, a large variety of vacuum tubes came to be needed for use in the various types of equipment. In this situation, if Nippon Electric continued to be dependent on Tokyo Electric for its supply of vacuum tubes, it meant that the company would face limitations in the design of radio equipment and would not be sure if it could develop products that would respond immediately to the rapid advances in the market. As well, it was also clear that Tokyo Electric was a step ahead of Nippon Electric in developing its business in the radio field, and therefore if Nippon Electric depended on Tokyo Electric for supplying it with components, Nippon Electric would be placed in a competitively disadvantageous position. In addition, the cost of importing components had risen because of the weakened yen on foreign exchange markets, and customers were requesting domestically made communications equipment. If Nippon Electric were to produce its own vacuum tubes, moreover, technologies different from what it had been using up to then would be needed, such as production technology for tubes and bulbs. There was also an understanding between the two companies that in return for Tokyo Electric holding back from entering the field of wired communications, Nippon Electric would refrain from entering the vacuum tube field. In 1928, however, Nippon Electric independently developed an amplifier vacuum tube for use in telephone repeaters, and the following year it developed another amplifier vacuum tube for oscillation. In 1931, moreover, the company successfully manufactured a water-cooled transmission tube. Not long after Shida assumed the top managerial position, he visited Tokyo Electric and informed them that Nippon Electric intended to produce independently the vacuum tubes it had been procuring from WE. Subsequently, in 1932, Nippon Electric built a plant for producing vacuum tubes.

Sumitomo Goshi Kaisha and ISE were not enthusiastic about Nippon Electric becoming self-dependent regarding vacuum tubes. In a letter dated November 2, 1932, Condict of ISE wrote concerning the large-size water-cooled tube. He said there was no market in which Nippon Electric could participate. In December 1933, Condict also expressed an objection about Nippon Electric's technology concerning the 120kW water-cooled tubes for the Hsinking Broadcasting Station. It took several years before ISE would favorably evaluate Nippon Electric's water-cooled tube technology. Despite the concerns of Sumitomo Goshi Kaisha and ISE, Yasujiro Niwa and other engineers in Nippon Electric insisted that continuous advances in vacuum tube technology were essential for the company's growth in the radio field. Depending on expertise Masatsugu Kobayashi had acquired from the U.S. and Europe, the company moved forward with development of original technology.

In these ways, then, in the first half of the 1930s Nippon Electric developed transmission tubes one after another for producing various types of short-wave radio equipment and short- and medium-wave broadcasting equipment. By 1935, Nippon Electric even began manufacturing radio receiver tubes. These products were listed in the company's general products catalog at the time. Nippon Electric not only met its own internal demand but also sold its products to other companies. Also, once the new Tamagawa-mukai Plant was completed in 1936, the company shifted all production of vacuum tubes there.

Meanwhile, the NE-type phototelegraphic technology developed by Niwa and his research team was later improved, and successful tests were conducted in 1936 for transmitting wireless photos between Tokyo and Berlin. This same technology later became essential for television broadcasting.

Nippon Electric began research into television in 1928, the same year that television tests were first successfully conducted in Japan. Its television system used a Nipkow disc for scanning. Because of the effects of the Showa Recession, however, the company temporarily halted its research into television. But after RCA invented its iconoscope in 1933, Nippon Electric, Tokyo Electric, and other companies began developing similar technology in Japan. After television broadcasting was inaugurated in Germany at the Berlin Olympics in 1936, research into television in Japan moved forward, keeping in mind the Olympics scheduled to be held in Tokyo in 1940. Nippon Electric succeeded in producing a prototype television receiver in 1939, and also began selling cathode ray tubes. In January 1940, the company's first successful public demonstration of television was conducted at the Hankyu Department Store in Osaka. As the clouds of war grew darker, the Tokyo Olympics were cancelled and research into television was halted. The research and tests conducted during these prewar years, however, proved to be important when Nippon Electric resumed its television research after the war.

4. Business Results Turn Favorable

Recovery of Business Results

Nippon Electric's business results, both sales and profits, began recovering with 1931 as a turning point. It took several years for business to return to the level of the mid-1920s but compared to the second half of the1920s, when the results had fallen from their peak to their lowest level, the recovery process in the first half of the 1930s was steady. As well, the number of employees, which had continually decreased up to then, turned toward increase.

A principal reason for the recovery of the company's business results was the increase in the demand for communications equipment accompanying the economy's break from recession. In September 1931, moreover, the so-called Manchurian Incident broke out, which also contributed to an expansion of demand for military-use communications equipment in Manchuria and other places. Another major contribution was the shift toward expansion in the telephone business of the Ministry of Communications. As the company's business results began improving, its traditionally strong areas of telephone sets and telephone switching systems took the lead among the company's business as both areas recovered and expanded at rates faster than the expansion of the telephone business of the Ministry of Communications. The size of production of these products in monetary terms increased to 2.4 million yen in 1932 and to 7.1 million yen in 1935. Except for a short period of economic nationalism, there was essentially no great negative influence on the business of Nippon Electric. Compared to the telephone sets and switching system business, moreover, the newly emerged areas of carrier transmission and radio equipment expanded at an even faster pace, accounting for 30 percent of the total value of Nippon Electric's production in 1933. In parallel with these new business areas, the development of overseas markets, such as in Manchuria, is worth note. In 1931, overseas markets accounted for between 10 and 20 percent of the company's total sales; in 1933, their share expanded to 40 percent.

Compared to the traditional telephone business from the Ministry of Communications, the overseas markets and carrier transmission and radio equipment markets could be called newly developed markets.

Apart from traditional single-channel per line type, the telephone carrier equipment enabled providing multiple channels per line. WE had developed a practical model of this type in 1925, and in 1929 Nippon Electric moved to produce it domestically as "Teishinsho-Type Telephone Carrier Equipment." Based on WE technology, Nippon Electric in 1931 successfully developed a "C-type Three-Channel Telephone Carrier System," the standard in the U.S. at the time. It was used in the telephone system between Tokyo and Aomori. The Ministry of Communications promoted the introduction of this carrier system but it was Nippon Electric that was able to immediately respond by assimilating technology from WE. As a result, once into the 1930s Nippon Electric received most of the orders from the increased demand for this type of equipment. This equipment came to be delivered not only to the Ministry of Communications but also to the Railroad Ministry, the Korean Railroad Bureau, and the Southern Manchurian Railways.

Manchurian Communications Apparatus Co., Ltd.

Radio, meanwhile, was a new field, and it developed in parallel with the expansion of the demand for military-use telephone equipment, centered on Manchuria. After the Imperial Army overran Mukden in Manchuria, it set up a special communications group of the Kanto Army there. From January 1932, the group began short-wave relayed broadcasting between Manchuria and Japan, and also began offering telephone services using radio. These broadcasting and telephone services led to a demand for Nippon Electric products, such as confidential communications devices and NE-type phototelegraphic equipment. In 1933, as the Kanto Army pushed forward with the war on mainland China, it began using air transport. This led to a demand for airborne radio equipment. In order to handle the radio transmissions between pilots and the ground, radio stations were built throughout Manchuria. The radio equipment used aboard planes and at the ground stations was made by Nippon Electric. Besides these orders, the company also met the demand for many small-size radio transmitters and receivers. In 1934, as related earlier, a broadcasting station was built in the outskirts of Hsinking and 100kW broadcasting equipment from Nippon Electric was installed there.

The expansion in new demand in Manchuria directly influenced operations at Nippon Electric's plants. In 1931, the company had been forced to lay off plant employees on three different occasions, and in September had to revert to a 5-day workweek. The situation began changing in October, and in November idled production equipment was once again put into full operation, and the workweek was expanded to six days. In the following month, employees began putting in overtime, and were asked to work two Sundays a month. The demand in Manchuria for communications equipment continued to expand and came to include not only radio equipment but also telephone sets and switching systems. As a result, the Kanto Army requested Nippon Electric to enter Manchuria in order to be able to respond immediately to the increased demand. Nippon Electric began moving forward with preparations to build a plant in Mukden. It turned out, however, to be illegal for a Japanese company to build a plant annex in Manchuria. As a result, Nippon Electric established a wholly owned subsidiary, Manchurian Communications Apparatus Co., Ltd. (MCA), in 1936.

Mita Plant Expanded, and Tamagawa-mukai Plant Built

After the Great Kanto Earthquake of September 1923, Nippon Electric planned the reconstruction of the Mita Plant and bolstered it in several stages. In 1930, the company completed construction of the No. 9 and No. 11 plants, thus completing 60 percent of its overall plan, and then halted further work because of the Showa Recession. The plan was restarted in 1935. At a board meeting held in February 1935, a budget was approved for restarting the plan. The expansion work for the No. 8 and No. 10 plants was completed in late 1935. By February 1938, a total of 18,000 square meters of new floor space was added. The Mita Plant's total floor space was thus expanded to over 40,000 square meters, making it one of Japan's largest plants.

An additional plant was also built. In December 1935, land was purchased in Kawasaki, Kanagawa Prefecture, and the decision was made to build the Tamagawa-mukai Plant there. This was because, in the context of the rapid expansion of business related to radio equipment, merely expanding the Mita Plant was insufficient. After the first-stage construction work on the Tamagawa-mukai Plant, a total of 23,000 square meters of floor space was completed in July 1936, and the company shifted all radio and vacuum tube production operations there. After an additional 26,000 square meters were added in 1937, the production of transmission and acoustic equipment, previously carried out in the Mita Plant, was also transferred there.

From 1932, as business results turned toward recovery, Nippon Electric refrained from all-out capital investment. Investment began increasing rapidly again from 1936. Although such investment in the past was covered by internal reserves, the company began depending on borrowing, which increased especially rapidly from 1937. This was the first occasion for Nippon Electric to develop its business operations on the basis of borrowings.

In the past, Nippon Electric's shareholdings were its equity in Sumitomo Electric Wire and Cable Works and China Electric Company (CEC). From the first half of the 1930s, however, the investment of capital in affiliated companies increased rapidly. These companies then became part of Nippon Electric's keiretsu. Investments were made by 1937 in about a dozen companies. These investments were based on Managing Director Shida's policy of nurturing those companies. In other words, Nippon Electric not only invested in promising parts manufacturers but also moved to nurture them by seconding directors to them. None of the companies was very large but they had outstanding technology regarding particular components or products. The keiretsu companies specialized in producing time recorders, galvanometers, condensers, vacuum tube glass, ultrashort-wave radio equipment, capacitors, transformers, power supply equipment, and components for such products.

The policy of strengthening a network of keiretsu companies continued to the mid-1940s. Eventually, Nippon Electric had about 30 companies in its keiretsu, including even quite large companies, such as Toyo Communication Equipment Co., Ltd., Tohoku Metal Industries Co., Ltd. (today's NEC TOKIN Corporation), and Anritsu Electric Corporation (today's Anritsu Corporation).

Chapter 4

Nippon Electric in Wartime Structure: 1937 – 1945

1. Communications Business in Wartime Structure

State Control in Wartime Structure

Two incidents in the 1930s led to all-out war between China and Japan. The first was the Manchurian Incident that broke out in Manchuria in September 1931; the second was the Marco Polo Bridge Incident that broke out in the outskirts of Beijing in July 1937. This war differed from Japan's previous wars in how the state came to exercise thorough controls over industrial activities. In September 1937, for example, the Temporary Funds Adjustment Law was promulgated to nurture war industries. In the same month, the cabinet issued an Ordinance Concerning the Control of Plants and Business Facilities. Thus began state control of plants supplying the military. Next, in April 1938, the National General Mobilization Law was promulgated. These several pieces of legislation placed industries supplying the military under state control and reorganized the overall economy with the aim of forging a structure that would efficiently allot materials for conducting war. For this purpose, the National General Mobilization Law regulated all matters related to labor, material, capital, facilities, business, and price.

The development and production of telecommunications equipment, Nippon Electric's area of business, was strategically one of the most important industries in Japan. It was thus one of the business areas in which the state introduced controls. The controls substantially changed both the nature and the content of Nippon Electric's business. An example was the copper needed for use in the wired communications business. In 1937, before controls went into effect, the telecommunications industry accounted for consumption of 12 percent of the total supply of copper. That was the next highest level of consumption after the electric light and power industry. Immediately after the Regulations Concerning Restrictions on the Use of Copper went into effect, however, the telecommunications industry's consumption of copper was curbed to 8 percent of the total. Similar changes occurred related to the consumption of lead, tungsten (used in vacuum tubes), and other materials. Studies were also conducted to find alternative approaches to old methods, such as the development of technology for using a single line for multiple telephone channels and for using aluminum to replace copper.

After 1941, and particularly after December 1941, when the Pacific War began, the state tightened its controls over industry and the economy. In October 1941, the first designation of important industries was carried out in line with the Directive Concerning Important Industrial Associations. The Electrical Machinery Control Association was established in January 1942 as a voluntary control organization with electrical machinery manufacturers as members. Although this was an industrial association, it was called an "association for promoting national policy through cooperation among the military, government, and private sectors." Its main objectives were to have companies participate in the government's plans related to production and distribution, and to supply and demand of the material, labor, and capital needed for production. This allowed the government to control such supply and demand, and to provide guidance to manufacturers.

Nippon Electric and ISE

The foregoing circumstances also brought about changes in the relationship between Nippon Electric and ISE. The two companies had continued their close relationship even after Sumitomo assumed Nippon Electric's management in 1932, mainly by ISE owning equity in, and transferring technology to, Nippon Electric. ISE continued to hold almost half of Nippon Electric's shares, and required Nippon Electric to file a detailed Monthly Letter. Major changes in the relationship between the two companies started to take place from 1937.

The number of Nippon Electric shares ISE held increased by 77 percent, from 124,995 to 221,495 shares, an increase of 96,500 shares, when Nippon Electric increased its capital in January 1938, but its relative holdings against the total number of shares dropped from 49.9 percent to 36.9 percent. This percentage was still greater than the 31.2 percent held by Sumitomo-related shareholders, so there was no change in ISE's top shareholder position. That drop in the relative percentage of shares held and other changes that eventually took place did not result from ISE's initiative. Rather, they resulted from a policy that Managing Director Fumio Shida and others introduced, and advice from Takeshi Kajii, director of the Installation Bureau of the Ministry of Communications.

In short, although Sumitomo assumed the management of Nippon Electric, and although Nippon Electric moved energetically afterward to expand its plants and to promote the localization of production through independent research, it was felt that there were a great many management-related inconveniences related to ISE's influence in the company that derived from the past relationship between the two companies and because ISE held almost 50 percent of the company's shares. In particular, as orders from the Army and Navy increased, Nippon Electric began to feel an urgent need to sever its capital ties with ISE. In that context, and as it became necessary to procure huge amounts of capital in order to handle its expanded business, the company formulated a plan for recapitalizing and simultaneously reducing ISE's equity.

ISE was keenly aware of the importance of the fast-growing Japanese telecommunications market and was determined to maintain its interests in Nippon Electric. For that reason, the negotiations with ISE to reduce its percentage of shareholdings were extremely difficult. Managing Director Shida traveled to the United States in March 1937 for the initial discussions with ISE, and the two companies finally reached an agreement in December of that same year. Under the terms of the agreement, Nippon Electric's capital would be increased to 30 million yen from 12.5 million yen. Of the 350,000 new shares to be issued, ISE would acquire only 96,500 shares. In line with that agreement, Nippon Electric increased its capital in January 1938.

From 1937, the Monthly Letter was discontinued, because "caution is needed in sending a detailed report overseas about a plant supplying products to the military." Based on an agreement signed between Nippon Electric and ISE in January 1938, however, the Monthly Letter started up again, containing information on monthly business results, sales subject to Western Electric (WE) royalties, and an analysis of royalty income. This monthly reporting continued until October 1941.

In August 1941, Nippon Electric increased its capital by 20 million yen to 50 million yen. Relations between Japan and the U.S. were already strained at the time, and government restrictions prevented ISE from participating in that recapitalization. Instead, Sumitomo Honsha, Ltd. (formerly Sumitomo Goshi Kaisha), absorbed the shares ISE would have been allotted. As a result, ISE's shareholdings dropped from 32.769 percent to 19.7 percent, and ISE relinquished its position as Nippon Electric's top shareholder to Sumitomo Honsha, whose shareholdings rose to 30.4 percent. Including shares held by other Sumitomo-related companies, Sumitomo's shareholdings rose to 46.1 percent. Moreover, ISE's shareholdings in Nippon Electric were confiscated in accordance with the Enemy Property Control Law of December 1941. ISE's shares were sold as enemy assets and the proceeds were placed in the custody of Sumitomo Trust Company. At that point, the capital ties between Nippon Electric and ISE were temporarily suspended.

Concerning the transfer of technology from and the payment of patent royalties to ISE, Nippon Electric and ISE agreed, based on their January 1938 agreement, that ISE would inform Nippon Electric about its new patents and would turn over to Nippon Electric any patents it needed, with Nippon Electric then paying patent royalties to ISE. As royalties, Nippon Electric agreed to pay 2 percent of its sales of telephone, telegraph, and radio equipment. Actually, however, after war broke out between Japan and China in 1937, technological research and other forms of assistance provided by ISE to Nippon Electric gradually decreased. In that context, when J. E. Fullam, vice president of ISE, visited Japan in the spring of 1941, negotiations were conducted for reducing royalty payments to 1 percent. Agreement on this new percentage was just about reached when war broke out between Japan and the U.S. in December 1941. As a result, in early 1942 the government revised related legislation, making it clear that "belligerents lost their rights to patents, and the sole rights to those patents rested with the Minister of Commerce and Industry." The agreement with Fullam was thus never finalized. Based on the discussions with Fullam, however, Nippon Electric paid an amount equivalent to 1 percent of sales as royalties and placed it in an escrow account in the Yokohama Specie Bank.

2. Shift toward Military Production

Management, and Company's Name Changes

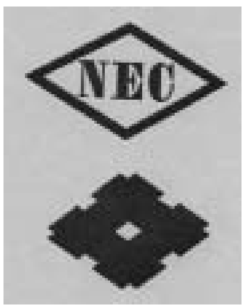
Major changes occurred in Nippon Electric's top management in 1938 after two of the company's top executives passed away early in the year. Chairman Akiyama died in March and Man-

Masatsune Ogura
(1875-1961)
Ogura was chairman from May 1938 to April 1941. He resigned from his positions as director general of Sumitomo Honsha, Ltd., and chairman of Nippon Electric in April 1941 to become Minister of Home Affairs in the Cabinet of Prime Minister Konoe.

Takeshi Kajii
(1887-1976)
Kajii was managing director from July 1938 to February 1943, president from February 1943 to January 1946, and chairman from November 1951 to July 1952. He resigned as director of the Installation Bureau of the Ministry of Communications to become managing director of Nippon Electric after Shida.

Shun-nosuke Furuta
(1886-1953)
Furuta was chairman from April 1941 to October 1945. He resigned his position as director general of Sumitomo Honsha, Ltd., and chairman of Nippon Electric when the Sumitomo zaibatsu was dissolved in October 1945.

Together with changing its name in January 1943 to Sumitomo Communication Industries Company, Limited, Nippon Electric also changed its company logo from the old logo (top; used from 1903) to the Sumitomo logo (bottom).



After the Pacific War started, Nippon Electric's main production became weapons using radio wave applications. One such weapon was a radio wave detector using ultra-short waves.

Nippon Electric established a Technical Training Center in 1939 to provide training and education for the rapidly increasing number of young inexperienced workers.

As the war expanded, many Nippon Electric employees were drafted. Here, fellow employees at the Tamagawa-mukai Plant see Yutaka Ikeda off to war.

Meters and gauges were assembled at the Otsu Manufacturing Works, one of the plants built in the provinces during the late war years. The photo shows a factory scene in 1945.

aging Director Shida died suddenly in April. Director General Masatsune Ogura of Sumitomo Honsha assumed the office of chairman in May, and Takeshi Kajii, former director of the Installation Bureau of the Ministry of Communications, became Shida's successor as managing director in July. Kajii entered the Ministry of Communications in 1912 after graduating from the Electrical Engineering Department of the Imperial University of Tokyo. He became director of the Installation Bureau in 1934. In April 1941, Chairman Ogura resigned from his positions as director general of Sumitomo Honsha and chairman of Nippon Electric to become Minister of Home Affairs in the Cabinet of Prime Minister Konoe. Shun-nosuke Furuta then succeeded Ogura in both positions.

After war broke out between Japan and the U.S., the capital ties between Nippon Electric and ISE were severed. At the General Shareholders Meeting in February 1942, therefore, the directors representing ISE—Sosthenes Behn, J. E. Fullam, and A. G. Jillard—were not reelected. Jillard had represented ISE as a director of Nippon Electric since December 1920. He resided in Japan and contributed substantially to Nippon Electric's growth through a tremendously difficult period, including the Great Kanto Earthquake, the Showa Recession, and a worsening of Japan-U.S. relations. His 21 years of service ranked with that of P. K. Condict, who resigned in September 1937. Nagao Saeki of Sumitomo replaced Jillard on the board of directors, thus strengthening Sumitomo's presence in Nippon Electric.

In January 1943, Nippon Electric was made a major affiliate of Sumitomo, and on February 20 its name was changed to Sumitomo Communication Industries Company, Limited. From that point on Nippon Electric became subject to the same provisions as other major Sumitomo affiliates. It became obligated, for example, to submit a regular internal business report to Sumitomo, its selection of officers was conducted according to Sumitomo provisions, and a president system was introduced, with Managing Director Takeshi Kajii assuming the position of president.

Expansion of Military Production

The shift toward military production changed the composition of Nippon Electric's product line and brought about changes in how it managed its plants. Until the mid-1930s, the mainstay products in Nippon Electric's product line were telephone sets, switchboards, and other wired communications equipment. Sales were almost entirely to the Ministry of Communications, the Railway Ministry, and other government offices, and to the private sector. In terms of the percentage of total production, demand from the military—the Army and Navy—accounted for only 8 percent of the total in 1937. After 1938, however, the percentages changed abruptly as military demand rose rapidly. In 1938, military demand by itself accounted for 23 percent of the company's total production. It came to account for two-thirds of total production in 1941, the year the war began between the U.S. and Japan, 80 percent in 1942, and almost all production afterward. In 1944, for example, it accounted for 96 percent.

By product, the percentage of total production accounted for by telephone sets, telephone switchboards, and carrier equipment—the company's traditional products, aimed mainly at the government and private sectors—decreased steadily. These products had accounted for about half of total production in 1938 but that share dropped to one-third in 1941, and to no more than 8 percent in 1944. The percentage accounted for by products aimed mainly at the military, meanwhile—such as radio and acoustical equipment, and vacuum tubes—was 21 percent in 1938 but increased to 45 percent in 1941, and reached 90 percent in 1944. Nippon Electric's sales rose rapidly during this period from 25 million yen in 1937, to 55 million yen in 1941, and to 375 million yen in 1944. For the period April 1945 to March 1946 (the war ended in August 1945), however, sales dropped abruptly to 86 million yen.

After war broke out with China, an increase in radio facilities on mainland China resulted in a greater demand for radio equipment. The newly built Tamagawa-mukai Plant, where all vacuum tubes and radio equipment were being produced, was expanded several times to meet the increased demand. In 1938, the value of production at the Tamagawa-mukai Plant exceeded that at the Mita Plant for the first time. In December 1937, about 49,000 square meters of the original expansion plans for the Tamagawa-mukai Plant were completed. Even then expansion did not stop. Because of a rapid increase in demand for radio equipment, an additional 15,000 square meters were constructed in 1938. By 1940, the Tamagawa-mukai Plant was twice the size of the Mita Plant. Even afterward, expansion continued until in 1945 the plant's total floor space reached 135,000 square meters. In June 1942, the Mita and Tamagawa-mukai plants were renamed "manufacturing works."

After the Pacific War began, the frontlines for Japan's military spread from the Solomon Islands to New Guinea, Singapore, and Burma in the south. In the north they spread to Attu at the tip of the Aleutian Islands. As the frontlines spread, the main demand from the military shifted from wireless equipment for land troops to equipment for use in aircraft and aboard warships. Emphasis was placed on equipment using radio waves, such as wireless devices, radio wave detectors, and directional finders, and on acoustic devices and equipment such as underwater sound detectors, water depth sounders, and underwater signal locators. In sharp contrast with the restrictions placed on supplying material to the private sector, priorities were given to allocating raw materials to meet the military demand, including radio systems, under the planned economy.

R&D of Radio-Applied Weapons

The wartime structure brought about changes in Nippon Electric's technical relationship with ISE, including the development of a new R&D phase in Nippon Electric. Despite the renewal in January 1938 of the technical agreement between ISE and Nippon Electric, the deteriorating relationship between Japan and the U.S. brought an effective end to the transfer of technology from ISE. From 1938, at the request of the military authorities, Nippon Electric began cooperating with the military in the research of radio-applied weapons. Most of the research was for technology that more or less tied to military objectives.

Because of the need to conduct research not only into communications technology but also into a wide range of related areas, the company established a research laboratory in July 1939 inside the Tamagawa-mukai Plant. Among the radio-wave military weapons researched and developed at this research laboratory was radar. To promote such R&D further, a research laboratory annex was established in 1941 in Ikuta, a part of Kawasaki. The Ikuta annex became the focal point for research of radio-wave weapons, such as radar using ultrashort waves and sonar using ultrasonic technology. To offset the halt in importation of the materials needed for producing vacuum tubes, moreover, in 1943 a new plant was built in Takasaki, a city in Gumma Prefecture north of Tokyo, for the development and production of substitute materials. A research annex was also established in Chiba, east of Tokyo, for researching and developing chemical materials to use in the recording paper for water depth sounders. In 1944, the research laboratory located in the Tamagawa-mukai Manufacturing Works was moved to Ikuta. At its peak, the laboratory had a large staff of 1,250 researchers and other employees.

Among the various research conducted in Ikuta, radar research deserves particular mention. In 1938, when Nippon Electric was conducting research into television, researchers noted that whenever aircraft passed overhead the image on the television screen deteriorated. This phenomenon provided the hint for development of a radio wave detector. Research in this area was subsequently promoted and a radio wave detector using ultrashort waves was developed. Once into 1944, it became possible using this detector to detect aircraft 250 kilometers away. In the postwar period, this ultrashort wave technology became the basic technology for Nippon Electric's development of microwave multiplex communications systems and television broadcasting equipment.

Nippon Electric under Military Control

Military controls affecting the management of Nippon Electric began in 1931 when the Mita Plant was placed under the Army's supervision. A plant under military supervision meant that a military supervisor would supervise the plant's production processes and accounting procedures, both closely related to orders placed by the military. It was not until 1937, however, that a military supervisor was actually assigned to the Mita Plant. After the Tamagawa-mukai Plant and the Shibaura Annex were designated in 1938 as plants under military control, a military officer was stationed permanently at each location. In plants under military control, the military issued all instructions related to production. After the Pacific War began in December 1941, the military tightened its controls. Inspection departments were set up in each manufacturing works, for example, cost accounting sections were made independent, and the military began making direct decisions regarding personnel and the organization. The method of cost accounting was switched to the military method from that introduced originally from WE and developed inside Nippon Electric.

After the Munitions Company Law was promulgated in October 1943 and the first round of munitions plant designations took place in January 1944, all the manufacturing works of Sumitomo Communication Industries (new name of Nippon Electric) and the Ueno Plant were designated as munitions plants. In April 1944, all the company's other plants and research laboratories were designated as munitions plants. This designation meant the company had to appoint an officer responsible for production. In Sumitomo Communication Industries, President Kajii was appointed the officer responsible for production. Together with production supervisors appointed at each plant, the production officer controlled and operated the plants. Because the production officer and production supervisors were "drafted," in line with the Munitions Company Law, the state effectively controlled the company's management. The representative rights of all officers other than the production officer were cancelled, and the board of directors, normally the organ that carries out the company's business, became merely an organ for discussing business matters.

In order to expand production, the military soon designated the plants of Sumitomo Communication Industries "conscript" plants. As such, the equipment and existing workforce of the plants were to be used for military purposes and large numbers of outside workers were conscripted to work in the plants. Many students were also conscripted. In this way, the military strengthened its controls in the personnel area. When the war ended in August 1945, a total of more than 12,000 such workers were in the plants of Sumitomo Communication Industries.

In February 1944, Army and Navy officers were appointed to the company's board of directors. As well, many military-related persons held positions as advisors or as non-regular employees. At different times, the military asked the company to evaluate these advisors and non-regular employees. The company, under the signature of the manager of the Administration Department, provided such evaluations and also responded to the military about whether or not it wanted particular persons to continue in their positions. Sometimes the company's evaluations and responses were negative.

3. Management During Wartime

Organization and Management

As production related to military demand increased, the company's administrative organization expanded and became more complicated. This was because, in the context of the planned wartime economy, plans were changed several times and the volume of administrative work rapidly increased, at the same time that purchasing activities and labor management duties also rapidly increased because of material shortages and the need to secure labor. In October 1932, two main divisions—the sales and industry divisions—comprised Nippon Electric's overall organization. In 1938, the Head Office had three divisions—sales, general affairs, and administration. The Mita and Tamagawa-mukai plants were separate. Several changes took place afterward. In 1944, there were five divisions in the Head Office: general affairs, accounting, planning, administration, and procurement. The manufacturing works, meanwhile, spread to Mita, Tamagawa-mukai, Ogaki, Okayama, and Otsu. Each was a large organization that included a staff division comprising administration, labor relations, and purchasing departments, as well as a large number of factories. In addition, various new committees were set up.

In parallel with the development of this administrative organization, the "Nippon Electric Service-to-the-Nation Association" was established in October 1939. All employees were organized into this association, and branches were formed in all the company's offices and plants. These branches were then integrated into a company-wide supervisory union. The association was concerned with a wide spectrum of activities, especially concerning employee welfare and morale boosting. Other activities included finding ways to improve work efficiency, raising the technical level of workers, and promoting inventiveness.

Attention was also paid to building and improving educational facilities for the employees, such as opening a technical training center, providing schooling for young workers, and opening an engineering institute. As the workforce expanded rapidly, several dormitories were also built.

In such ways, Nippon Electric was strengthened organizationally as the war progressed. But the war effort also took its toll on the production workshops and staff functions. The number of employees drafted into the military, for instance, reached 19 percent of the entire workforce by May 1944. The percentage of factory workers drafted was relatively lower, at 17 percent. The total number of factory workers drafted, however, was a high 2,400, and many of them were men with 10 years or more experience in the company. The percentages of engineers and clerical workers drafted were even higher, at 23 percent and 26 percent, respectively. The draft thus took away from the plants many skilled workers and engineers, the persons comprising the very core of production activities. It was a blow to Nippon Electric, in terms of maintaining control and efficiency levels, to lose such a large percentage of its skilled workers.

Even as the draft took employees away, the number of employees at the manufacturing works, including those working as conscripted laborers, rapidly increased. At the end of 1936, there were 4,252 employees on the company's payroll. This figure jumped to 10,000 at the end of 1939, 15,000 at the end of 1942, over 20,000 at the end of 1943, and a tremendous 26,159 at the end of 1944. The rapid increase in the size of the workforce related directly to the increased production. As well, the volume of paperwork also expanded rapidly, involving directives received from the military, responses to never-ending changes in specifications and plans, and preparation of the activity reports.

Due to the situation where the number of workers with no experience was rapidly increasing while the number of middle-level managers and other workers able to provide guidance was relatively small, it was difficult to bolster production.

As the planned economy developed further in the wartime structure, restrictions on foreign currency and the rationed supply of raw materials brought about major changes in the procurement of raw materials. In particular, the wired communications business depended heavily on imported materials and was directly influenced by restrictions on the use of foreign currency. To overcome these restrictions, Nippon Electric in 1939 sold off dollar-denominated public bonds it held and used the proceeds to purchase raw materials from overseas. It did this by turning over those U.S. dollar-denominated bonds to ISE and whenever it purchased materials from overseas it had ISE sell the bonds and use the proceeds to pay for the materials.

In comparison, huge orders were received from the military for radio-related products, and the military was allocated the raw materials to support production. To handle those orders, special efforts were made to raise productivity at the Tamagawa-mukai Manufacturing Works and to turn some of the facilities in the Mita Manufacturing Works to the production of radio-related products.

In proportion to the expansion of its radio-related business, the number of Nippon Electric's affiliates also increased. In the radio and acoustic divisions, the percentage of semi-finished products outsourced was high. So-called "cooperative" suppliers provided most of these products. Such companies numbered over 260 in 1944.

As a reflection of the rapid expansion of its facilities as stated above, Nippon Electric's total assets expanded from 60 million yen at the end of 1937 to 438 million yen at the end of March 1944. The expansion was particularly noteworthy from 1942, the first full year after the Pacific War began. Expenditures during the years beginning in 1942 were always much greater than originally budgeted at the start of each year. The main items listed for additional expenditures were expenses related to acquiring or constructing dormitories, research facilities, and plant annexes, along with the purchase of the shares of the principal cooperative suppliers.

The sources for procuring funds also became more diversified. Until the end of 1936, equity investment and internal reserves provided almost all the capital the company needed. From 1937, however, the company's borrowings rapidly increased. Before too long the size of the borrowings exceeded the company's equity investment. From that point on, the size of the company's borrowings continually exceeded its paid-in capital. Even after the company increased its capital twice (by 20 million yen in 1941, and by 100 million yen in 1944), its borrowings as of March 1944 reached 165 million yen, surpassing the size of its paid-in capital. The company also issued corporate debentures in 1938, 1939, and 1943, each issue worth 10 million yen.

Management of Overseas Plants

From 1943 on, Nippon Electric's expansion was centered on establishing business offices in Manchuria and other parts of mainland China and in Southeast Asia. This expansion was necessary to establish and bolster the communications facilities of the military as it widened its areas of activity and its telecommunications networks.

In December 1936, the company set up the wholly owned Manchurian Communications Apparatus Co., Ltd. (MCA), with its head office and plant in Mukden. MCA's main activities were the assembly and repair of wired communications equipment, including telephone sets and switchboards. Initially, MCA mainly sold Nippon Electric products it bought at cost. It was from March 1938 that MCA began its own production as well as the knock-down assembly mainly of wired communications equipment. The key employees in MCA were seconded from Nippon Electric, and at the end of 1939 there were 230 Japanese managers and employees and 300 Chinese factory workers. Including some other workers, the total workforce was 670. Even in 1941, 70 percent of the company's sales was accounted for by Nippon Electric products. MCA's main customers were the Japanese military stationed in China, the Southern Manchurian Railway, and Manchurian Telegraph and Telephone Company. Telephone sets and switchboards accounted for over half of the company's sales.

After the Pacific War began, the Japanese military requested that the manufacture of products destined for the private sector be suppressed and that priorities be given to meeting military demand. As a result, MCA began limiting its production of wired communications equipment and increasing its production of radio equipment and vacuum tubes. The company's manufacturing facilities, however, and its engineers were both aimed mainly at producing wired communications products, making it difficult to switch to producing radio equipment. Indeed, MCA had to rely on Nippon Electric for the facilities and materials needed for the switchover. In that context, even in 1942 telephone sets and switchboards accounted for the majority of MCA's production value. Production of radio equipment and vacuum tubes began to increase from 1943.

As a foothold in mainland China, Nippon Electric had China Electric Company (CEC), based in Shanghai. WE and Nippon Electric established CEC with joint capital participation, initially to handle the products of both companies. Not long after CEC was established in 1918, however, a movement broke out in China to exclude Japanese-made products from the Chinese market, and it thus became impossible for the company to handle products made by Nippon Electric. Later, CEC extended its business activities into Manchuria as well. As a result, Nippon Electric was able to do business only in the areas in Manchuria where Japan held business interests. Nippon Electric began doing business throughout Manchuria only after signing an agreement with CEC in 1934. In return for those sales rights, Nippon Electric agreed that only CEC could do business in the other territories of China.

In 1936, however, the Japanese military requested Nippon Electric to open business offices in parts of China other than Manchuria. As a result, Nippon Electric had to send representative personnel from Tokyo to Tianjin. And after war broke out between Japan and China in 1937, the Japanese military requested Nippon Electric to build a plant in Tianjin for repairing their communications equipment. Because of the relationship with CEC, Nippon Electric was not positive in responding to the Japanese military. At the request of ISE in 1939, however, Nippon Electric transferred all of its equity in CEC to ISE, thereby ending its relationship with CEC. In 1940 the company began working with Toyo Communication Equipment Co., Nippon Communication Industries Co., Ltd. (later, Nitsuko Corporation, today's NEC Infrontier Corporation), and Anritsu Electric Corporation to open a joint repair plant in Tianjin. The Tianjin Repair Plant opened for business in September 1941. The engineers and key plant workers were seconded from Japan, and Chinese workers were also employed. At its peak, the company employed 300 persons at its Tianjin Repair Plant.

In 1939, the Japanese military requested Nippon Electric to build another communications equipment repair plant in the central part of China. Although Nippon Electric submitted a business plan to the military in September 1939, negotiations took much time and it was not until 1942 that preparations were begun. A plant was built in Shanghai, and employees were seconded there from Nippon Electric and related companies. Operations began at the Shanghai Plant in October 1942. The main business of the plant was to make the rounds of the Japanese military bases deep inside China and repair the communications equipment there. Concurrent with the outbreak of the Pacific War in December 1941, the Japanese military took over the operations of CEC. In December 1943, management of the company was entrusted to Sumitomo Communication Industries (Nippon Electric). In March 1944, both the Shanghai and Tianjin repair plants were absorbed by CEC. When the war ended in 1945, the Shanghai Plant had a workforce of 1,400.

Another overseas plant was Java Radio Equipment Manufacturing, which Nippon Electric began managing after the Japanese military occupied Java. This facility was originally a plant attached to a radio technical research workshop in Bandung operated by the Dutch East Indies government, when Indonesia was a Dutch colony. It employed over 600 workers, including Dutch nationals. The Army Ministry officially ordered Managing Director Kajii in August 1942 to have Nippon Electric take over management of the Java plant. Actual management of the plant by Sumitomo Communication Industries began in May 1943, under order from the local Japanese military authorities. Business operations were solely to repair and maintain equipment for local radio stations. Later, together with Japan's military withdrawal, all transportation between Java and Japan was cut off. In compliance with the military directive for local procurement of munitions, the company shifted to manufacturing military products. A facility to produce vacuum tubes and one to assemble small-size radio equipment were added to the plant. Those products were supplied to the Japanese and the Java military forces. Although the workforce increased to 800, the company continually operated in deficit.

Plants in Provinces, and Evacuation

From 1943 onward, the expansion of facilities at Sumitomo Communication Industries was achieved through the acquisition of outside plants. The objective of such acquisition included minimization of the possible damage to any single facility by U.S. air raids. In 1943, part of a department store in Ueno, Tokyo, was rented. The Ueno Plant was established there and some of the production functions of the Mita Manufacturing Works were transferred to that plant. In June of the same year the sites of former spinning plants were purchased in Ogaki in Gifu Prefecture and in Okayama. Manufacturing works were established there, not only expanding production but also dispersing the plants to the provinces. To further disperse its facilities, in February 1944 Sumitomo Communication Industries also purchased the plant of a company in the chemical industry in Otsu. Not long after the bombing of Tokyo began in early 1944, the government ordered the company to relocate its production facilities and employees to the provinces, and the company began a planned move of both.

The move was to stretch over six phases beginning in May 1944. Carrying out this plan was greatly delayed, however, and on March 10, 1945, Tokyo was bombed extensively and the company's Ueno Plant and Fukagawa Annex were destroyed by fire. Dispersion of production plants to the provinces proved to be insufficient, and it became an urgent task to relocate plants to remote areas. During air raids in April and May 1945, half the buildings of the Tamagawa-mukai Manufacturing Works were destroyed. The Fifth Phase of relocation plans was thus speeded up to disperse the plant's production operations, and over 2,000 workers were sent to work in the provinces. In June 1945, the company carried out its Sixth Phase of relocation plans, with 3,000 workers to be relocated to the provinces. At the end of June, however, the Okayama Manufacturing Works was completely destroyed in an air raid. Before production operations could get underway in the provinces, the war ended on August 15, 1945. The company dispersed its plants to the Hokuriku and Tohoku regions and divided operations to have production carried out in several locations, severely slowing the production system. Expenses related to relocating production plants totaled almost 40 million yen. The damage related to relocation, however, was not merely those expenses. The relocation of so much production negatively affected the restart of production after the war.

Chapter 5

Reconstruction of Nippon Electric: 1945 – 1952

1. Occupation Policies and Telecommunications Industry

Nippon Electric at War's End

With August 15, 1945, as a transition point, the business environment surrounding Nippon Electric (Sumitomo Communication Industries Company, Limited) changed tremendously.

Immediately after the war ended, state control of industrial plants through the military came to an end. At the same time, the plants of Nippon Electric, which functioned as munitions plants, saw their operations completely halted. Afterward, the occupation policies of General Headquarters (GHQ) of the Allied Powers replaced the military wartime controls and greatly altered the environment surrounding business and industry. The effect of the occupation policies was widespread: they put an end to the munitions industry, dissolved the zaibatsu (industrial combines)—of which Nippon Electric had also been a link—introduced measures concerning the restoration of the nation-wide telecommunications network, and enforced the Law for Elimination of Excessive Concentration of Economic Power. As time passed, moreover, the nature of the occupation policies changed. In the midst of this new, uncertain environment, Nippon Electric was forced to restructure its operations, reform its management, and reconstruct itself as a private company.

At the end of the war, Nippon Electric was a huge corporation with a large number of employees and many business offices and plants in Japan and overseas. In Japan alone it had 13 plants, although the plants in the Ueno part of Tokyo and in Okayama had been completely burned down during air raids. About half of the Tamagawa-mukai Manufacturing Works was also in ruins. In addition, the company had many work-sites in remote locations in Japan, along with several business locations overseas. Total employees numbered over 28,000. Even excluding student workers and conscript labor, the company still had over 16,000 regular, full-time employees.

After the war ended the military authorities informed the company of the termination of state control of its plants, instructed the company to release its conscript and student workers immediately, and urged the company to revert quickly to peace-time production. The company ordered employees who evacuated to work-sites in remote locations in the provinces to return to their home offices in the cities. It took over three months and the use of hundreds of railway cars to close those work-sites and have about 5,000 employees return to their home locations.

The schedule for employees stationed overseas to return to Japan varied according to the particular location. The operations at Manchurian Communications Apparatus (MCA), for example, were terminated when the war ended, and more than 500 locally hired Chinese employees were dismissed after being paid the wages owed them plus a separation allowance. The Soviet military had moved into the area after the war, and the Japanese employees dismantled the plant under their supervision. MCA was dissolved upon completion of that work in October 1945.

At Java Radio Equipment Manufacturing, meanwhile, when the war ended the military ordered the company to halt its production of munitions. The company was returned to its pre-occupation status and once again began repairing radio receivers. In view of the return to the Dutch government of the Javanese company's ownership, the employees who worked in the company prior to the Japanese occupation, and the Japanese workers, remained with the company. Around the same time, an Indonesian government was formed, with Sukarno as president. At the end of September 1945 the new government took over the company.

China Electric Company (CEC), whose management was entrusted by the Japanese military to Nippon Electric in December 1943, had absorbed in March 1944 repair plants belonging to Nippon Electric in Shanghai and Tianjin. It later also opened a plant in Beijing, and eventually came to have 2,000 employees. After the war ended, Nippon Electric was relieved from management of the company and the Chinese military took over the company's plants and repair facilities.

In September 1945, GHQ clarified its policy concerning the reversion of former munitions plants to production for meeting private sector demand. Based on that policy, the Japanese government issued a ministerial ordinance in October requesting companies with former munitions plants to submit plans for reverting their plants to production for supplying private demand. Accordingly, Nippon Electric submitted a plan for reverting its plants to production aimed at the private sector. During the period from December 1945 to January 1946, it received permission to resume production at its Otsu and four other manufacturing works.

According to the plan it submitted for reverting to production to meet private sector demand, the company would dedicate five manufacturing works, one research laboratory, and 14,000 employees to the production of radio and carrier equipment, wired communications equipment, acoustic equipment, and vacuum tubes. Viewed by value of total production nationwide at the time, Nippon Electric accounted for 25 percent of the production value of radio equipment, 30 percent of vacuum tubes, 45 percent of wired communications equipment, 60 percent of acoustical equipment, and 70 percent of carrier equipment.

Name Reverts to Nippon Electric

As the company reorganized its production system to supply private sector demand, it also substantially changed its management structure. At the general shareholders meeting held in October 1945, Director General Shun-nosuke Furuta of Sumitomo Honsha resigned from his position as chairman of Sumitomo Communication Industries. The following month the directors appointed by the military also resigned their positions. At the general shareholders meeting held on November 30, 1945, a resolution was passed to change the company's name back to Nippon Electric Company, Limited. The company thus reverted to its original name two years and nine months after being changed to Sumitomo Communication Industries Company, Limited, in February 1943.

Even prior to these developments, the controls which Sumitomo Honsha had exercised over its major affiliates and which had ended when the affiliates were designated munitions companies, reverted to their original form when the military controls ended. GHQ had already made clear its intention to dissolve the zaibatsu, however, and on November 2, 1945, issued a directive to dissolve the zaibatsu and freeze their assets. In compliance, Sumitomo Honsha announced the dissolution of the Sumitomo zaibatsu.

On January 21, 1946, prior to being publicly purged from office, President Takeshi Kajii of Nippon Electric resigned and Senior Managing Director Nagao Saeki, originally from Sumitomo, assumed the presidency. President Saeki later also became a purge target and on June 25, 1947, Managing Director Toshihide Watanabe replaced him as president. President Watanabe had joined Nippon Electric in 1942 from Sumitomo Honsha as manager of the General Affairs Division. He became a director in 1944, and managing director in November 1945.

GHQ's Policies and Nippon Electric

Another GHQ policy that affected Nippon Electric's business environment considerably concerned Japan's telecommunications business. In terms of its goals in administering the occupation, GHQ had requested the Japanese government to quickly restore and put into order the domestic telecommunications and railway networks. In that backdrop, the Ministry of Communications formulated a three-year plan beginning in 1946 for restoring the nation's severely damaged telecommunications network; the ministry revised the plan in the following year, making it a five-year plan. One result of the plan was that the number of telephone subscribers, which in August 1945 had fallen to half its previous number, increased to 1.08 million in 1949, a recovery to the prewar level. In response, the Mita Manufacturing Works moved into full operation to increase production of telephone sets and telephone switching systems. In addition, demand arose from the private sector for all-wave radio receivers, and for fish detectors based on sonar technology, both produced at the Tamagawa-mukai Manufacturing Works, and receiver tubes for radios, produced at the Otsu Manufacturing Works.

The effect of GHQ policy toward the telecommunications industry was not limited to the quantitative aspect of production. Restoring the nation's telecommunications network was a most important matter for GHQ, and within the telecommunications industry it was especially important to increase the supply of vacuum tubes. Plants in Japan, however, had been used harshly during the war years, and the equipment was superannuated. The product quality of vacuum tubes was uneven and generally poor, and it was impossible to achieve a smooth supply of products. As early as May 1946, W. S. Magil of GHQ's Civil Communications Section (CCS) recommended that Nippon Electric begin using scientific methods of quality control. Magil was an engineer from Western Electric (WE), Nippon Electric's partner when it was founded, where he was in charge of quality control. The scientific methods he recommended were centered on introducing statistical quality control (SQC) in the production of vacuum tubes for telecommunications applications. Beginning in October 1946, Koji Kobayashi, manager of the Tamagawa-mukai Manufacturing Works, and Hidehiko Nishio, assistant department manager of the

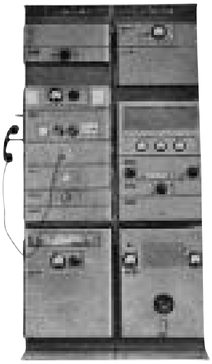
Nagao Saeki (1894-1959)
Saeki was president from January 1946 to June 1947. He joined Nippon Electric from Sumitomo as senior managing director. An expert in labor relations, Saeki was in charge of negotiations with the company's labor union. When he became a purge target, he resigned.

Toshihide Watanabe (1896-1966)
Watanabe was president from June 1947 to November 1964, and chairman from November 1964 to April 1966. He joined Nippon Electric from Sumitomo to head the General Affairs Division. Watanabe steered the company through its reconstruction in the turbulent postwar years and the succeeding period of high economic growth.

Nippon Electric unionists demonstrated against designated layoffs in June 1949.

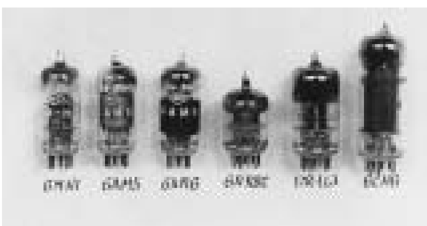
In November 1951, capital ties with ISE were restored. Seen at the signing ceremony are J. E. Fullam (center) and C. B. Allsopp, vice presidents of ISE, President Watanabe of Nippon Electric, and others.

Emperor Hirohito traveled throughout Japan in the immediate postwar years. In October 1946, the Emperor toured Nippon Electric's Ogaki Plant and spoke directly to employees.



In the early 1930s Nippon Electric began developing power line telephone carrier equipment for transmitting telephone calls. The PL-3, completed in 1947, was an improved version of that equipment.

Nippon Electric developed all-wave radio receivers in the early postwar years. A product advertisement released in 1948 using a foreign model attracted much attention.



In 1949 Nippon Electric announced a series of miniaturized vacuum tubes which it later also exported after meeting U.S. electrical specifications.

Nippon Electric marketed a wire-type sound recorder before the war. After further development, in 1949 the company marketed the Talky Box tape recorder. Shown here is a 1952 model of the Talky Box.

Inspection Department of the Tamagawa-mukai Manufacturing Works, visited Magil every week at his office in Tokyo and received training in SQC methods. This marked the occasion for quality control methods to be introduced to Japan. After Magil returned to the United States in December 1946, Kobayashi and Nishio received further guidance from H. M. Sarasohn, who later taught managers and engineers of other telecommunications manufacturers as well. In February 1947, Nippon Electric set up a quality control section in the Inspection Department of the Tamagawa-mukai Manufacturing Works. This was an unusually early step for a Japanese corporation at the time. Afterward, the company continued its efforts in quality control and in November 1952 was awarded the Deming Application Prize. This prestigious award was established in 1951 in memory of W. Edwards Deming, the leading U.S. expert in quality control methods at the time. Deming came to Japan in 1950 and provided guidance in quality control to Japanese individuals and corporations. When Nippon Electric won the prize, there were still few persons in Japan other than experts who knew about it. Being awarded the prize was a tremendous accomplishment for the company.

GHQ's policy toward the telecommunications industry was not limited to production. In 1949, the chief executive officers of the telecommunications equipment manufacturers were invited to attend an 8-week course in business management, sponsored by CCS of GHQ. The content of the 8-week course was aimed at inducing a change in the management practices of the Japanese companies. The curriculum included functions of the chief executive, standard rules and regulations for work procedures, organization, responsibility and authority at each level of management, systems of cooperation among divisions, and methods of production control. Although these were subjects of common interest for other industries as well, it is most interesting that the concept of American-style management was transferred to postwar Japan initially through companies in the telecommunications equipment industry.

As thus seen, GHQ's policies emphasized the putting into order of the telecommunications industry on the one hand while on the other it promoted the Law for Elimination of Excessive Concentration of Economic Power and restrictions aimed at holding companies, thus restricting the reopening or continuance of companies in their existing form.

Nippon Electric was directly affected in several ways. When the zaibatsu were dismantled, for example, Nippon Electric was designated a “restricted concern” in November 1945. Next, in August 1946, under the Emergency Law for the Accounts of Companies, the company was designated a “special accounts enterprise,” making it impossible for the company to dispose of any funds or assets without approval. As such, the company was obliged, in accordance with the Enterprise Reconstruction and Reorganization Law, to prepare a reconstruction and reorganization plan for government approval. Also, in December 1946, Nippon Electric was designated a holding company. This was because during the war the company held the shares of a large number of affiliates. The value of the shares held in 1946 was over 63 million yen. By 1949, the company turned over almost all those shares to the Holding Company Liquidation Commission. As a result, the equity relationship between Nippon Electric and its affiliates was almost completely eradicated, and in May 1951 the holding company designation was lifted.

In February 1948, Nippon Electric was also designated a company with an excessive concentration of economic power. As such, it was requested to formulate a reorganization plan that included splitting itself into independent companies. Right around that time, however, changes in the international political situation, including the start of the Cold War between the U.S. and the Soviet Union, resulted in a less strict application of the Law for Elimination of Excessive Concentration of Economic Power. In February 1949, the designation of Nippon Electric under that law was lifted. The problem, however, was that because of its designation as a restricted concern and later as a special accounts enterprise, the company had to apply for approval even if it merely wanted to dispose of, say, a broken-down motor vehicle. Its activities, in other words, were restricted across a wide range.

2. Rebuilding Corporate Foundation

Postwar Restructuring

Even before it could reopen its plants in line with its plan to revert to production for meeting private sector demand, Nippon Electric had to downsize its operations, which had swelled to meet military demand during the war. Even excluding the conscripts and student workers, the company had over 16,000 employees. Adding to that figure were the employees returning home from overseas assignments and draftees returning from military service. At the end of September 1945, in a move toward retrenching its operations, the company called for a large number of voluntary retirements. As a result, 12,200 employees retired, centered on those retiring voluntarily. This included 3,800 clerical and 8,400 factory workers.

Between November 1945 and March 1946, employees at Nippon Electric's plants organized their own labor unions, and in June 1946 these unions merged into the Nippon Electric Combined Labor Union, representing the Tokyo and Yokohama areas. In the process of organizing the labor union, management and labor agreed to establish a "Consultation Conference," comprised of management and labor representatives. Setting up the Consultation Conference meant it was necessary for management to obtain the labor union's agreement concerning decisions made regarding important business matters. A labor contract was signed in May 1946. It was a simple contract, covering seven items. The third item, however, required that the labor union's consent was needed for matters related to hiring and firing. Also, since the consent of the labor union was required concerning important business matters, management and labor had equal rights. Worded differently, the rights that top management had concerning personnel matters, including hiring and firing, were restricted by the labor union.

Restrictions on management rights were not a problem unique to Nippon Electric. In large companies throughout Japan in 1949-50, serious differences of opinion between management and labor emerged regarding the setting up of consultation conferences. The labor contract in Nippon Electric was extended to June 1949, but then expired and for a long period afterward there was no labor contract. During that period, however, management and labor continued tough negotiations for revising the previous contract. Management wanted to turn the Consultation Conference, which allowed labor's participation in management, into a Labor-Management Discussion Meeting where management would inform the labor union about management matters and decisions. For its part, the labor union felt strongly, in the context of the economic recession following introduction of the Dodge Line, that it needed employment guarantees and that therefore its consent was required regarding matters related to hiring and firing. The negotiations between the two parties for revising the labor contract continued through countless meetings. Finally, in October 1952, a new labor contract was signed. It was a highly detailed contract comprised of 11 articles and 84 clauses. It emphasized that while Nippon Electric would remain a "union shop," employees in positions of section manager and above would be non-union members. The name Consultation Conference, moreover, was changed to Labor-Management Discussion Meeting. Regarding personnel matters, it was agreed that management would inform the labor union in advance of any plans for substantial numbers of new hiring, reassignments, or seconding. This contract has basically been maintained since 1952; other companies are said to have referred to it in preparing their own labor contracts.

Nippon Electric's sales increased each year after the war, from 180 million yen in 1946 to 565 million yen in 1947 to 1,498 million yen in 1948. This sales growth, however, was principally a reflection of upward revisions to controlled prices because of inflation. The period, therefore, cannot be called one of production expansion in real terms. As well, upward revisions to controlled prices did not keep up with the sharp rise of raw materials and labor costs. In that inflationary situation, Nippon Electric was not able to break from deficit operations until 1950.

In September 1947, the Nippon Electric Combined Labor Union demanded wage increases because of the low standard of living its members were being forced to endure due to inflation and the shortage of food. Negotiations between the two parties broke down, however, and the unionists went on an unlimited strike from October 1. The strike lasted 45 days, ending on November 14 after management proposed new concessions. Company operations resumed on November 15.

During wage negotiations in September 1948, management proposed three rationalization measures to the labor union. The first measure was an increase in work efficiency; the second was termination of unprofitable products, and an efficient concentration of production; and the third was reduced consumption of materials and other resources. Together with the termination of unprofitable products, the company planned to reassign or relocate 1,100 employees. Not long afterward, GHQ reversed its policy of promoting labor unions and started to prohibit strikes. This was the background when management proposed its rationalization measures in September 1948. The labor union accepted management's proposal.

At the time that management proposed the above three measures, the company was forecasting monthly sales of 180 million yen. From the end of 1948, however, business began languishing. The Dodge Line was introduced in fiscal 1949, government expenditures were greatly reduced, and the business recession became serious. In those circumstances, the company faced the need for a fundamental reconstruction.

Prior to that, in October 1946, the government promulgated the Enterprise Reconstruction and Reorganization Law. Nippon Electric was designated a "special accounts enterprise" and as such was obliged to prepare a reconstruction and reorganization plan and submit it to the government for approval. This law provided the legal basis for allowing corporations to return to normal management by letting them readjust their unusually bloated credits and/or liabilities that had arisen during the war. The reconstruction plans drew up based on this law had to clarify the format the companies would take for disposing of the credits and/or liabilities, and had to include a business plan and fund-raising plan. Nippon Electric formulated a reconstruction plan based on the continuation of its existing corporate entity, and on April 30, 1949, filed applications to the government. Earlier, on April 23, this same plan was presented to the labor union at the Eleventh Combined Consultation Conference.

President Watanabe explained the reconstruction plan to the labor union. It had four parts: an outline, the outlook for reconstruction, the offices and facilities to be closed, and personnel reductions. The outline clearly stated the company's management policy. President Watanabe explained that the company's critical managerial issues, including a reduction in orders, an increase in borrowings, payments owed for materials purchased, unpaid taxes, and delays in the payment of wages. He said there was no other way left except to revert to healthy, independent management. The plan comprised three principal sets of measures: 1. reorganizing or reducing existing operations by closing the Ogaki Manufacturing Works and Takasaki Plant and Ikuta Research Laboratory, and by introducing an independent profit center system in the Otsu Manufacturing Works; 2. reducing the size of the plants, and reshuffling their personnel; and 3. reducing the size of the overall workforce by 3,600 persons.

The labor union held a special meeting to discuss the plan and afterward officially expressed its opposition. The labor union presented a memorandum to management that emphasized the need for full employment, and union leaders requested a meeting of the Consultation Conference. The company refused to accept the union's proposals, however, and announced that effective May 27 about 2,700 designated employees would be laid off, operations would be halted at the Ogaki Manufacturing Works, and the Takasaki Plant would be shut down. Faced with the company's hard-line stance, the union leaders adopted a concessionary attitude, and on July 16 approved the basic items in the company's proposal.

As a result of the new agreement, the company released over 3,500 of its 10,300 employees. The operations at the Ogaki Manufacturing Works, centered on the wired communications products division, were integrated in the Mita Manufacturing Works, and the Ogaki Manufacturing Works and Seto Annex Plant were closed. The Takasaki Plant was also shut down, and its vacuum tube operations were integrated in the Tamagawa-mukai Manufacturing Works. The most serious problem was closing the Ikuta Research Laboratory. Even after 1946, Ikuta still employed 500 persons, applying radio and acoustics technology for developing and producing prototypes of radio equipment and fish detectors. The company, however, decided it could no longer invest the substantial funds needed to maintain the laboratory. It thus transferred the personnel and the research operations to the various plants and closed the research laboratory.

After the successful introduction of these reconstruction measures, Nippon Electric returned to the size it was when the wartime control structure was first introduced. The company was now ready to start anew, with three manufacturing works—Mita, Tamagawa-mukai, and Otsu. The Mita Manufacturing Works exclusively produced wired communications products, and the Tamagawa-mukai Manufacturing Works produced radio products. Each had manufacturing, engineering, and purchasing functions. In July 1949 they were renamed the Mita Division and the Tamagawa Division. The Otsu Manufacturing Works was turned to the exclusive manufacture of radio receiver tubes, whose demand was expanding rapidly. It was reorganized as the Radio Receivers Division, provided with a sales force, and made into an independent profit center.

The reconstruction plan submitted to the government, meanwhile, emphasized the method by which Nippon Electric would dispose of its liabilities. By 1949, Nippon Electric had incurred liabilities of 480 million yen, an amount equivalent to about three times its paid-in capital. Accounts receivable from sales to the military during the war accounted for two-thirds of the total. After indemnities payments for sales to the military were halted, those accounts receivable became losses the company had to bear. Also involved were the losses of old accounts, overseas assets, and others. The company reported an overall special loss of 295 million yen, the difference between the total profits in the old account and the total of the foregoing losses plus others. Management intended to cover the special loss by reappraisals of inventories and fixed assets, as well as by profits realized from disposing of fixed assets. Included in those fixed assets were the Ogaki Manufacturing Works and Takasaki Plant and the Ikuta Research Laboratory.

The reconstruction plan the company submitted also called for Nippon Electric to increase its capital from 150 million yen to 350 million yen, mainly to rectify the make-up of its shareholders and to pay off its liabilities. Some of the new shares were allocated to the employees, and some to the general public. The government approved the company's reconstruction plan on October 15, 1949. With its continued existence thus guaranteed, the company moved forward with reconstructing itself along the lines of its plan.

Restoration of Relationship with ISE

Not long after the war ended, discussions were begun with International Standard Electric (ISE) to restore the business ties the war had interrupted. It took until 1951, however, to work out a new relationship. In a letter dated September 20, 1945, a little over a month after the war ended, President Takeshi Kajii told President S. Behn of ISE (concurrently president of International Telephone and Telegraph Corporation) that he would like to see the prewar relationship between the two companies restored. Vice President J. E. Fullam, former director of Nippon Electric before the war, was originally scheduled to visit Japan in early 1946 but was not able to make the trip until 1947. ISE later also sent Vice President C. B. Allsopp to Japan to conduct the actual negotiations with Nippon Electric.

The discussions between Nippon Electric and ISE centered on their equity relationship and technical ties. Concerning the equity relationship, ISE had owned 196,755 (32.796 percent) of Nippon Electric's 600,000 shares (paid-in capital of 30 million yen) in December 1941 when war broke out between Japan and the U.S. These shares had been sold as enemy assets and the proceeds were in the custody of Sumitomo Trust. In order to return the former shares to ISE and allow ISE to restore its 32.796 percent equity—especially because in the interim the number of the company's issued shares had increased to 7 million—ISE's shareholdings would lack 2,295,720 shares.

In that situation, Nippon Electric increased its capital again, by 150 million yen (3 million shares), and allotted all the shares at par value to ISE. This was done in line with a government ordinance concerning the recovery of the assets of shareholders of the Allied Powers. The company's new capital then became 500 million yen, with 10 million outstanding shares. ISE's total shareholdings became 3,279,600 shares, of which 3 million shares were allocated at the time of the new capital increase. The 196,775 shares originally confiscated as enemy assets were returned to ISE gratis, and the 82,825 designated shares were sold to ISE at par value. In November 1951, therefore, Nippon Electric increased its capital by 150 million yen to a total of 500 million yen, and the equity relationship with ISE was restored.

In these ways, ISE's shareholdings were returned to the original 32.796 percent, and William H. Harrison, Mark A. Sunstrom, and Walter F. Flanley were appointed to represent ISE on Nippon Electric's board of directors. Unlike before the war, there was now no other Nippon Electric shareholder with as many shares as ISE. Shares held by Sumitomo-related companies as of the end of March 1953 were no more than 11.4 percent of the total.

The technological partnership between Nippon Electric and ISE was restored preceding the equity relationship. Senior Vice President Sunstrom of ISE visited Japan to negotiate the new partnership. On July 19, 1950, barely two months after promulgation of the Foreign Investment Promotion Act, the two companies signed a technological assistance agreement that GHQ approved on November 6. This agreement restored the technological ties between the two companies, and Nippon Electric gained a license monopoly on patents owned by ISE. ISE also provided Nippon

Electric with all related blueprints, specifications, and documentation. Licensing was by product, and was limited to the products Nippon Electric selected. The two parties agreed to discuss the conditions for particular products or licenses. The agreement also allowed Nippon Electric to export to other countries in Asia.

3. Nippon Electric's Reconstruction

Business Results Turn Favorable

Nippon Electric's postwar reconstruction was supported by the recovery in demand in the government and private sectors. At the same time, reconstruction would not have been possible without the company's all-out efforts in promoting innovations in management and technology.

By 1950, therefore, as explained above, the internal and external conditions necessary for Nippon Electric's reconstruction were in place. Although sales seemed to hit a ceiling of 1,695 million yen in 1949, they began expanding again in 1950. Sales in fiscal 1950 increased 64 percent over fiscal 1949, reaching 2,786 million yen. The trend toward growth continued afterward as well, recording 4,577 million yen in fiscal 1951 and 6,089 million yen in fiscal 1952. The company turned profitable beginning in fiscal 1950, with profits increasing in proportion with the increase in sales in both the 1951 and 1952 business terms.

The favorable turn in Nippon Electric's business performance was certainly speeded up by changes in the external environment, especially the Japanese economy's recovery beginning in the second half of 1950. After the Korean War broke out in June 1950, a boom in "special procurements"—orders from the U.N. forces—added a new vitality to the economic activities of industry in Japan. The boom continued for three years, and in October 1951 the nation's mining and manufacturing index recovered to the level recorded before the Pacific War. The economic boom stimulated an increase in demand for telecommunications equipment for use in the private sector, including sales of radio receivers and other products to individual consumers. Sales in the corporate sector also increased rapidly, centered on vacuum tubes and other electronic components, as well as carrier equipment.

Meanwhile, funds budgeted for the government's five-year plan beginning in 1947 for restoring the nation's telecommunications network totaled 5.3 billion yen in fiscal 1947 and increased to over 20 billion yen in fiscal 1950, reaching 22.3 billion yen. In the wired communications area, new products such as the No. 4 type telephone sets and multichannel carrier equipment were marketed. Centered on these new products and automatic telephone switching systems, sales in the government sector contributed to the overall increase in Nippon Electric's sales.

The special U.N. procurements demand generated by the Korean War that started in June 1950 contributed about 3.5 to 4.5 percent to Nippon Electric's gross sales, not an especially large percentage. The figures, however, were significant beyond their size. Although the product quality requirements of the special procurements, handled through GHQ, were stringent, payment was assured and the outlook for profitability was certain.

As seen, therefore, the economic recovery in Japan from 1950 benefited Nippon Electric's reconstruction in various ways. That alone, however, is insufficient for explaining how Nippon Electric was able to grow rapidly ahead of other companies. Even before changes in external factors began influencing the company's business favorably, the company had taken action early on in innovating its technology and its style of management.

In its efforts to revert its production facilities to meet private sector demand during the postwar reconstruction period, Nippon Electric first began producing all-wave radio receivers, fish detectors, high-frequency industrial dryers, magnetic sound recorders, and vacuum tubes for radio receivers. Radio receivers, whose production was banned during the war, were one of the first products to be produced by Japanese companies in the postwar period. They enjoyed great popularity because the Japanese populace had been deprived for so many years of any form of entertainment.

Nippon Electric also developed and marketed an original all-wave radio receiver, and mass-produced radio receiver tubes in Otsu. By applying sonar technology developed for the military during the war, meanwhile, fish detectors were also developed. Nippon Electric also applied the same technology to the development of ultrasonic cleaning devices and ultrasonic whale detectors. Radar-related microwave technology, on the other hand, was applied to develop high-frequency industrial dryers. Concerning sound recorders, Nippon Electric had developed a wire-type recorder before the war, but was forced to halt research in that area. While continuing the development of new wire-type recorders in the postwar period, in 1949 Nippon Electric jointly acquired with Tokyo Tsushin Kogyo (Tokyo Telecommunications Engineering Corporation, today's Sony Corporation) the industrial rights to a patent held by Anritsu Electric Corporation, an affiliated company, and began producing tape-type sound recorders.

In December 1947, William B. Shockley and others at Bell Telephone Laboratories in the U.S. developed the transistor, the chip that raised the curtain on the modern electronics age. After news of the transistor reached Japan, engineers from Nippon Electric commuted regularly to the libraries of the Civil Information & Education Section of GHQ in Tokyo's Hibiya area and in Yokohama to read and absorb whatever information they found about the transistor in the *Bell System Technical Journal* and other academic journals. One of those engineers was Hiroe Osafune (later, vice president), engaged at the time in the vacuum tube production factory in the Tamagawa Plant. Osafune became keenly aware of the need to conduct transistor research and development, and he continued his personal research despite the lack of a budget to do so.

In 1950, Chief Engineer Masatsugu Kobayashi (later, senior managing director) traveled to the U.S. as the first person from NEC to inspect the latest industrial developments overseas after the war. He obtained a sample point contact transistor from Bell Telephone Laboratories and after returning home immediately ordered the start of transistor research by Nippon Electric. In 1951, the company successfully completed its first prototype transistor, a germanium point contact transistor.

Introducing New Production Management Systems

Around this time, Nippon Electric implemented a series of changes in production management, beginning with the introduction of a method of product quality control.

As mentioned earlier, the stimulus for introducing quality control in Nippon Electric came from guidance provided by the CCS of GHQ. It was first applied to improve the product quality of vacuum tubes used for communications. Due mainly to efforts by Koji Kobayashi, manager of the Tamagawa-mukai Manufacturing Works, statistical quality control methods spread not only to other divisions in Nippon Electric but also to other telecommunications equipment manufacturers and to other companies in Japan.

The Tamagawa Plant played a pioneering role among Nippon Electric's manufacturing plants in spreading the application of statistical quality control in production operations. The Mita Plant, on the other hand, played an important role in introducing improvements into overall production control, including process control. In the favorable business environment in Japan from 1950, in particular, the demand for telephone-related products expanded and management at the Mita Plant felt a need to improve its production system.

In 1951, a tact system was built at the Mita Plant by introducing a belt conveyor system in the processes for assembling No. 4 type telephone sets. A belt conveyor system was also introduced in the assembly processes for switches to be used in A-type automatic switching systems in 1952. For improvements in the areas of production control and manufacturing technology, Nippon Electric owed much to guidance it received from the Japan Management Association (JMA).

In April 1951, P. A. Stoops of Bell Telephone Manufacturing Co. (BTM) of Belgium was sent to Japan to provide guidance to Nippon Electric in the area of cost accounting. That marked the beginning of the company's renewed efforts to utilize WE's cost accounting system. After about a year and a half in Japan, Stoops prepared reports that discussed problematical points and suggested methods of improvement of a standard cost accounting system. He emphasized the importance in a standard cost accounting system of analyzing by individual processes the difference between standard and actual costs. He also made proposals for improving production control, including the control of inventories and semi-finished products, methods of issuing purchase orders, and production planning.

Early in the postwar period, in April 1948, Nippon Electric did away with the old system of differentiating between clerical and factory workers, and began calling both categories of workers "employees." A difference remained, however, between employees paid monthly and those paid daily. The system of paying daily wages was discontinued in 1966.

Of special interest are the changes seen in the total number of employees in Nippon Electric. In September 1949, just after more than 3,500 employees were released as part of the company's reconstruction plan, there were 6,750 employees (2,128 paid monthly, and 4,622 paid daily). The number of employees continued to decrease over the next two years, reaching 5,983 (1,930 paid monthly, and 4,053 paid daily) in March 1951. Afterward, in line with the company's favorable business growth, the number of employees began increasing. In March 1953, there were 6,819 employees (2,265 paid monthly, and 4,554 paid daily), an increase of over 830 persons in two years. Less than 300 of the new employees were males, and about 530 were females. At that point, females accounted for 1,755 of the total number of employees. The employees paid monthly had an addition of 40 college graduates with engineering degrees, bringing the total number of employees with engineering degrees to 205. Besides new college graduates, the company also aggressively hired mid-career college graduates.

Chapter 6

Nippon Electric during Period of High Economic Growth: 1953 – 1964

1. Telecommunications Business and Technological Innovation

Arrival of Period of High Economic Growth

By the mid-1950s, Japanese industry and the economy completed their recovery from the effects of the Second World War and entered a new period of growth. Technology was introduced in new industries such as petrochemicals and electronics, and a mass-consumption market began taking shape mainly for consumer products such as clothes, food, and electric home appliances. The nation's manufacturing index almost quadrupled between 1953 and 1964, with the value of production in the manufacturing sector showing particularly strong growth, increasing from 6 trillion yen to 27 trillion yen. During the same period, the telecommunications equipment market expanded about seven-fold.

One feature of the expanding telecommunications equipment market was the entry of many new companies. Nippon Electric, however, grew at a comparably higher pace than the market. The company's employed capital, for example, increased about 15-fold between 1953 and 1964, and sales of 7,889 million yen in 1953 increased 9-fold to 71,376 million yen in 1964. Especially noteworthy growth was attained in sales of radio equipment, as well as in new product areas such as electronic equipment, electronic components, and electric home appliances. While sales of wired and carrier transmission equipment expanded 6-7-fold, sales of radio equipment expanded 10-fold, and sales of electronic equipment and electric home appliances recorded an even higher rate of expansion. The course of growth in each product area, however, was not always smooth. Sales began to grow at a steady pace from 1956. This steady growth was due not only to the company's business strategy but was also tied closely to the market opportunities presented in each product area.

Nippon Telegraph and Telephone Public Corporation

In 1952, a major event occurred in Japan that affected all aspects of the country's telephone business. The telephone business had been conducted as a state-run enterprise since its start. In August 1952, however, the Nippon Telegraph and Telephone Public Corporation (NTTPC) was established as a public corporation for managing the country's domestic telegraph and telephone businesses. For managing the international telegraph and telephone businesses, Kokusai Denshin Denwa Co., Ltd. (KDD), was established in March 1953.

The first president of NTTPC was Takeshi Kajii, former president of Nippon Electric. Kajii was purged from public office after the war but later returned to serve as chairman of Nippon Electric.

The initial tasks facing NTTPC were putting the domestic telephone trunk lines into order and increasing the number of telephones, simultaneously reducing and then eliminating waiting times. At the time, the diffusion of telephones was at the rate of slightly over two telephones per 100 persons, lower than the world average of three telephones per 100 persons. Telephone usage, however, was 3,600 calls annually per telephone, the world's highest rate.

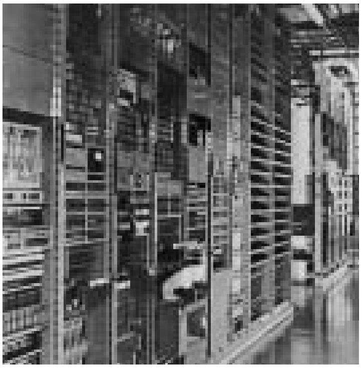
NTTPC's first full fiscal year was 1953, the year that it formulated its First Five-Year Telegraph and Telephone Expansion Plan. The plan called for investments over five years of 277 billion yen, the laying of 1.2 million kilometers of toll telephone lines, and an increase of 700,000 subscribers. It was expected that at completion of the plan there would be more than double the number of telephone lines, the number of subscribers would increase by about 45 percent, and the telephone diffusion rate would increase to three telephones per 100 persons. The actual figures turned out to be much higher. Three times the length of toll telephone lines as projected at the start of the plan in 1953 were laid, the number of telephone installations increased 1.7 times, and the number of public telephones installed increased six times.

The demand for telephone service, however, exceeded even this rapid expansion in supply. Each year, for example, no more than 30 percent of total subscription applications were processed. Also, two-thirds of all toll calls required the calling party to wait. In that sense, there was not much change from the situation existing prior to implementing the plan. In those circumstances, the Second Five-Year Telegraph and Telephone Expansion Plan was introduced in 1958. It included a goal of expanding the number of telephones in use by 1.83 million.

NTTPC's first and second five-year telegraph and telephone expansion plans provided Nippon Electric with the opportunity to increase its production. In addition, because two of the principal aims of the plans were to realize immediate connection of toll calls between large urban areas and to reduce connection time between other areas, it was necessary to introduce technological innovations related to telephone switching systems and telephone lines.

In 1953, development work began on a crossbar-type switching system to replace the step-by-step system currently being used. Successful development of the new system would allow nationwide direct dialing. The crossbar (XB) telephone switching system was developed through joint research between Nippon Electric and the NTTPC Electric Communications Laboratories.

The first president of Nippon Telegraph and Telephone Public Corporation was former Chairman Takeshi Kajii of Nippon Electric. The photo shows President Kajii with citizens to answer their questions in 1953, to improve NTTPC's services.



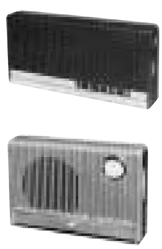
Nippon Electric played a leading role in developing and mass-producing crossbar (XB) switching systems. Shown here is a model C80 system installed in the Sendai Toll Telephone Office in 1959.

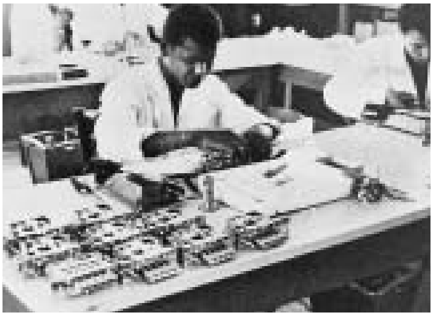
The Sagamihara Plant was built in 1962 to mass-produce XB switching systems. The plant was the third one Nippon Electric built in the Tokyo metropolitan region.

Development of the fully transistorized NEAC-2201 computer was completed in September 1958. It was exhibited in June 1959 at the UNESCO AUTOMATH Show in Paris.

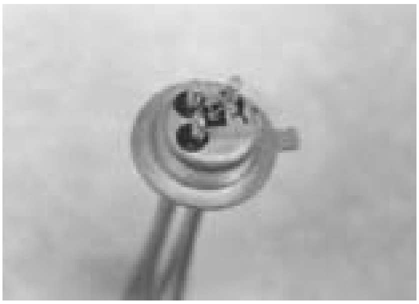
The Fuchu Plant was built in 1964 in Fuchu, Tokyo, to meet expanded demand in the computer business.

New Nippon Electric was established in June 1953. Its main products were vacuum tubes and fluorescent lamps. In 1957 the Otsu Plant also began mass-producing transistor radios, such as the NT-6B and NT-7P portable models.

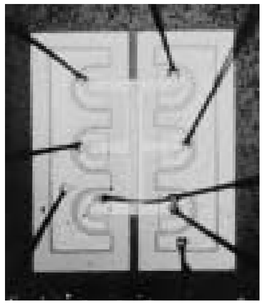




Nippon Electric aggressively provided technical assistance to developing countries. In 1959 the company signed an agreement with Transistor Company of Egypt (TCE) for assisting in assembling and marketing transistor radios. Shown here is a 1964 factory scene in TCE.

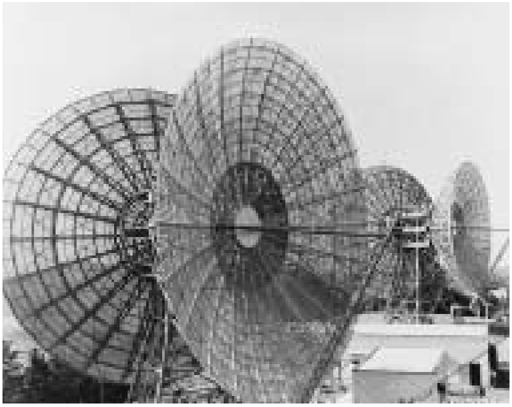


The 2SC33 silicon mesa transistor Nippon Electric developed in 1960 for use in communications was a pioneering product using the diffusion techniques in Japan.

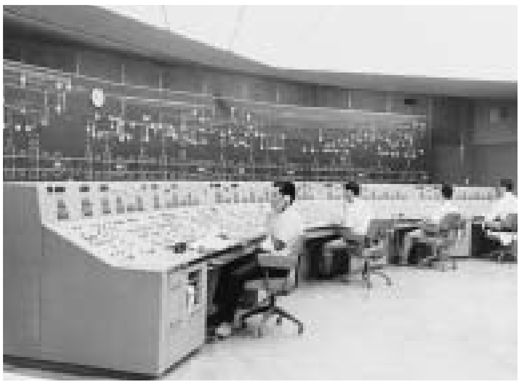


As early as 1961 Nippon Electric developed integrated circuits for electronic switching systems. Its NOR block appeared on the cover of the July 1962 issue of *Electronics* in the U.S.

President R. N. Noyce of Fairchild Semiconductors visited Japan in 1961. Nippon Electric recognized the significance of FCS's planar process technology and signed an exclusive patent licensing agreement in 1963. The photo shows Yutaka Ikeda of New Nippon Electric visiting Noyce in June 1962 to discuss the hermetic seal business.



Nippon Electric's over-the-horizon microwave communications technology was highly evaluated at home and abroad. In 1961 the company received a large order from the U.S. Air Force to construct a network connecting military facilities in Japan, Okinawa, and South Korea. The repeater station at Oura in Kagoshima Prefecture connected Okinawa with mainland Japan.



Remote monitoring & control equipment was one of Nippon Electric's specialized fields from the 1930s. The company installed an integrated monitoring & control system, networking the transformer stations of the Japan National Railways, when the Shinkansen "bullet" train began operating in 1964.

A bird's-eye view of the Tamagawa Plant in 1964; the Shinkansen Line passed right through the plant.

The first domestic-made XB switching system was completed in 1956, near the end of the First Five-Year Telegraph and Telephone Expansion Plan. The results of the joint research were opened publicly to Oki Electric Industry, Fuji Communications Equipment Manufacturing Co., Ltd. (later Fujitsu Limited), and Hitachi Ltd., but Nippon Electric played the leading role in terms of mass-producing the XB switching system and developing its components.

In the radio field, NTTPC pushed forward from 1951 with research into a 4 GHz microwave communications system. The results of the research were applied in 1954 to the trunk line between Tokyo and Osaka. Based on its research experience and the problems met at that time, Nippon Electric developed its own microwave communications system that combined oscillation and amplification. In 1956, Nippon Electric proposed that NTTPC use its system for the line between Tokyo and Sapporo. NTTPC subsequently accepted the proposal, and Nippon Electric's system was used as the standard system throughout the period of the Second Five-Year Telegraph and Telephone Expansion Plan. The company produced several hundred units of that system.

The PAM-FM (Pulse Amplitude Modulation-Frequency Modulation) system the Japan National Railways used in its 7 GHz microwave communications line between Moji in Fukuoka Prefecture and Tosu in Saga Prefecture was based on an invention by Nippon Electric's Masasuke Morita and others. It was the first time for a high-sensitivity receiver system to be used. Improvements were later added to this system for use in over-the-horizon communications and satellite communications systems.

The environment surrounding the broadcasting field also began changing. Radio broadcasting in Japan had long been a monopoly of Nippon Hoso Kyokai (NHK), for example, but from 1951 a number of private radio stations received government approval and began broadcasting. Nippon Electric took advantage of this business opportunity and installed much of the broadcasting equipment used in the newly opened radio stations. The successive opening of radio broadcasting stations also brought about a parallel boom in the sale of radio receivers as their use spread rapidly. A new demand also emerged for the miniaturized vacuum tubes (MT tubes) needed in small radios. Nippon Electric had already taken steps at its vacuum tube factory in the Tamagawa Plant to shift from producing the previous standard vacuum tubes (ST tubes) to mass-producing MT tubes. In the early 1950s, the plant's production capacity was 40,000 units/month. Radio receivers later moved away from using vacuum tubes to using transistors, and portable radios became popular. From 1957, Nippon Electric began mass-producing transistor radios.

From the mid-1950s, a television boom followed the boom in sales of radios and radio broadcasting equipment. In February 1953, NHK's Tokyo Broadcasting Station provided the first regular television broadcasting services in Japan. This was followed in August the same year by regular television broadcasting by Nippon Television, a private broadcasting station. Nippon Electric received orders for television broadcasting equipment in 1954 from two private broadcasting stations: Osaka Television, and Chubu-Nippon Broadcasting in Nagoya, thus taking the initiative in the television boom. After mutual broadcasting became necessary, a demand emerged for microwave repeaters and repeater circuits.

In these ways, the first half of the 1950s saw new business opportunities open in the wired and radio communications fields. Devices such as microwave repeaters provided business not only in those two fields but also in the electronic components field, centering on semiconductors. A demand thus emerged for electronics technology, which called for a comprehensive integration of expertise in those fields, and an electronics market appeared.

2. Technological Innovation, and Expansion of Business Domains

Introduction of New Technology

The Foreign Investment Promotion Act went into effect in May 1950, making it possible for Japanese companies to import foreign technology. New electronics technology subsequently introduced from the advanced Western countries considerably changed Japan's electrical machinery industry.

Nippon Electric's basic business policy during the period 1953 to 1964 pointed in three directions. First was improvement of the company's technological capabilities. This was realized by introducing the latest technology from Western countries and catching up with them. Second was improvement of the company's competitiveness. This was realized by improving product quality and reducing costs, and by placing importance on becoming more competitive in overseas markets. Third was entry into new business domains, including areas such as electric home appliances, transistors, integrated circuits (ICs), and computers.

Once into the 1950s, business turned favorable, and Nippon Electric was able to catch up with Western companies technologically. In July 1953, in order to promote technological innovation, the company reopened the research laboratory it closed in 1949. Managing Director and Chief Engineer Masatsugu Kobayashi, deputy manager of the laboratory when it was closed, was appointed manager of the research laboratory.

The new technology Nippon Electric imported between the 1950s and first half of the 1960s did not come solely from International Standard Electric (ISE) but from a wide range of Western companies. Nippon Electric and ISE restored their technical ties in November 1950, well ahead of such ties between other Japanese and overseas companies. At first, the new ties covered almost the entire product line of Nippon Electric, but the company quickly absorbed the technology it imported from ISE. In 1960, therefore, when the two companies renewed the agreement, it was limited to 20 products, mainly related to carrier transmission and navigation. During the subsequent renewal of the agreement in November 1965, it was further narrowed down to seven products. Also, it was a licensing agreement and did not cover know-how, only patents.

Besides from ISE, Nippon Electric imported a wide range of technology from many other overseas companies. After International Telephone & Telegraph (ITT) and Western Electric (WE) entered into a patent licensing agreement in June 1951 concerning various types of telephone switching equipment, for example, Nippon Electric entered into a sublicense agreement with ITT in March 1955 for the same products. The company also signed an agreement with WE in 1962 concerning know-how related to reed switches used in XB switching systems, and a patent licensing agreement in 1963 related to various types of communications and electronics equipment.

In the television field, Nippon Electric formed new relationships from early on. These included patent-licensing agreements, concluded during the period from 1953 to 1957, with RCA (U.S.), EMI (U.K.), and Philips (the Netherlands) concerning television receivers and transmitters.

In the semiconductor field, Nippon Electric signed two agreements in 1958 with U.S. companies. The first was with RCA concerning transistor patent licensing; the second was with General Electric (GE) concerning know-how and patent licensing for semiconductors. The company also signed a patent licensing agreement with Fairchild Camera and Instrument Corporation in September 1963 concerning planar semiconductor devices for producing transistors and ICs. This agreement proved to have great significance for the later development of Nippon Electric's business. Fairchild Semiconductors Co. (FCS) had developed planar technology in 1959, important basic technology related to transistors and ICs that allowed transistor circuits to be placed on silicon by leaving an oxide film. FCS President Robert N. Noyce visited Japan in 1961 expressly to sell this technology. Although other Japanese manufacturers ignored him, Nippon Electric highly evaluated the significance of FCS's patents on planar technology and entered into an agreement with FCS, which included the right for Nippon Electric to sublicense the patents in Japan. The importance of the technology was proven later when other Japanese companies approached Nippon Electric to sublicense the patents.

Once into the 1960s, the range of technology being introduced from overseas spread to include computers. In order for Japanese computer manufacturers, including Nippon Electric, to move all-out in promoting their computer business, it was necessary for them to use IBM patents. IBM's worldwide policy at the time, however, was not to license the use of its patents. But in return for the government allowing IBM Japan to produce computers domestically, IBM licensed the use of its patents to Japanese computer manufacturers. In January 1961, Nippon Electric signed a patent licensing agreement with IBM for data processing equipment and related components.

One significant event as Nippon Electric moved to develop its computer business was the agreement it signed in July 1962 with Minneapolis-Honeywell Regulator Co. (later, Honeywell Inc.) for know-how and patent licensing related to electronic data processing equipment and components. Behind Nippon Electric's business ties with Honeywell was the belief held by Senior Managing Director Koji Kobayashi that the future success or failure of the company's computer business would depend on its software capabilities.

Original Technology, and Development of Business

Besides absorbing technology imported from overseas companies and applying it to the Japanese situation, the engineering staff of Nippon Electric also accumulated original technology.

After joint research into XB switching systems with the NTTPC Electric Communications Laboratories, in September 1956 Nippon Electric installed Japan's first domestic-made XB switching system in the Sanwa Telephone Office in Tochigi Prefecture. The company continued to promote research and development into XB switches afterward as well, and into wire spring relays. In fact, it took four years of research into wire spring relays before successful development of a system fitting for the Japanese situation. For mass-production of XB switching systems, meanwhile, Nippon Electric built a new plant in 1962 in Sagamihara, Kanagawa Prefecture. The company also conducted research into electronic switching systems, and in 1958 delivered a semi-electronic switching system, using parametrons—logic devices composed of two stable states of oscillation, and able to store one binary digit—to the NTTPC Electric Communications Laboratories.

In 1961, NTTPC introduced the 600-type telephone set as its standard model. Nippon Electric, a major player in the manufacture of telephone sets, cooperated extensively in developing this telephone model.

Nippon Electric also tackled technological innovations in the area of carrier transmission equipment. In 1958, for example, the company successfully transistorized multiple power line telephone carrier transmission equipment. Next, while contributing to the development of various coaxial cable carrier transmission systems, in 1959 the company successfully developed a fully transistorized system. The 12 MHz coaxial cable system NTTPC adopted in 1962 carried a tremendous 2,700 channels. At the time of the 1964 Olympics in Tokyo, Nippon Electric contributed in the development of a submarine cable carrier transmission system between Japan and the United States. In 1963, when NTTPC decided to introduce a new system for short-haul carrier transmission, the system it adopted was the Pulse Code Modulation (PCM) system that Nippon Electric had been researching for some time using original technology. The short-haul 24-channel PCM carrier transmission equipment that Nippon Electric delivered to NTTPC in 1965 was Japan's first digital carrier transmission system.

A major subject around this time in the radio field was the development of microwave communications technology. Engineers at Nippon Electric recognized the future potential of ultra-multiple microwave communications systems and moved forward with basic research to develop such systems. While importing related technology from ITT, on the one hand, Nippon Electric applied the combined oscillation and amplification and the high-sensitivity receiver systems to establish ultra-multiple line technology. The superior quality of Nippon Electric's over-the-horizon system using the high-sensitivity receiver system was recognized at home and overseas. In 1959, the company received a substantial order from the U.S. Air Force in Japan to construct a microwave communications network connecting 17 radar stations over a distance of 2,740 kilometers. Next, in 1963, Nippon Electric developed the world's first fully transistorized microwave repeaters, using silicon transistors for microwave amplification. The repeaters were exported to Mexico. In November 1963, when KDD opened its Ibaraki Space Communications Test Center (later, KDDI Ibaraki Satellite Communications Center) as Japan's first satellite communications earth station, Nippon Electric provided the station with a high-sensitivity receiver system, marking the company's entry into the space communications field. This high-sensitivity receiver system contributed to the success of the first experimental television broadcast on November 23, 1963, between Japan and the U.S. using a satellite. The first satellite-relayed images received reported the assassination of President John F. Kennedy. In these ways, Nippon Electric came to assume a world leader's position in the development of microwave communications technology. In the early 1960s, even overseas companies in the ITT group that formerly exported technology to Nippon Electric began sending engineers to Nippon Electric.

In order for Nippon Electric to move all-out in promoting its satellite communications business, it was essential that the company's engineers be totally familiar with technology related to satellites. With cooperation from Hughes Aircraft Company, a manufacturer with leading-edge technology in this field, Nippon Electric gradually raised the level of its satellite-related technological capabilities. And even as it applied the new technology it absorbed, the company also jointly developed Random Multiple Access System technology with Hughes Aircraft for building satellite communications networks. The new technology was called Satellite Telecommunications with Automatic Routing (STAR) and it subsequently was highly evaluated at home and abroad. Two of the engineers who participated in this joint project were Tadahiro Sekimoto and Hisashi Kaneko (later, successive presidents of Nippon Electric). The original opportunity for initiating this joint development project with Hughes Aircraft presented itself when Senior Managing Director Koji Kobayashi visited Hughes in Los Angeles in the summer of 1962. Kobayashi was visiting Chicago before traveling to Los Angeles and viewed the world's first television broadcast using the Telstar 1 satellite. Kobayashi had a strong interest in satellites, and Vice President L. A. Hyland of Hughes likewise had a strong interest in Nippon Electric's microwave communications technology. When Kobayashi visited Hughes, therefore, Hyland proposed that Nippon Electric and Hughes work jointly to develop satellite communications technology, combining Nippon Electric's microwave communications technology and Hughes' geostationary satellite technology. Kobayashi immediately accepted the proposal. That was the start of Nippon Electric's entry into the satellite communications business. The International Telecommunications Satellite Consortium (Intelsat) was established in August 1964. Communications Satellite Corporation (COMSAT), established in 1963, was designated to be Intelsat's management company. Japan's KDD immediately joined Intelsat. Nippon Electric approached the member countries of Intelsat through KDD or by responding to direct requests from COMSAT to market equipment for satellite communications earth stations and other related equipment.

A foundation was built for the company's computer business during this period. Japanese companies originally lagged far behind overseas companies in computer research. After the parametron was invented as a computer device at the University of Tokyo in 1954, however, the NTTPC Electric Communications Laboratories, Nippon Electric, and other Japanese companies all began developing parametron computers. In March 1957, the NTTPC Electric Communications Laboratories completed development of the MUSASINO-1, the first parametron computer in Japan. Nippon Electric had set up a company-wide project organization for computer research and development from early 1956 after accepting a proposal from Tohoku University for joint research into a computer to be used for scientific calculations. After the company's research laboratory completed its original development of the NEAC-1101, its first parametron computer—in

March 1958—it then completed development of the NEAC-1102 jointly with Tohoku University in the same month. The ultra-small parametron-type NEAC-1201 put on sale in 1961 became popular and sold well over a long period.

The first transistorized computer developed in Japan was the ETL Mark IV, completed in November 1957 by the Electrotechnical Laboratory of the Agency of Industrial Science and Technology, MITI (Ministry of International Trade and Industry). With guidance from that laboratory, Nippon Electric completed development of the fully transistorized NEAC-2201 in September 1958. This computer was exhibited in June 1959 at the UNESCO AUTOMATH Show in Paris. Although IBM also exhibited a transistorized computer at that show, it was introduced using panels, without showing the hardware. Nippon Electric, however, exhibited and demonstrated an actual model of the NEAC-2201 computer, thus marking the first time in the world for a fully transistorized computer to be operated in a public venue. In 1960, Japan's first online, real-time seat reservation system was put into operation using a NEAC-2203.

Based on its accumulation of original technology, Nippon Electric entered into technical ties with Honeywell in July 1962. The company aimed at marketing a full line of computers from ultra-small machines to large-scale machines by combining computers developed with its own technology with computers developed using imported technology. That policy bore fruit when Nippon Electric marketed the medium-size NEAC-2200 in May 1964. Besides orders from first-time users, replacement orders for the NEAC-2200 also came from customers using the IBM 1401. About 100 units of the NEAC-2200 were sold in its first year on the market. Those favorable sales provided an important business foundation for NEAC-Series 2200 computer systems later introduced in May 1965 as the nation's first domestically developed models incorporating the "one-machine concept." Convinced that the market for computers would expand, Nippon Electric completed construction of its Fuchu Plant in Fuchu City, Tokyo, in May 1964.

Concerning electron vacuum tubes, Nippon Electric placed particular importance up to the mid-1960s on research into microwave tubes. The field replaceable-type traveling wave tube the company developed in 1962 was highly acclaimed by customers in countries such as the U.S. and Canada. Doing business through Varian Associates, with whom it had technical ties, Nippon Electric exported large volumes of the traveling wave tube to GE and other companies.

Although Nippon Electric began research into transistors from early on, it placed more importance at first on diodes rather than on transistors. The company thus experienced one of the first detours in its business. Its decision to study diodes, however, was closely related to the efforts that NTTPC, the company's single largest customer, placed on commercial applications of microwave communications. The greatest priority was placed on developing mixing diodes because they were essential in microwave communications.

Immediately after reopening its research laboratory in 1953, Nippon Electric moved to produce prototype germanium point contact diodes and alloy transistors and to commercialize the products. Concerning diodes, the company established a mass-production system early on for diodes used in microwave communications. The main applications for transistors at first were in electric household appliances. Nippon Electric was not a major manufacturer of electric home appliances at the time and thus did not have much in-company demand for transistors, making it a latecomer in moving all-out in the transistor business. As a manufacturer of vacuum tubes, moreover, the company hesitated to mass-produce transistors because they were competitive products. At any rate, the total production of transistors in Japan in 1954 was only about 6,500 units. Afterward, however, production continuously increased at an explosive 10-fold annual rate. The year 1955 saw production of 85,000 units, and 1958 saw 27 million units. As the importance of transistors became more obvious, Nippon Electric realized that perhaps its priority on diodes had caused a tardy response to entering the transistor business. Based on that realization, in 1956 the company decided to move all-out in the transistor business.

The technology Nippon Electric developed while working with diodes was put to good use in the development of transistors. In short, the technical problems that emerged and were subsequently resolved concerning diodes opened the way to the development of transistors and then ICs. In 1956, Nippon Electric succeeded in developing a grown junction transistor; in 1957, it commenced the mass-production of transistors; and in 1958 it built a dedicated transistor production plant inside the Tamagawa Plant. The agreement the company signed with GE in 1958 for know-how and patent licensing was aimed at reducing the gap in leading-edge transistor technology and rapidly expanding the company's transistor business.

In 1959, Nippon Electric commercialized a super grown junction transistor. Once into the 1960s, the company began developing many original transistor technologies one after the other. One such technology was a silicon mesa transistor developed in 1960 for use in communications, a pioneering product in the development of diffusion-type transistors in Japan. Nippon Electric also tackled the development of epitaxial and planar technology from 1960, and in 1964 succeeded in developing a silicon epitaxial planar transistor that covered the 900 MHz range, thus making possible the transistorization of microwave communications equipment. In 1962, based on its technological successes up to then, the company developed a micro disc transistor. Although the principal material used in transistors at the time was germanium, in 1961 Nippon Electric adopted a policy of shifting to silicon. In short, when the company came to recognize how transistors could be applied in communications and industry, and saw the move toward ICs, it also realized the superior qualities of silicon.

Behind the demand for greater miniaturization in electronics were several lines of technology. In January 1959, J. S. Kilby of Texas Instruments succeeded in building a flip-flop circuit, one of the basic circuits in computers, in a germanium crystal chip. He announced this breakthrough in March 1959, calling it a "solid circuit." Nippon Electric took notice of this solid circuit, which later came to be called an "integrated circuit," and when the company succeeded in 1960 in developing a mesa transistor it began research into practical applications of ICs. As early as 1961, the company developed ICs for use in electronic switching systems, and in 1963 began successfully mass-producing ICs. Since IBM did not announce its System/360, the first computer to use a hybrid IC, until 1964, Nippon Electric was one of the earliest companies in the world to mass-produce ICs and to market products using them.

In these ways, from the first half of the 1950s to the first half of the 1960s, Nippon Electric absorbed technology from overseas companies in a wide spectrum of electronics-related fields and also developed original technology. Based on these various technologies, Nippon Electric diversified its business into areas such as semiconductors, computers, and electric household appliances. Formerly known mainly as a manufacturer of communications equipment, the company was changing to become a comprehensive electronics manufacturer.

3. Managing Rapid Growth

Rapid Growth, and Reorganization

The years from 1953 to 1964 correspond to the first half of a long period of high economic growth in Japan. It was also a period during which Nippon Electric began to grow steadily and to maintain that growth. The company's sales during this period increased nine-fold, its operating profit increased about the same, and its net assets increased eight-fold. The workforce more than tripled during the same period.

In 1953, Nippon Electric's organization comprised the Head Office, including the Sales Division, and the Mita, Tamagawa, and Radio Receivers divisions, with each including manufacturing, engineering, and purchasing functions. The Mita and Tamagawa divisions managed their respective regional plants, thus differing substantially from the basic concept of business divisions that should have authority, responsibility, and functions that allowed them to conduct the business of manufacturing specific products and serving certain market areas. The Radio Receivers Division, on the other hand, not only manufactured products for the private sector, including vacuum tubes and fluorescent lamps, but also had its own sales department. The Radio Receivers Division was split off in June 1953 and its operations were transferred to the newly established New Nippon Electric Company, Ltd. These steps were taken because after witnessing the increased demand from general consumers for radios in the early 1950s, Nippon Electric felt there would be a similar demand for other consumer products and decided that the most effective way of responding to that demand was to turn the Radio Receivers Division into a separate company. Next, in October 1954, the Mita and Tamagawa divisions were renamed "manufacturing works," as they had been called previously, remaking them in name and in fact into organizations centered on manufacturing in their geographic areas. The new organizations made it possible to promote more efficient control of product quality and production in the plants, and to train onsite managers to use those control methods, making them the most appropriate organizations for tackling the various challenging tasks the company faced at the time.

Organizational reform on a company-wide scale began in 1956. In August, the company reorganized its business operations into five "industry divisions," categorized by product and market. In each industry division, engineering and manufacturing were integrated by major product group. The head of each industry division was provided wide-ranging authority in each product group concerning both engineering and production. As well, administrative divisions were set up in the Mita and Tamagawa plants to manage the general affairs, labor relations, accounting, purchasing, and other functions of the area. Sales, meanwhile, remained as previously in the Head Office. Of the five industry divisions, the Wired Communications Industry Division was located in Mita, and the Electron Tube, Transmission, Radio, and Special Products industry divisions were located in Tamagawa. The organizations were able to respond effectively to each separate market.

The principal customer of the Wired Communications and Transmission industry divisions was NTTPC, but the Radio Industry Division also handled important customers such as television broadcasting stations, the Japan National Railways, and electric power companies. The Electron Tube Industry Division dealt mainly with the private sector, and the Special Products Industry Division almost exclusively handled general consumer products.

As its business developed further the company immediately saw the need to branch out certain operations from this organization. In 1957, first of all, an Apparatus Industry Division and an Electronic Equipment Industry Division were newly established by splitting them off, respectively, from the Wired Communications and Transmission industry divisions. The Electronics Equipment Industry Division's mission was to promote the development of computers and automatic control equipment, two leading-edge areas in the electronics field. Next, in 1958, a Broadcasting Equipment Industry Division was newly established by splitting it off from the Radio Industry Division, and, in order to respond to the boom in electric home appliances, the Special Products Industry Division was renamed the Consumer Products Division. Then, in 1960, in response to the boom in the use of transistors, a Semiconductor Industry Division was made independent from the Electron Tube Industry Division.

In April 1961, Nippon Electric introduced a business division system to replace the industry division system. The main reason for this company-wide organizational reform was to respond to the diversification of the company's product line, which had accompanied the expansion of its business and the rapid advances in technological innovations. The main changes were: (1) establishment of a system of five business divisions by merging and reorganizing the sales divisions and industry divisions; (2) control of these divisions by improving and strengthening the Head Office structure and the administrative divisions; (3) establishment of a Subsidiaries and Investment Division to handle business affairs related to affiliated companies; and (4) strengthening of sales in rural areas.

Besides the existing Consumer Products Division, the resultant new organization had four new divisions: the Communications, Radio, Electronic Equipment, and Electronic Components divisions. All matters related to production and sales in the various product areas were under integrated control of the divisions. In short, the divisions were reorganized to control the basic functions of production, engineering, and sales. In order to introduce the new business division system, an internal cost-charging system was put into effect to reinforce the independence of the divisions and to clarify the responsibility for realizing a profit in the manufacture of each product.

When New Nippon Electric was established in June 1953, the main products it manufactured were vacuum tubes and fluorescent lamps. Before long, however, it also began developing and producing lighting appliances, television sets, transistor radio receivers, and acoustic equipment. At first, the company's production was carried out mainly at the Otsu Plant. In 1960, however, it began operating the Minakuchi Plant in Shiga Prefecture for producing electronic components. Next, in 1963, Mizonokuchi Seisakusho Ltd., a Nippon Electric subsidiary originally set up for the exclusive production of television sets, was merged into New Nippon Electric and renamed the Tokyo Plant. Produced there were television sets, tape recorders, transistor radios, stereo sets, and other products.

Bolstering of Production System

As Nippon Electric expanded its business and its product line, it also expanded and bolstered its production plants. As already mentioned, in 1958 it built—inside its Tamagawa Plant—Japan's first plant for the exclusive production of transistors. A notable leading-edge feature of the plant was that it had no windows. This was to allow strict temperature control and the prevention of dust, because transistors are extremely sensitive to dust and temperature fluctuations.

Construction was also completed on the Sagamihara Plant in 1962 and the Fuchu Plant in 1964. The Sagamihara Plant was fitted with the most modern production equipment. Besides XB switching systems, the plant also mass-produced printed wiring boards (PWBs) and various types of condensers. It was also an unusual plant in that it included an employees' hall, dormitories for female employees, and housing for other employees. The Fuchu Plant was put in charge of electronic products. Extreme care was placed on minimizing the negative influence that vibrations and the operation of other equipment had on computers and other electronics products. Besides the above new plants, other plants were built as separate companies. Two examples were Mizonokuchi Seisakusho Ltd. established in 1959 for the exclusive production of television sets, and Nichiden Takahata Works, Ltd., established in 1964 for mass-producing transistors.

In each of these plants, as well as in the existing plants, Nippon Electric during this period introduced high-level product quality control and production control methods from companies in Western countries. Among the methods introduced, statistical quality control methods were promoted in later years as well. And once into the 1960s, quality control activities began to be developed as a company-wide movement. QC Circles were established at the various worksites in 1964, and the company's first QC Activities Presentation Meeting was held at the end of that year.

Two of the engineering control methods Nippon Electric introduced in the early 1960s were industrial engineering (IE) and value analysis (VA). IE was an analytical engineering method that enabled establishment of the most suitable production systems for the company. In 1962, Nippon Electric established an IE Expert Committee. While receiving guidance from the Japan Management Association (JMA) on the most up-to-date methodology, the company also began applying operations research (OR) and system engineering (SE) methods of control. VA was first used in June

1961 in the Purchasing Department of the Tamagawa Plant to reduce the cost of materials, after Nippon Electric personnel participated in an industrial tour in the U.S. arranged by the Japan Productivity Center (today's Japan Productivity Center for Socio-Economic Development). Afterward, the use of VA methods spread to all the purchasing departments of the company, and cost reductions were also promoted through a suggestion system. From 1967 onward, VA came to be called value engineering (VE), and a company-wide movement was promoted to reduce overall costs not only in purchasing but also in the areas of software and service.

4. Development of Markets

Dependence on NTTPC, and Expansion of Private Sector

Nippon Electric's principal market during the 1953-1964 period was the government sector, centered on NTTPC. Demand from the private sector and from overseas, however, gradually came to play a more important role in the company's business. The percentage of Nippon Electric's overall sales accounted for by the government sector in 1954, for example, was 75 percent (NTTPC alone was 62 percent), but ten years later, in 1964, that percentage had dropped to 56 percent (NTTPC, 48 percent). During the same ten-year period, private sector demand increased from 24 percent to 35 percent, and exports increased from slightly over 1 percent to over 9 percent.

NTTPC introduced three five-year telegraph and telephone expansion plans beginning in 1953, and orders from NTTPC during those 15 years accounted for roughly half of all communications equipment sold in Japan. The volume of communications equipment business as recorded in the amount of orders in Japan continuously increased from 1953 at an annual rate of almost 20 percent, and orders from NTTPC grew at about that same rate. During those years, Nippon Electric maintained close to a 50 percent share of all orders from NTTPC for communications equipment. Although the company's dependence on sales to NTTPC later decreased, they still accounted for almost 50 percent of Nippon Electric's total sales as late as fiscal 1964. The fact that an important customer such as NTTPC was promoting five-year telegraph and telephone expansion plans was a major factor making it possible for Nippon Electric to realize stable growth from a long-term perspective. On the other hand, the demand from NTTPC was linked closely to overall government spending, so the available budget was directly influenced by the government's management of the economy and was not always determined by actual need. Although Nippon Electric's sales to the private sector increased between 1954 and 1955, for example, overall sales decreased because of reduced orders from NTTPC.

In that background, Nippon Electric moved to develop private sector markets. The main products were electric household appliances, centered on television sets, as well as semiconductors and electronic equipment. Sales of these products grew at rates higher than those of communications equipment, and became an impetus for Nippon Electric being able to break away from its over-dependence on sales to NTTPC. As sales to the private sector increased, moreover, the company reorganized its sales system. For sales of electronic components, for example, the company moved to organize a network of special-contracted retailers. In 1956, six such companies selling Nippon Electric's electronic components joined together to form an association of NEC retailers. Although the number of participating companies decreased to five in 1957, they expanded their networks of sales offices in their regions. They comprised especially important sales channels for handling Nippon Electric's semiconductors.

Development of Overseas Markets

Nippon Electric began developing overseas markets in the early 1950s. Initially centered on markets in Asian countries, sales to overseas markets expanded noticeably. The percentage of total sales accounted for by exports in the early 1950s was no more than

1-2 percent, and they were influenced by special procurements to the U.S. military related to the Korean War. By 1964, that same percentage increased to almost 10 percent. The growth in exports was not realized as a matter of course but resulted from President Toshihide Watanabe early on emphasizing the need to set export goals and to implement various measures to achieve those goals.

President Watanabe recognized the importance of exports not only as the president of Nippon Electric but also as a leader among Japan's telecommunications equipment manufacturers. He also emphasized that same point at every available opportunity to the employees of Nippon Electric. In his New Year's Greetings to the employees in 1953, for example, President Watanabe said, "The demand for our company's products is almost entirely limited to the domestic market. But from the standpoint of having Japan's economy stand on its own two feet, those of us working in industry must make strong efforts to export." This kind of thinking gradually spread throughout the company. In 1964, Nippon Electric's contribution to the country's increase in exports was recognized with a special citation from the Minister of International Trade and Industry.

The first overseas destinations for Nippon Electric's products were Taiwan and Korea, the closest neighboring countries in Asia, followed by the Philippines, Thailand, India, Pakistan, and then the Mideast countries.

According to the technical agreement signed in 1950 between Nippon Electric and ISE, Nippon Electric was allowed to export products to all of Asia. Exports to other destinations, however, required ISE's approval. Although this restriction on sales to destinations other than Asian countries was lifted in 1965, Nippon Electric's exports to regions other than Asia, such as Latin America and Africa, expanded rapidly from around 1960, and quickly came to account for one-quarter of total exports.

The main products Nippon Electric exported were wired and radio communications equipment. Beginning with the export to Taiwan in 1953 of common-battery switching systems, the company also exported automatic telephone switching systems, nonloaded cable carrier equipment, microwave communications equipment, and television receivers. In the Philippines, meanwhile, a plan emerged to build a communications network as a part of government war reparations, and in 1961 Nippon Electric signed a contract to participate in that large-scale project. Ten telephone offices were built in Manila and its outlying area, and automatic telephone switching systems for handling 12,000 lines were installed.

Meanwhile, India, Pakistan, and other countries in Southeast Asia, markets traditionally monopolized by European companies, were viewed as highly potential export destinations, and President Watanabe personally visited them with Senior Managing Director Koji Kobayashi and others to lay the groundwork for opening the markets. One result was the successful export to India in 1956 of microwave testing equipment. Other products exported to India in those early days were coaxial cable carrier transmission equipment and broadcasting equipment. And 1964 saw the first exports of microwave communications equipment to India. Exports to Pakistan included coaxial cable carrier transmission equipment in 1962, and equipment for experimental television broadcasting in 1964. The main feature of these exports was that they were mostly large orders for equipment related to the construction of communications networks in the destination countries.

Nippon Electric introduced various measures to develop overseas markets. One was the establishment of overseas liaison offices. The first three of these were established in 1961 in Taipei, Bangkok, and New Delhi. An office was set up in New York in 1962, and five new offices were established in 1963, including in Jakarta.

Based on a policy of emphasizing the U.S. market, the New York Liaison Office was reorganized in January 1963 as Nippon Electric New York, Inc. (later, NEC America, Inc.). One of the first items exported to the U.S. was solid-state (transistorized) carrier transmission terminal equipment, exported in 1961. In 1964, submarine cable terminal equipment and international telephone switching systems were also exported. They were delivered to

AT&T, a remarkable feat for Nippon Electric at the time that provided a solid foothold for all-out development of the U.S. market. In February 1963, Nippon Electric became only the second Japanese corporation after Sony to issue American Depositary Receipts (ADRs), thus raising the level of familiarity of the company's name in the U.S.

Although the countries of Asia were important export markets for Nippon Electric, the host governments began introducing policies to shift from the import of completely built-up products to local production. The governments called for technical assistance to establish local assembly plants and also to make it possible to produce parts locally. Nippon Electric responded to such a request from the Taiwanese government and in 1958 established Taiwan Telecommunications Company (TTC) jointly with a Taiwanese company. It then signed a technical assistance agreement with TTC relating to the production and sale of transistor radios, telephone sets, and telephone switching systems. That was the first such technical agreement Nippon Electric signed with a foreign company in the postwar period. Afterward, it signed similar agreements with companies in Egypt, India, South Vietnam, Pakistan, and other countries relating to the production and sale of products such as transistor radios, television receivers, and short-wave transmitters and receivers for use at broadcasting stations.

5. Rapid Increase in Size of Workforce, and Training and Education of Employees

Workforce Changes, and Training and Education System

At the end of March 1953, Nippon Electric had 6,819 employees. Four years later, in March 1957, this number had increased to 6,958. Afterward, however, it increased rapidly. In March 1965 the number had increased to 20,755. Every year after 1957, the workforce increased substantially by somewhere between 1,000 and 2,500 persons. The increase was related to the new workers hired together with the construction of new plants and the mass-production of transistors, and to the engineers and others newly employed as the company moved all-out into the electronics field.

There were several changes over the years in the composition of the workforce. The ratio between salaried employees and employees paid daily wages, for example, was 1:2 at the end of March 1953, but at the end of March 1965 the ratio was about equal. During that period, the number of salaried employees increased steadily while the number of employees paid daily wages tended toward decrease from 1963. Changes also occurred in the composition of the workforce by gender and age. At the end of March 1953, the ratio of male to female employees was 3:1. At the end of March 1961, that ratio had changed to 2:1. The average age of the employees also moved steadily downward. It was 30.2 years (male: 32.6; female: 22.4) in March 1954, but decreased to 26.0 years (male: 26.8; female: 20.7) in March 1965. Together with the rapid increase in the scale of Nippon Electric's business, the number of salaried male employees increased while the overall number of female employees increased, even though there was a short-term turnover of female employees paid daily wages.

As the number of newly hired employees increased, there was an especially rapid increase in the number of young workers. This necessitated changes in the personnel system and a strengthening of the training and education system. One of the first steps was taken in April 1956 when training centers for technical personnel were established in the Mita and Tamagawa plants. Next, in 1957, the Nippon Electric Technical School, a new training and education center, was opened in the Tamagawa Plant, and all the company's technical training programs were integrated there. Middle-school graduates expected to form the future core of skilled workers in Nippon Electric were trained at this center. Establishing that training center was based on the thinking that a high level of manufacturing technology would have to be maintained in the future. The efforts at the training center soon began to bear fruit. Since 1962, the center has given birth to a number of award winners in competitions at the World Skills Competitions.

Next, in May 1960, Nippon Electric opened the Nippon Electric Engineering School. This school was aimed at teaching technical subjects to high-school graduates. Its curriculum covered four main subjects: electricity, machinery, applied chemistry, and applied physics. The full course of study took three years. Since 1960, 70 students have been accepted every year.

From the early 1960s, a number of programs were introduced for the training and education of middle-level managers. In November 1960, management control expert seminars were established for section managers. These were followed in April 1961 by management seminars for assistant section managers. This training emphasized showing the assistant section managers how to teach and how to handle the quickly expanding group of young employees. Also, in October 1964, education programs for mid-level employees were begun.

Chapter 7

Formation of Strategic Management: 1964 – 1976

1. From High Economic Growth to Information Age

From High Growth to Steady Growth

The mid-1960s witnessed the end of a long period of high economic growth for Japan. Externally, Japan joined the Organization of Economic Cooperation and Development (OECD) and acceded to Article 8 status in the International Monetary Fund (IMF), thus agreeing to open its economy by liberalizing its trade and capital. Domestically, a shortage of labor placed restrictions on the high economic growth, and between 1964 and 1965 the Japanese economy fell into the most severe recession since 1945, the year the war ended. Japanese companies improved their international competitiveness and began to export more, however, and the government increased its spending based on the issuance of government bonds. The recession thus did not last long and another period of high growth began. Anticipating increased competition from liberalization, Japanese companies aggressively invested in plant and equipment. As a result, companies mainly in the steel, shipbuilding, and electrical machinery industries greatly improved their international competitiveness. The rise in personal income levels accompanying high economic growth, meanwhile, led to increased consumer spending, and consumer assets moved steadily toward color television sets, passenger cars, and other expensive items. The growth rate of the Japanese economy greatly exceeded the average growth rate of the advanced Western countries, and Japan came to be included among the major economic powers.

During this same period, the U.S. economy languished, and confidence in the U.S. dollar—the key world currency—began to diminish. As it gradually turned more difficult to support the system of fixed currencies, with the dollar in the center, U.S. President Richard Nixon finally, in August 1971, halted dollar-gold convertibility. Next, at the end of 1971, the leading industrial nations signed the Smithsonian Agreement, a plan that replaced the fixed exchange rates with a major currency realignment. The Japanese yen, formerly fixed at 360 yen per U.S. dollar, was adjusted upward to 308 yen. Although this adjustment had a serious impact on the Japanese economy, Japanese companies had already begun strengthening their international competitiveness and in 1972 the economy recovered and business turned favorable. In this unstable situation, however, the Fourth Mideast War erupted in October 1973 and within a short time oil prices quadrupled. The Japanese economy was heavily dependent on oil, and the higher oil prices affected it severely. The costs of raw materials and labor soared, and wholesale prices skyrocketed. Although the government introduced measures to suppress overall demand, the higher costs remained as is and the profitability of corporations worsened considerably. In 1974, for the first time since 1945, the Japanese economy recorded minus growth.

Development of Electronics Industry

Among the manufacturing industries in Japan around this time, the electric machinery industry grew the fastest, expanding at 1.7 times the average growth of all manufacturing industries. And amidst that growth, the electronics-related business areas—the central product areas in Nippon Electric's overall business—showed the most noticeable growth. The growth rate of electronic equipment for industrial use was particularly remarkable. Supporting the sales growth rate of that equipment were computers. They not only led to the development of new electronic components and changed the nature of the electronics industry but also opened two new fields—information processing, and information-related services.

The government recognized that Japan lagged in these new fields and took steps to help companies catch up by nurturing industry and putting the legal system into order. In April 1966, for example, the Electronics Industry Deliberative Council made recommendations to the government in a report titled "On Bolstering the Competitiveness of the Electronic Computer Industry." One goal outlined in that report was to have domestically manufactured computers account for over half of the value of all computer installations by 1968. It recommended achieving this by promoting the industry in such ways as having the domestic manufacturers work jointly on projects and developing ultrahigh-performance giant computers. The government's plan to develop these computers turned into a large-scale project, with the government assuming the entire burden of a 10-billion-yen budget.

Once into the 1970s, business ties were promoted among domestic computer manufacturers to increase their international competitiveness. Three main groups were formed. Nippon Electric, for example, entered into business ties with Toshiba Corporation. The companies in the three groups proposed plans to the Ministry of International Trade and Industry (MITI) for developing new computers to compete with the IBM System/370. Over a five-year period beginning in 1972, the companies received government subsidies totaling 57 billion yen. The Nippon Electric-Toshiba group announced the ACOS Series of computers in 1974, and the other groups soon followed with newly developed computers of their own. This project contributed to an increase in the market share of domestic-made computers from the early 1980s.

One important change around this time was the spread of data communications. From September 1970, Nippon Telegraph and Telephone Public Corporation (NTTPC) introduced two services in the 23 wards of Tokyo, using as the host computer a DIPS-1 mainframe developed jointly with Nippon Electric and other companies. One was a sales inventory control service; the other was a data communications service that allowed customers to use computing services via ordinary telephone lines. The demand for data communications services increased afterward together with the increase in computer performance, and calls grew louder for liberalizing the use of public telephone lines, up to then a monopoly of NTTPC. In May 1971, the Public Telecommunications Law was revised and it became possible for private computing service companies to use NTTPC lines to provide data processing services.

Meanwhile, NTTPC implemented its fourth and fifth five-year telegraph and telephone expansion plans, following the successful Third Five-Year Telegraph and Telephone Expansion Plan it implemented from 1963, thus putting the nation's communications network into better order. At the close of fiscal 1967 (end of March 1968), when the third expansion plan was completed, the backlog of subscribers waiting for telephone installations was 2.42 million. This figure peaked at 2.91 million at the end of fiscal 1970, and then began decreasing. When the fifth expansion plan was completed at the end of March 1978, the backlog was zero, and the long-held wish for immediate installation of telephones was finally realized.

In these ways, because of the use of computers, and especially the combined use of communications, the environment surrounding the electronics industry gradually began centering on information. In that backdrop, Nippon Electric's key business domains became communications equipment, electronic equipment, and electronic devices. The company also expanded its business to include products aimed at private sector demand, such as color television sets. Except for 1971, the year of the "dollar shock," Nippon Electric saw rapid increases in its sales and its assets throughout this period. In contrast, after increasing rapidly from 1965, ordinary profits suddenly decreased in 1971. After recovering quickly they began decreasing rapidly again in 1974. They decreased to the 1964 level in 1975, and finally began recovering in 1976. The company's business performance thus moved in line with changes occurring in Japanese industry. Worded differently, it can be said that as Nippon Electric passed through the period from the mid-1960s to the mid-1970s it came to occupy a central position in Japanese industry.

2. Management Reform Program

Koji Kobayashi Assumes Presidency

At a meeting held on November 11, 1964, the Board of Directors elected Koji Kobayashi as president. President Toshihide Watanabe had served as president of Nippon Electric for 17 years, from the postwar years starting in 1947, through the company's reconstruction and its subsequent growth. He assumed the position of chairman after recommending Kobayashi to be his successor. In his first press conference after assuming office, President Kobayashi expressed his determination to lead Nippon Electric to greater business successes.

> Nippon Electric began in business as the first Japan-U.S. joint venture in Japan. Our company was thus internationally oriented from its founding, and that continued to be one of its main features as it grew. For many years, in fact, our company depended on overseas companies and was passive in its dealings abroad. That was true during the years of development prior to Toshihide Watanabe serving as president and turning the company into a strong independent corporation. It is important today for Japan to establish an open economic system, and I firmly believe it is my duty and mission as president to promote our company's energetic advance onto

Koji Kobayashi (1907-1996)
Kobayashi was president from November 1964 to June 1976, chairman from June 1976 to May 1988, and chairman emeritus from May 1988 to November 1996. A gifted engineer, he turned the company into a world-class enterprise. He also spread the C&C concept widely in Japan and overseas.

Tadao Tanaka (1911-1983)
Tanaka was president from June 1976 to June 1980. He navigated Nippon Electric through the difficult period following the First Oil Crisis. He also focused on improving the business performance of the company's affiliates to strengthen the NEC Group on a consolidated basis.

Small groups of about 10 persons each were formed to work out Zero Defects (ZD) ways to improve quality control at the worksites. The photo shows one of those groups in 1969.

An inauguration ceremony was held in Japan to mark the opening in 1976 of a KDD telephone office using an XE-1 international electronic switching system made by Nippon Electric.

In 1969 the first short-distance submarine cable system was completed in Uchiura Bay in Hokkaido.

The photo shows an unmanned communications repeater station in Greenland. Great difficulties were met in maintaining and operating such stations in sub-zero temperatures. Nippon Electric developed low-power consumption equipment that required less fuel supply.

The Yokohama Plant was constructed in 1969 to meet growing demands for microwave and satellite communications systems.

In 1971 Nippon Electric was awarded a contract in Kuwait to construct a car telephone service network.

The first of satellite communications earth stations Nippon Electric supplied to Switzerland became operational in 1974.

In 1974 Nippon Electric and Toshiba jointly introduced new computers called the ACOS Series 77. Exhibited at the same time were miniature models of the ACOS System 200, 300, and 400.

The NEAC System 100 series of office computers, announced in 1973, became best-selling products. They were marketed as the ASTRA series in the U.S. from March 1979.

The photo shows the NS-100 fully automated mail processing system undergoing a final test at the Fuchu Plant in 1971. It handled mail in a sequence of cull and face, postage stamp franking, ZIP code reading, and mail sorting functions.

The new Central Research Laboratories was built in Kawasaki, near Tokyo, in 1975.

An automated air traffic control system supplied by Nippon Electric became operational in 1977 in the outskirts of Tokyo. The photo shows air traffic controllers observing flight information in the control room of the Tokyo Air Traffic Control Center.

the international stage and to develop Nippon Electric into a first-class world enterprise.

The year 1964 marked the first steps in the opening of the Japanese economy. In April, Japan acceded to Article 8 status in the IMF, and exchange transactions related to trade were liberalized. Japan also joined the OECD that same month, thus accepting the obligation to liberalize non-trade current transactions and the movement of capital. With the Tokyo Olympics held in October 1964 as a demarcation point, business in Japan entered a downward phase, and then plunged into a "structural recession." President Kobayashi thus assumed the presidency in an unstable situation, and had a crisis awareness of the many internal problems requiring attention.

Management Reform Program

In his New Year's Greetings at the start of 1965, President Kobayashi announced two goals for the company in the form of slogans. One was "Let's make Nippon Electric an internationally first-class corporation"; the other was "Let's produce internationally first-class products." He then went on to clarify several items in a management reform program. Three items were of particular importance: (1) to reorganize top management and change its awareness of the current situation the company faced—actually, a reform of the structure of the top managerial organization; (2) thoroughgoing implementation of the business division system; and (3) introducing the ZD (Zero Defects) Movement.

In the past, all authority in Nippon Electric was concentrated in the president as top manager. In the mid-1960s, for example, President Kobayashi directly headed over 40 divisions and departments. The central idea in the management reform program was to delegate some of the president's authority to other officers at the managing director or higher level. President Kobayashi referred to this as moving from "point" to "plane." The "plane" he referred to was the company's top management group, the Executive Committee. It met twice a week.

A second management reform program followed the first with a reform of the business division system. President Kobayashi felt that this system, originally introduced in 1961, had not been implemented thoroughly enough. The business divisions were profit centers and each was responsible for earning a profit. The head of each division was thus the "president" of the division. Based on instructions from President Kobayashi, a major overhaul of the business division system was carried out in May 1965. The new system that resulted replaced five business divisions with 14 business divisions and three development divisions. As well, the Central Research Laboratories, NTT & Government Sales Division, Regional Sales Division, and Overseas Operation Division were established and given equal rank. Each division head was assigned clear responsibilities regarding the division's product area. Also, for business and development divisions doing business in closely related fields, four business groups were established—communications, radio & electronics, electronic data processing, and electronic components—and a director was assigned as the head of each. By establishing line sales departments in parallel with the business divisions, the company's structure came to resemble a matrix organization. Although a number of organizational revisions and changes were made as the company later developed and expanded, the basic structure remained as it was established during this period.

Besides introducing reforms in this way from the top to the middle management levels, the ZD Movement, in which all employees participated, was promoted to realize company-wide management reforms. In the ZD Movement, each employee was asked to participate in clarifying and eliminating the cause of product defects. Eliminating defects was a company-wide, quality-control movement that later came to be called Total Quality Control (TQC). After a little over six months of preparation, the ZD Movement was implemented from May 1965. Each year afterward the movement picked up momentum. The Japan Management Association (JMA) recognized the effectiveness of the movement and requested Nippon Electric's cooperation in having the ZD Movement used widely throughout Japanese industry. The movement thus spread to other companies as well.

Dispersal of Plants

As mentioned earlier, Nippon Electric built the Sagamihara Plant in 1962 and the Fuchu Plant in 1964. Next, to meet the thriving business in the areas of microwave communications and satellite communications, the company decided in 1968 to build a new plant in Yokohama. Operations began at the Yokohama Plant in August 1969. Even as plans for constructing this plant were moving forward, President Kobayashi hammered out his basic concept of having future plants dispersed throughout the country, away from urban centers. This concept was based on his judgment that in the general capital region it had become increasingly difficult to obtain the land and labor needed for plants. New plants would be established as separate companies, generally as wholly owned subsidiaries of Nippon Electric, using the Nippon Electric name and the region's name in the company's name. These plants came to be referred to as local Nippon Electric subsidiaries. The first such company established was NEC Kagoshima, Ltd., set up in Izumi, Kagoshima Prefecture, for producing fluorescent indicator panels (FIP) and other electrical components. That company was soon followed by NEC Kyushu, Ltd., and NEC Shizuoka, Ltd. Including Nichiden Takahata Works, Ltd., whose name was changed to NEC Yamagata, Ltd., in 1969, a total of 11 local Nippon Electric subsidiaries were established by 1975.

Besides the local subsidiaries, Nippon Electric also moved to improve its managerial efficiency by spinning off selected internal operations to create other subsidiaries. As a result, operations such as maintenance service and engineering were spun off as separate companies. By 1975, Nippon Electric established 15 such new subsidiaries.

Response to Dollar Shock and Oil Crisis

Once into 1971, the Japanese economy began showing signs of stagnation. In his New Year's Greetings that year, President

Kobayashi said the company had tended in the past to depend too heavily on an increase in sales for an increase in profit. He urged the company's employees to strive harder in the future to reduce costs and improve their productivity. In that context, the company introduced a movement to reduce expenses. The dollar shock occurred in the midst of this move to reduce expenses, and among other measures Nippon Electric introduced a plan to reduce its workforce from 40,000 to 36,000. It did this by relocating or reassigning middle age and older workers, halting hiring midway through the year, and employing fewer new graduates. In his New Year's Greetings in 1972, President Kobayashi said that Nippon Electric faced a serious business environment, and emphasized the importance of fundamentally changing management's way of thinking premised on high economic growth. In short, a need existed to built a foundation for future growth by changing the corporate structure's orientation from quantitative growth to improved quality.

One step needed was incorporation of the approach contained in the ZD Movement, with emphasis on product quality improvement, into all the company's activities. President Kobayashi thus proposed a company-wide quality management program called Operation Quality ("Operation Q"). In a message dated April 1972, President Kobayashi outlined seven targets for quality improvement in a framework for Operation Q. The seven were management, products and service, worksite environment, community relations, personnel behavior, business performance, and corporate image. In reflecting on the thinking behind the Operation Q concept in later years, President Kobayashi said it derived from the company's original slogan at its founding, "Better Products, Better Services." Operation Q was highly evaluated outside the company as well, and in November 1974 President Kobayashi was awarded the distinguished Deming Prize for Individuals.

Between 1973 and 1974, the increase in commodity prices and the shortage of commodities that accompanied the First Oil Crisis also had a serious negative influence on Nippon Electric's business. While price increases were difficult, on the one hand, the cost of labor increased together with substantial wage increases. In the first half of fiscal 1974, Nippon Electric was forced to report a reduced profit and reduced stock dividends. Business turned sharply downward in the second half of the year, and it became clear that the workforce was too large. As the Japanese economy recorded its first year of minus growth since the end of the war, caused by an unprecedented business recession, Nippon Electric introduced thoroughgoing anti-recession measures. In September 1974, first of all, a request was made to the labor union for carrying out temporary layoffs. These layoffs affected all workers except those involved in sales. On average, workers were asked to stay home between two and four days a month. From October, the salaries of managers and remuneration of directors were reduced between 6 and 10 percent.

Tadao Tanaka Assumes Presidency

President Koji Kobayashi, president of Nippon Electric since 1964, resigned from the presidency at the Board of Directors meeting held in June 1976. He then assumed the position of chairman. The Board then appointed Tadao Tanaka to be president. Tanaka's career in Nippon Electric spanned many years in the areas of planning and accounting. This timing was selected for shifting to a new leadership because the chaotic period after the First Oil Crisis had passed and some brightness was visible in the company's business prospects. Due to the negative influence of the oil crisis, Nippon Electric recorded a loss of 190 million yen on a consolidated basis for fiscal 1974. And although a profit was recorded in fiscal 1975, it was only 1,700 million yen. For that reason, as related earlier, the company was forced to tighten its belt in various ways. President Kobayashi said it would take at least two years for Nippon Electric's business to recover. The Japanese economy, however, recovered relatively quickly, and the prospects for Japanese companies turned bright from 1976. Nippon Electric, in fact, recorded a profit of 7,700 million yen in fiscal 1976. Since assuming office, President Kobayashi had emphasized communications, computers, and electronic devices as the three main pillars of the company's business, and during his tenure he made efforts to have the company lead the competition in those business areas. He saw his goals just about achieved, and saw that each business field held bright prospects for the future. In that situation he decided the time was ripe for a new leadership.

3. New Developments in Communications Business

Crossbar Switching and Electronic Switching

The three major positive influences on the communications equipment market from the early 1960s were the Third Five-Year Telegraph and Telephone Expansion Plan of NTTPC introduced in 1963 and the subsequent fourth and fifth five-year expansion plans. These three plans were aimed at the continuingly increasing demand for telephone sets, especially to eliminate the backlog of applications (installing telephones immediately) and to connect toll calls immediately (realizing nationwide direct dialing).

NTTPC began working jointly with Japan's top four telephone switching systems manufacturers—Nippon Electric, Fujitsu, Hitachi, and Oki Electric—from December 1963 to develop the C400 crossbar (XB) telephone switching system for use in local telephone offices. Three years later, in 1966, a more economical, higher performance switching system than was originally planned was completed. NTTPC decided to use the C400 as the standard system for large-size local telephone offices.

Together with the C400, development of the C460 XB switching system for use in medium-size and smaller local telephone offices was also promoted. It was completed in 1967. Even before that, the C62 was completed in 1963 for use in large toll telephone offices and the C63 was completed in 1964 for use in medium-size and smaller toll telephone offices. Completion of the C460, therefore, meant a complete line of switching systems for telephone offices was available. NTTPC purchased a large volume of XB switching systems to meet the demand for telephone service for several million new telephone sets every year.

Production progressed smoothly at Nippon Electric's Sagamihara Plant, built in 1962 for producing XB switching systems. By 1969, the thirteenth year since installing its first XB switching system in 1956 at the Sanwa Telephone Office (Tochigi Prefecture), Nippon Electric produced over 4.2 million lines for XB switching systems. That volume matched the company's total production of A-type automatic switching systems produced over a period of 44 years. In order to meet the increasing demand for XB switching systems, Nippon Electric established NEC Hyogo, Ltd., in 1969 in Hyogo Prefecture for mass-producing reed switches, a major component used in XB switching systems, and in 1970 established NEC Tohoku, Ltd., in Iwate Prefecture for exclusively producing wire spring relays, another major component. At the end of March 1978, when NTTPC's Fifth Five-Year Telegraph and Telephone Expansion Plan was completed, there were over 33.95 million ordinary telephone subscribers, and the goal of installing telephones immediately after application was realized. At the end of March 1979, the long-held wish of nationwide direct dialing was also realized.

After Bell Telephone Laboratories in the U.S. announced in 1963 the No. 1 ESS, the first electronically controlled central office switch, NTTPC began studying the development of a stored program control type electronic switching system. In 1964, NTTPC entered into an agreement with Nippon Electric and the three other major Japanese manufacturers of telephone switching systems concerning joint research of electronic switching systems. Based on this joint research, development moved forward on the DEX-1, a space division type electronic switching system. Next, in order to compare the space division and time division types, NTTPC asked Nippon Electric to produce the DEX-T1, a prototype time division type digital electronic switching system. The DEX-T1 was based on the world's most advanced technology at the time, but it was not as economical as the DEX-1 space division type, especially because digital transmission circuits employing PCM (pulse code modulation) were not yet being used widely. NTTPC thus decided to use the DEX-1 as the standard electronic switching system in central offices with large volumes of traffic. Improvements were later added to the DEX-1 and it was made available commercially as the D10 electronic switching system. Nippon Electric installed the first D10 in June 1971 in the Ginza Central Office in Tokyo. By the end of fiscal 1976 the D10 electronic switching system was installed in 189 telephone offices throughout Japan. Nippon Electric installed 55 of those systems. For international-use electronic switching systems as well, Nippon Electric cooperated with Kokusai Denshin Denwa (KDD) in developing the space division type XE-1 international electronic switching system. It installed the first system in 1976.

Development of Digital Transmission Systems

One of the goals of NTTPC's Third Five-Year Telegraph and Telephone Expansion Plan was to build a nationwide network allowing direct dialing for long-distance calls between cities where prefectural offices were located. As this network was being built, the demand increased for products such as coaxial cable repeater systems and carrier transmission terminal equipment. Even while improving and increasing production of the analog transmission systems and carrier transmission terminal equipment it was already providing, Nippon Electric vigorously developed digital transmission systems.

From 1965, the company promoted the development of large-capacity, small-size, economical repeaters and terminal equipment for use in coaxial cable systems that accommodated multiple analog signals. The C-60M type developed in 1970 had 10,800 channels, over eleven times the transmission capacity of the 960-channel C-4M developed in 1961.

The short-haul, 24-channel PCM-24 digital transmission system that Nippon Electric developed jointly with NTTPC underwent field trials in 1965. It had the outstanding features of comprising inexpensive terminal equipment and allowing an increase in lines by using existing telephone cables. A large number of these systems were installed over the years, even as improvements were added. In 1967, the PCM-24B was introduced. It used integrated circuits (ICs) that allowed the repeaters and terminal equipment to be made smaller and use less electricity. The DC-100M digital transmission system utilizing coaxial cables was announced in 1975. It was put into commercial use as a medium-distance, medium-capacity digital transmission system. Also, field-testing of the PCM-400 (DC-400M) for a long-distance, large-capacity digital transmission system was conducted in 1976. The PCM-400 made possible the introduction of digitalized systems for use with trunk lines.

A move toward digitalization also occurred in the overseas transmission market. In 1967, for example, Nippon Electric received an order from Kuwait for PCM-type equipment. Afterward, the company received many orders for digital transmission systems from countries such as Brazil, Thailand, and Pakistan. Also, an order came to Nippon Electric from New York Telephone Company in 1971 for a high-speed 100MB PCM system using coaxial cables. The company also completed development of a 30-channel PCM system according to European specifications. This system later sold extremely well in Latin America.

Nippon Electric's business related to submarine cable carrier transmission systems began with special terminal equipment it produced for use in the interval between Ninomiya, Kanagawa Prefecture, and Hawaii of the Pacific Ocean submarine cable completed in 1964. Afterward, the company participated in an NTTPC project for developing a short-distance submarine cable system for domestic use. In 1969, the first domestic submarine cable system was completed and delivered for use in Uchiura Bay in Hokkaido. Among submarine cable systems for use overseas, Nippon Electric cooperated with KDD and in 1976 delivered repeaters and terminal equipment for submarine cable systems to be used over the 875 kilometers between Japan and China.

Microwave and Satellite Communications Businesses

Nippon Electric's over-the-horizon microwave communications system technology gained worldwide acclaim. Domestically, Nippon Electric installed much microwave communications equipment for NTTPC, the Civil Aviation Bureau of the Ministry of Transport, the Japan National Railways, electric power companies, and others. Orders were also received from Mexico, Australia, India and Brazil, as well as from the U.S. Forces in Japan. Nippon Electric also participated in an international consortium that successfully won the order to build an Integrated National Telecommunications System in Iran (Iran INTS). Meanwhile, the international circuit completed in 1968 for connecting Japan and South Korea gained much attention for marking the first time ever for over-the-horizon communications to be used with an international circuit.

Nippon Electric pushed further ahead with research into digital microwave communications systems, and in 1969 completed development of a 240-channel PCM microwave communications system. That marked the world's first commercialization of a digital microwave communications system for use in a public communications network. It positioned Nippon Electric about three years ahead of competitor companies in the advanced Western countries. Besides the system delivered to New York Telephone Company in 1971, Nippon Electric expanded its market by also selling systems to independent telephone companies in the U.S. The company's microwave communications systems were sold around the world, with exports to over 60 countries by 1978.

Nippon Electric's outstanding microwave communications technology opened a new frontier in the field of satellite communications. In August 1964, for example, Nippon Electric and Hughes Aircraft Company announced joint development of satellite communications technologies utilizing a geostationary satellite. Using Hughes' Syncom-3 satellite, portions of the 1964 Tokyo Olympics were successfully televised to the U.S. In December 1965, land experiments of the STAR communications system, developed jointly by Hughes and Nippon Electric, were successfully conducted at the Tamagawa Plant. In 1966, an experimental station for testing the STAR system was built in Hot Springs, Arkansas. These successes led to increased worldwide acclaim for Nippon Electric's technological capabilities in satellite communications.

By building earth stations, satellite communications enabled communications with any country within sight of the satellite. In August 1964, the International Telecommunications Satellite Organization (Intelsat) was created. And in April 1965 the geostationary Intelsat I was launched to provide Atlantic Ocean coverage, followed by Intelsat II and Intelsat III to provide coverage for, respectively, the Pacific Ocean and Indian Ocean, thus completing a global network. Meanwhile, the number of countries participating in Intelsat increased, and Nippon Electric won successive orders from many of them to build earth stations. COMSAT, the management company of Intelsat, called for the participation of engineers from many countries to work on various projects. Nippon Electric was requested via KDD to second one engineer to COMSAT. Tadahiro Sekimoto (later, president), who was then manager of the Basic Research Department in the Communications Engineering Laboratory of Nippon Electric, was seconded to COMSAT. Sekimoto traveled to COMSAT in Washington, D.C., in August 1965 where he became project manager for developing the PCM-Time Division Multiple Access (PCM-TDMA) system. This system was used in satellite communications in the early 1970s. Nippon Electric received its first order for a commercial satellite communications earth station in 1967, from the government of Mexico. This earth station was used to televise the 1968 Mexico City Olympics. Other contracts for earth stations followed from Kuwait, Peru, Taiwan, South Korea, Australia, Jordan, New Zealand, Singapore, and Switzerland. As of January 1974, Nippon Electric had built an aggregate total of 50 earth stations around the globe. The company's share of total earth station contracts in the international satellite communications market exceeded 50 percent, positioning Nippon Electric in the world's number one spot.

In September 1972, Prime Minister Kakuei Tanaka of Japan visited Beijing to normalize Sino-Japanese relations. At that time, the Japanese government asked Nippon Electric to provide the equipment needed to televise this historic event. Nippon Electric was already developing a small earth station with about a 30-foot diameter antenna, and hastened to form a project team to respond to the request. The company completed development of a transportable earth station and air freighted it to Beijing. The Chinese government cooperated completely with the project, and an earth station was set up next to Beijing Capital International Airport in just three days. Clear pictures of the historic ceremony were televised, and Nippon Electric's feat won high acclaim. This transportable earth station later became the prototype for Intelsat's standard small-type earth station.

The artificial satellite business of Nippon Electric traces back to the first half of the 1960s. At the time, the company's space development business was supported by its cooperative relations with the Institute of Space and Aeronautical Science (ISAS) of the University of Tokyo and by its ties with Hughes. Even as ISAS successfully developed rockets, the worldwide pace of space development quickened. The need to promote the development of artificial satellites was increasingly recognized in Japan as well. After the National Space Development Agency (NASDA) was established in 1969, ISAS became responsible for developing scientific satellites and NASDA became responsible for developing application satellites. In February 1970, ISAS successfully launched Japan's first experimental satellite, called the Osumi, manufactured by Nippon Electric, from the space station on Osumi Peninsula in Kagoshima Prefecture. A large number of scientific satellites were launched over the years afterward, all manufactured by Nippon Electric. NASDA eventually introduced Delta Rocket technology from the U.S. and developed the N Rocket. In September 1975, NASDA launched its first experimental technology satellite, the Kiku. Nippon Electric was selected as the prime contractor for supplying the N Rocket launch control equipment in that project. In the field of practical-use satellites, Nippon Electric strengthened its R&D efforts, anticipating orders for geostationary meteorological satellites. In October 1973, NASDA and Nippon Electric signed a basic design contract for the GMS Series of geostationary meteorological satellites. The Himawari was the first satellite in that series. It was launched successfully in July 1977 using a Delta Rocket of NASA.

4. Establishing Foundation for Information Processing Business

NEAC-Series 2200

The computer market in Japan began growing rapidly in the second half of the 1960s. Domestic production of computers increased in parallel with that growth. The value of all computer installations during the five years from fiscal 1965 to fiscal 1970 increased over six-fold from 51,400 million yen in 1965 to 330,900 million yen in 1970. At first, U.S. computer manufacturers, IBM Corporation (IBM) in particular, held an overwhelming share of the Japanese computer market. Afterward, however, domestic manufacturers rapidly increased their market share until in 1968 the situation was reversed and domestic manufacturers came to hold the majority share. In fiscal 1970, the share of the market held by domestic manufacturers reached 60 percent. Concerning large-size computers, however, overseas manufacturers, centered on IBM, continuously held the dominant position, and the overall market trend was still toward large-size computers.

Nippon Electric developed some computers on its own and others through ties with Honeywell, and continuously maintained the top market share among the domestic manufacturers. However, after IBM introduced in 1970 its IBM System/370—the so-called 3.5-generation machine—non-IBM compatible computers, including Nippon Electric's computers, struggled in the marketplace. In fiscal 1971, Nippon Electric gave up its top position among the domestic manufacturers to Fujitsu. Even as Nippon

Electric continued to maintain its ties with Honeywell, it worked to establish a firm foundation in the computer business such as by accumulating original technology.

IBM introduced the IBM System/360 in April 1964 as a "family series." The series included a range of products from small- to large-size computers. All the machines were compatible with each other, and they used common programs. To compete with the System/360, Nippon Electric in May 1965 introduced the NEAC-Series 2200. The series comprised five models: the 100, 200, 300, 400, and 500. This series was the first domestically made family of computers. It was highly popular right from its introduction. The medium-size Model 200 was equivalent to the NEAC-2200 marketed in 1964. Cumulative shipments of the best-selling Model 200 eventually reached over 400 units. The first Model 500—the high-end in the series at the time—developed by Nippon Electric with original technology, was installed at Osaka University in 1966. In January 1968, this machine was used to connect the main university campus with outreach terminals on the university's four campuses, thus enabling the operation of Japan's first full-scale time-sharing service utilizing a public telecommunications network.

IBM's introduction of its System/370 in June 1970 sent shock waves across the world's computer market. IBM already controlled the European computer market, and in May 1970 the world's largest electrical machinery company, General Electric (GE), announced its withdrawal from the computer business. In September 1971, RCA also withdrew from the computer business. GE's withdrawal from the computer business was a matter of great concern to Nippon Electric because Honeywell, with whom Nippon Electric had ties, acquired GE's computer division. In September 1970 Honeywell spun off that computer division as a separate company named Honeywell Information Systems Inc. (HIS). GE and Toshiba had ties in the computer field, and that relationship was continued between HIS and Toshiba. As a result, Honeywell came to have business relationships in Japan with both Nippon Electric and Toshiba.

In April 1973, the Japanese government announced its schedule to fully liberalize computers, peripheral equipment, and ICs as of December 1980. At the same time, the government positioned the computer industry as a strategic industry and asked the six domestic computer manufacturers to align themselves into three groups. The government then aggressively provided them with assistance. In line with the government's request, Hitachi and Fujitsu, Mitsubishi Electric and Oki Electric, and Nippon Electric and Toshiba entered into business ties in the computer field.

ACOS Series

Nippon Electric from early on had considered developing a new series of computers to replace the NEAC-Series 2200. At the end of 1968, Nelson F. Chu, in charge of development at Honeywell, visited Nippon Electric in Tokyo. He explained Honeywell's plans to develop a new product line (NPL), which later became the ACOS Series, and proposed that Nippon Electric work jointly with Honeywell to develop NPL computers. Honeywell's proposal basically emphasized switching from the character-based computers produced up to then, to byte-based computers, the same as IBM products. Nippon Electric was attracted to the proposal. Later, however, Honeywell bought out GE's computer division and, as related earlier, established HIS as an independent company. The introduction of GE's product line caused Honeywell to change its NPL development plans. HIS marketed GE's top-of-the-line H6000 and licensed the H6000 to Toshiba, with whom GE had had business ties. Nippon Electric, on the other hand, reviewed its joint development relationship with HIS, and the plan emerged of developing original products. In the end, however, Honeywell President Stephen F. Keating explained HIS's plan concerning a product series of byte-based machines, and during meetings with President Koji Kobayashi of Nippon Electric in October 1971 promised to provide assistance to Nippon Electric.

Domestically, meanwhile, Nippon Electric and Toshiba reached an agreement in November 1971 on jointly developing a new series of computers. In the development of this new series, Nippon Electric and Toshiba agreed on the particular machines each would develop, in line with the NPL development plans of HIS. Toshiba took charge of developing large-sized word-based computers in the GE line (the ACOS System 600 and 700); Nippon Electric took charge of developing small and medium-sized byte-based machines (the ACOS System 200, 300, 400, and 500). In January 1972, as a step for collecting and analyzing technical information received from HIS, Nippon Electric established NEC Systems Laboratory, Inc., outside Boston, Massachusetts.

In March 1973, prior to introducing the new series of computers, Nippon Electric and Toshiba established NEC-Toshiba Information Systems, Inc. The new company was placed in charge of preparing the basic plan for developing the new series of general-purpose computers, marketing, and managing each company's share of production.

In May 1974, Nippon Electric and Toshiba, earlier than the other two groups, introduced a new series of computers called the ACOS Series 77. The first models introduced were the ACOS System 200, 300, and 400. Six months later, in November 1974, two additional models were introduced, the ACOS System 600 and 700, in June 1975 the ACOS System 500 was introduced, and in April 1976 two top-end machines, the ACOS System 800 and 900—word machines—were introduced. That line-up completed the ACOS Series.

The ACOS Series was oriented toward online and distributed processing, and utilized a unique virtual memory system. It used the world's leading-edge technology, such as MOS memory and a Transistor Transistor Logic IC (TTL-IC) for its logic device. It was a compact series with improved speed and reliability. The ultra-large-size ACOS System 800 and 900 models greatly surpassed the IBM System/370 Model 168, the top-end of that system, in cost-performance.

Nippon Electric moved to enter the information service business by establishing NEC Information Service, Ltd., in September 1974. This company began offering online services from 1976 in

Tokyo and Osaka. Next, in September 1975, NEC Software, Ltd. (today's NEC Soft, Ltd.), was established, a company specializing in software development, including applications. Afterward, Nippon Electric established similar software companies in different parts of Japan.

Office Computers and Minicomputers

The very small-size computer NEAC-1240 that Nippon Electric marketed in February 1967 was the world's first computer to use ICs throughout. Sales of the machine proceeded smoothly, and by September 1970 had surpassed 1,000 units.

As the market expanded for very small-size computers, customer needs became more sophisticated, such as wanting various processing capabilities. In response, Nippon Electric marketed a new model in August 1973—the NEAC System 100—that possessed radically improved performance compared to previous small computers. The System 100 was a compact, highly reliable computer with a built-in communications control function and allowed online processing. As well, the EASY programming system was provided that made programming relatively simple. Cost was inexpensive, with the lease price for the smallest model with standard specifications set at 90,000 yen/month. During the single month of October 1973, when initial shipments of the System 100 started, the number of orders received for this machine reached 360 units, setting a new record. Toshiba and Mitsubishi Electric also marketed very small computers in the NEAC System 100 class in 1973, thus rounding out the market for these computers. In that developing situation, the Japan Electronic Industries Development Association (JEIDA; today's JEITA: the Japan Electronics and Information Technology Industries Association) began calling the very small computers in the NEAC System 100 class "office computers," a name that proved widely popular. The NEAC System 100 was thus the pioneer office computer. In further response to market needs, Nippon Electric introduced a series of new models. Models E and F of the NEAC System 100 series, introduced in April 1976, were fitted with 16-bit microprocessors and large-scale integrated circuits (LSIs) that allowed the CPU to be stored in an operations desk, and they were equipped with a separate CRT monitor.

Nippon Electric from early on began developing minicomputers for special applications, such as for various kinds of control operations. The NEAC-3100 marketed in 1967, for example, could be used for control and for data exchange. After Digital Equipment Corporation (DEC) of the U.S. marketed a new type of minicomputer in 1969, a number of other companies, including Nippon Electric, introduced similar machines. Besides the NEAC-3100, Nippon Electric also marketed the NEAC-3200 and the NEAC-M4. The NEAC-M4 was the localized version of a minicomputer developed by Varian Associates of the U.S. Some of its many applications were traffic control, building management, and communications control.

In the area of automation and labor savings, Nippon Electric developed various types of systems, including one for postal automation. In 1965, the company installed an experimental system for postal automation in the Omiya Post Office outside Tokyo. Together with introduction of the postal ZIP code system in July 1968, meanwhile, a need arose for equipment that would automatically read the first three handwritten numbers in the five-number ZIP code by an Optical Character Reader (OCR) and sort mail. To meet that need, Nippon Electric developed the NAS-5B automatic ZIP code recognition and mail sorting system in 1969 and delivered the first system to the Shinjuku Post Office in Tokyo. Next, in 1971, the company developed the NS-100 fully automated mail processing system, thus contributing substantially to the automation needs of post office mail processing. Nippon Electric's outstanding technology in the area of postal automation systems was recognized overseas as well. Beginning with the export of automation systems to the U.S. Postal Service in 1971, Nippon Electric exported some of the largest postal automation systems in the world to countries such as Iran in 1976 and Brazil in 1977.

Nippon Electric's lineup of computers came to be centered on the small to large-size machines in the ACOS Series, as well as office computers and minicomputers. Noteworthy technological advances were also seen in the development of peripheral equipment and terminals. Nippon Electric thus provided customers with the hardware and software needed to realize the concept of distributed processing. Large and small computers and terminal equipment could be installed as required, connected by communications circuits, and used for distributed data processing at various levels. In December 1976, Nippon Electric completed development of the architecture needed for realizing the distributed processing concept and announced it under the name Distributed Information-Processing Network Architecture. This architecture made it possible to utilize existing communications networks, terminals, and applications. It also made it possible for existing systems to be expanded, depending on the expansion of, or changes in, applications in the future. The architecture contributed to paving the way toward realizing Nippon Electric's C&C Concept, introduced in detail in the next chapter.

5. Electronic Devices Business

Expansion of Semiconductor Market

The value of semiconductor production in Japan in 1965 was 50,400 million yen. This figure jumped in 1976 over five-fold to 257,200 million yen. Nippon Electric's sales of electronic devices during this period were 7,400 million yen in fiscal 1965 and 100,600 million yen in 1976, more than a 13-fold increase. These favorable sales were the result of aggressive investment in the production of silicon transistors after shifting sooner than competitors from germanium to silicon as a transistor material, and also aggressively investing in IC development and related facilities.

In fiscal 1964, 60 percent of Nippon Electric's production of semiconductors was for external and 40 percent for captive use. Seventy percent of production was for industrial applications, and

30 percent for use in products sold to the private sector, such as radios, television sets, and tape recorders. Once into the second half of the 1960s, Nippon Electric began strengthening its efforts to increase external demand and develop the private sector market. In 1967, it set a goal of ranking first among all domestic manufacturers in total production and second in the world, thus moving all-out to develop a market-oriented business. As a result of its efforts, the composition of Nippon Electric's semiconductor production in fiscal 1976 changed greatly to 80 percent for external and 20 percent for internal use, and 40 percent for industrial applications and 60 percent for the private sector. The company thus succeeded in developing external demand and the private sector market. It increased its share of the worldwide semiconductor market from 3.7 percent in 1972 to 5.4 percent in 1976, and its ranking worldwide in production of semiconductors rose rapidly from seventh place in 1972 to third place in 1976.

Development of ICs, and MOS Memory

Using planar technology, Nippon Electric was one of the earliest companies to offer silicon transistors as commercialized products. By about 1965, the company had completed its lineup of major silicon transistor products. Its main task after that was to improve the performance and reliability of its products. The high-frequency transistors Nippon Electric developed for communications applications were commercialized in products aimed at the private sector market. Tuners the company produced for use in television sets secured a particularly large market share. Also, because of their advantage in low power consumption and improvements in their production method, the field effect transistor (FET)—a MOS (Metal Oxide Semiconductor) transistor—Nippon Electric developed between 1963 and 1964, came to be used in electronic calculators and for memory. The N-channel FET, the first such transistor Nippon Electric developed, came to be mass-produced from the end of 1965 as the 3SK14.

In organizational reform in November 1966, Nippon Electric established an Integrated Circuit Design Division. President Kobayashi appointed Atsuyoshi Ouchi (later, chairman)—called "Mr. Semiconductor" in later years—as head of the division. Ouchi later recalled that his first task as head of the division was "to bring together engineers knowledgeable in circuitry technology." To develop ICs, it was necessary not only to have components experts but also to have circuit engineers who could design devices.

When Nippon Electric began developing and producing ICs, the expertise it had accumulated through joint development of ICs for computer and electronic switching system applications, played a very important role. The logic IC for high-speed computer applications, called the Complementary Transistor Logic (CTL), developed between 1965 and 1966, was used in the Model 500 of the NEAC Series-2200. In 1965, Nippon Electric and the Electric Communications Laboratories of NTTPC began joint research to develop ICs for use in electronic switching systems. In order to satisfy the requirement of guaranteeing the product quality of electronic switching systems for 20 years, it was necessary for components to pass reliability tests at levels higher than ever set before. In the process of the joint research with NTTPC, Nippon Electric accumulated valuable experience related to improving the reliability of ICs. As a link in the MITI project that began in fiscal 1967 to develop a giant computer, Nippon Electric was asked to produce prototype LSIs for logic circuits. R&D conducted up to fiscal 1969 resulted in the development of 17 types of Current Mode Logic (CML) LSIs, and completion of the μ PB300 Series, high-speed LSIs that had a cycle time of 2ns (nanoseconds). The μ PB300 Series was used in Model 700 of the NEAC-Series 2200.

Electronic calculators were the first products for which an all-out demand for ICs emerged. In January 1966, Hayakawa Electric Co., Ltd. (today's Sharp Corporation), approached Nippon Electric with a request for joint research in developing a MOS IC for use in electronic calculators. From then until the beginning of 1967, a total of eight products were jointly developed. At the time, one electronic calculator used 105 MOS ICs. With this project as a turning point, Nippon Electric assumed top position in the IC market for electronic calculators in 1968. From around this time, however, LSI technology was introduced in ICs for use in electronic calculators, and U.S. manufacturers entered and took over the market. But after defects were discovered in 1971 among ICs being assembled in Southeast Asia by U.S. companies, electronic calculator manufacturers turned once again to ordering products from companies in the domestic IC industry. In response to demands from the manufacturers, Nippon Electric marketed a single-chip LSI from September 1972 for use in 8-digit electronic calculators.

The i4004 introduced by Intel Corporation in November 1971 was the world's first microprocessor. Around the same time, Nippon Electric received an order from Sharp and began developing LSIs for use with point of sales (POS) terminals. In April 1972, Nippon Electric completed the first domestic-made 4-bit microprocessor, the μ PD700. It then moved forward with development of a 4-bit general-purpose microprocessor (microcomputer), and in September 1973 introduced the μ COM-4 (μ PD751). Although the μ COM-4 surpassed the Intel i4004 in performance, Nippon Electric's development policy emphasized compatibility with Intel products and the company introduced other microcomputers, such as the 8-bit μ COM-8 (August 1974) compatible with the Intel i8008 and the 16-bit μ COM-16 (November 1974), thus successfully commercializing a series of microcomputers. The emergence of the microcomputer led directly to the later development of personal computers.

Nippon Electric produced its first prototype 2-bit MOS memory in July 1965. Afterward, the company developed an associative memory device that had only 1-bit capacity but allowed a retrieval of memory content with a cycle time of 150ns for both reading and writing. Early MOS memory was P-channel. Nippon Electric switched afterward to N-channel as a result of participating in MITI's ultrahigh-performance giant computer development project. In that project, Nippon Electric selected N-channel to achieve greater speed. In March 1968, the company succeeded in developing a 144-bit N-channel MOS memory, the μ PB391. This product was used in NTTPC's large-size computer, the DIPS-1. At the time, Intel had just begun marketing P-channel 1 Kbit DRAMs (Dynamic Random Access Memory). President Robert N. Noyce of Intel personally visited Nippon Electric in Tokyo and recommended that Nippon Electric use Intel's product in its computers and develop P-channel products as a second source for Intel. Nippon Electric's response was that N-channel MOS memory was faster and thus had more future potential than P-channel.

In competition with Intel, the company then developed the N-channel 1 Kbit DRAM μ PD403 in 1971 and μ PD404 in 1972. It also succeeded in raising production yield. The μ PD404 was loaded in the NEAC System 100 and earned a solid reputation. In 1974, moreover, the company provided Honeywell with samples of 4 Kbit DRAM. As a result of a favorable response from Honeywell, the μ PD411 4 Kbit DRAM with a high speed of 150ns was developed. In January 1975, Honeywell ordered 6,500 units of the 4 Kbit DRAM, marking the first export of DRAM to the U.S. Around the same time, Intel and other IC manufacturers all switched from P-channel to N-channel MOS memory. Computer manufacturers also began using N-channel 4 Kbit DRAM. As a result, Nippon Electric's N-channel MOS memory assumed the position of a global standard.

Semiconductor Production System, and Global Strategy

In response to the expansion of its semiconductor business, Nippon Electric steadily improved and bolstered its existing production plants and built new plants. NEC Kyushu, Ltd., established in Kumamoto in 1969, was originally planned to operate as a plant exclusively for producing ICs, with an eye toward an expected rapid increase in demand for ICs for electronic calculators. Because the electronic calculator manufacturers all turned to using LSIs made by U.S. companies, however, the company lost its customers just as construction of the plant was completed. Instead of ICs for electronic calculators, therefore, NEC Kyushu began assembling IC memory and linear ICs. In April 1971, it began operating a diffusion line and established an integrated production system of ICs.

In the context of the rapid increase in wages caused by the oil crisis and the shortage of labor in Japan, as well as import restrictions put in place by various countries, it became increasingly necessary to consider relocating semiconductor production operations overseas. Nippon Electric established NEC Malaysia Sdn. Berhad in July 1974 for assembling semiconductors destined for export to countries in Southeast Asia. From June 1976, NEC Malaysia began producing signal transistors. In July 1974, Nippon Electric also established NEC Ireland Limited. The aim was to supply ICs through NEC Ireland to the European Union (EU) market. The company began production of TTL ICs there in April 1976. Next, in May 1976, Nippon Electric established NEC Singapore Pte. Ltd. A plant was built there for assembling and marketing fluorescent indicator panels (FIPs) and semiconductors.

Electronic Components Business

During this period, Nippon Electric developed high-power transmitting tubes for television and radio transmissions. Those tubes contributed to the export of radio transmitters to countries in Southeast Asia and the Middle East. In the field of high-power microwave tubes, from 1964 the company began installing 10-150W traveling wave tubes for UHF television transmitters in over 200 satellite stations in Japan. Also, from 1968, in line with the introduction of UHF base stations, Nippon Electric developed and installed 1kW traveling wave tubes and 10-50kW klystrons. In addition, the company developed klystrons for use with over-the-horizon communications, klystrons and traveling wave tubes for earth stations for satellite communications, and traveling wave tubes for use aboard satellites. In these ways, Nippon Electric expanded to become one of the top manufacturers in the world in the field of high-power microwave tubes.

The company developed fluorescent indicator panels in 1967 and from 1970 NEC Kagoshima began mass-producing them. As their reliability increased and their life time extended, they became the mainstay indicator panels in electronic calculators. In 1971, the Otsu Plant of New Nippon Electric began mass-producing tantalum solid electrolytic capacitors. It became possible to sell these capacitors for less than one-third of their former price, leading to the successful development of the private sector equipment market. In 1976, the monthly production of tantalum solid electrolytic capacitors by companies in the Nippon Electric group reached 30 million units. The group eventually came to hold the world's second largest market share for that product.

6. Toward Becoming Global Corporation

Expansion of Overseas Markets

During the period from fiscal 1964 to fiscal 1976, Nippon Electric's sales increased from 71 billion yen to 486 billion yen, about a seven-fold increase. While sales of wired communications equipment and that of products categorized as "Other sales," including home electric appliances, both increased four-fold, and radio communications equipment increased eight-fold, sales of electronic equipment increased 17-fold and sales of electronic devices increased almost 15-fold. As a result, sales of wired communications equipment that accounted for 50 percent of total sales in fiscal 1964 decreased to less than 30 percent in fiscal 1976 while sales of electronic equipment increased from 9 percent of total sales in 1964 to 24 percent in 1976 and sales of electronic devices increased from 10 percent in 1964 to 21 percent in 1976. Sales of radio equipment, meanwhile, maintained about an 18 percent share during this period. Electronic equipment, with computers as their central products, and electronic devices, with semiconductors as their central products, lined up with communications equipment as two of the three main pillars of Nippon Electric's business.

Nippon Electric's exports of 6.6 billion yen in fiscal 1964 increased to over 10 billion yen in fiscal 1966. In July 1969, at a ceremony celebrating the company's 70th Anniversary, President Kobayashi spoke about the future outlook for Nippon Electric and about his determination to turn the company into a global corporation. "Within the next few years," he said, "I would like to see Nippon Electric develop into a billion-dollar company. By expanding the size of our company, and making it more internationalized, we can turn it into a global corporation in terms of its financial, technological, and managerial capabilities. Let us meet the competitive challenge of overseas companies and bring increasing prosperity to Nippon Electric."

Once into the 1970s, the export environment began changing tremendously. The dollar shock of 1971 was followed by the yen's upward revaluation and a move in February 1973 toward a system of fluctuating exchange rates, and in the fall of 1973 the First Oil Crisis broke out. Although the appreciated yen had a severe negative influence on exports, Nippon Electric's products were highly evaluated and trusted in overseas export markets, enabling the company to navigate safely through the period. As well, the company had built a firm foothold in Middle East markets since the second half of the 1960s. Therefore, after the oil producing countries of the Middle East came to accumulate huge amounts of foreign currency because of the much higher oil prices after the First Oil Crisis, those countries immediately became attractive export markets. A look at trends in exports by Nippon Electric shows a total of 53 billion yen worth of products exported in fiscal 1970, and 75 billion yen in fiscal 1975. In fiscal 1977, exports recorded 167 million yen and accounted for 31 percent of total sales. As of the end of March 1978, Nippon Electric was exporting to 123 countries.

As export activities turned brisk, the building of overseas production plants became an important consideration. The governments of the developing economies began strengthening their localization policies, and more countries began levying high import duties on imported products and in some cases prohibiting imports. From the second half of the 1960s, Nippon Electric began establishing overseas production plants, sometimes as wholly owned subsidiaries, and other times as joint ventures with local companies.

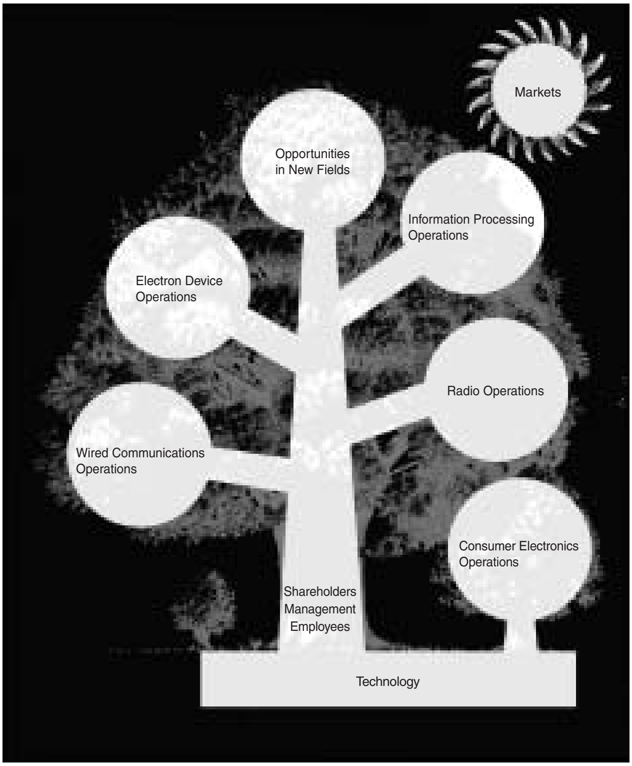
The first plant was NEC de Mexico S. A. de C. V., a wholly owned subsidiary, established in March 1968. Nippon Electric had already participated in many projects in Mexico, including those related to building earth stations for satellite communications and microwave communications circuits. It established NEC de Mexico to produce and market communications equipment but also to maintain and repair the NEC equipment already in use in Mexico. Next, in November 1968, NEC do Brasil-Eletronica e Comunicacoes Ltda. (later, NEC do Brasil S. A.) was established, also as a wholly owned subsidiary. Nippon Electric had already received orders to build 80 percent of Brazil's nationwide microwave communications network and decided to prepare a production system for responding to a new demand for XB switching systems expected to emerge as Brazil's large cities moved to put their networks of telephone switching systems into order. The next company was NEC Australia Pty, Ltd., a wholly owned subsidiary established in December 1969 in response to a plan by the Australian government to build a microwave communications circuit using domestic-made products.

Among the overseas joint ventures, Samsung-NEC, Ltd. (later renamed Samsung SDI Co., Ltd.), was established in January 1970 as a joint venture with the Samsung group in South Korea. Nippon Electric provided 40 percent of the equity, and the company produced receiver tubes and cathode ray tubes. Also, in cooperating with the Korean government to localize production of communications equipment, Nippon Electric participated with 20 percent equity in Gold Star Electric Co., Ltd. Next, in August 1971, Nippon Electric and the Iranian government established the joint venture Irano-Nippon Electronics Industries Private Joint Stock Company for producing transmission equipment and radio equipment. Nippon Electric participated with 40 percent equity. Less than two years later, in April 1973, PERNAS NEC Telecommunications Sdn. Berhad was established in Malaysia for producing carrier equipment. Nippon Electric also participated in this company with 40 percent equity.

As for developments with its marketing network, Nippon Electric changed the name of Nippon Electric New York, Inc., to NEC America, Inc., in December 1970, and the company began the all-out marketing of private branch exchanges (PBXs) and key telephone systems. Next, in May 1975, in order to provide marketing and software support in the context of an expected rapid increase in demand for microcomputers and memory devices in the U.S., NEC Microcomputers, Inc., was established in the outskirts of Boston. Next, in April 1977, NEC Information Systems, Inc., was established in suburban Boston to market printers and very small computers developed for the U.S. market. In Europe, NEC Electronics (Europe) GmbH was established in April 1973 in Dusseldorf, West Germany, mainly to market electronic devices and home electric appliances. In June of the same year, NEC Telecommunications Europe Co. Limited was established to market communications equipment throughout Europe and in Africa. In Southeast Asia, NEC Computers Singapore Pte. Ltd. was established in Singapore in April 1977 to market small computers and create a system for providing software-related services, maintenance of equipment, and training in nearby countries.

NEC Tree, and Corporate Identity

In Nippon Electric's 1972 Annual Report published in January 1973 for overseas shareholders, a drawing of a tree followed the page of the president's message. Called the "NEC Tree," the drawing was used to illustrate the company's main business areas, the role of its technology, and its markets. Five main branches grew from the thick trunk of the tree, standing firmly on roots called "Technology." From the same roots another smaller tree was growing. Above the tree, to the right, was the brightly shining sun, representing "Markets." The five main branches, representing the company's main businesses, were named "Wired Communications Operations," "Radio Operations," "Information Processing Operations," "Electron Device Operations," and "Opportunities in New Fields." The smaller tree was named "Consumer Electronics Operations." The NEC Tree clearly showed the main businesses of Nippon Electric, and how even diversified businesses derived from a common technological foundation. Each business was developed according to its particular market.



The NEC Tree drawing illustrated the company's business. The root was technology, the trunk was its shareholders, management and employees, the branches were its main businesses and future opportunities, and the sun was its markets.

From around 1970, in the background of the growing aggravation of environmental pollution, stronger calls were made concerning corporate social responsibility. Corporations were gradually forced to clarify their reason for being, their social significance. It was around this same time that the words "Corporate Identity" (CI) came into vogue. The NEC Tree was one method for highlighting Nippon Electric's CI. In later years, as the content of Nippon Electric's business developed, the NEC Tree was changed accordingly. For example, the smaller tree, representing "Consumer Electronics Operations," was integrated into the larger tree, while the sun's name was changed from "Markets" to "Customers." But the basic shape of the tree, with its foundation of common technology and markets (later, customers) that nurture the company's businesses, remained the same.

Central Research Laboratories, and Environmental Preservation

In May 1965, on the occasion of introducing organizational reforms, President Kobayashi spoke about the company's R&D activities and introduced the "Company-wide three-stage distribution system." The three stages of R&D were "Today's technology," "Tomorrow's technology," and the "Day-after-tomorrow's technology." For the technology needed in each stage, an in-company structure of responsibility also had to be in three stages. The business divisions were responsible for "Today's technology," because they were the closest to understanding current market needs. Because a single business division could not afford developing "Tomorrow's technology" which would drive the development of new businesses, the development division of the business groups assumed the main responsibility for that R&D. For R&D of the "Day-after-tomorrow's technology," the furthest technology from current market needs, the Central Research Laboratories assumed the responsibility. Its areas of responsibility included everything from basic research to applied research and basic development. In short, President Kobayashi emphasized that R&D activities had to be distributed company-wide, in three stages. Meanwhile, because much of the equipment and facilities at the Central Research Laboratories located on the premises of the Tamagawa Plant had become old and worn, Nippon Electric decided to build a new Central Research Laboratories in the Miyazakidai section of Kawasaki, south of Tokyo. Construction was completed in May 1975.

The high economic growth that began in Japan from the mid-1950s was of a scale previously unheard of in history. The growth was so rapid, however, that distortions appeared. Environmental pollution was perhaps the most notable distortion, and it developed into a major social issue.

Nippon Electric began aggressively tackling the prevention of environmental pollution even before it surfaced as a social issue. One of the first steps it took was in 1962 when it constructed a wastewater treatment plant at the Sagamihara Plant to process the wastewater accompanying galvanizing processes. From about 1968, anti-pollution facilities were also introduced at the existing Mita and Tamagawa plants. All these steps were taken prior to any environment-related legislation introduced by the government. Even as efforts continued at the Central Research Laboratories to develop anti-pollution technology, the company took steps to commercialize the technology. Major accomplishments included technology for turning sludge from wastewater treatment plants into concrete, technology for building a completely closed wastewater treatment system for use at galvanizing plants, and ferrite method technology for treating wastewater contaminated by heavy metal.

Bolstering of Training and Education System

In 1965, Nippon Electric introduced a two-way career review system aimed at male employees performing clerical and technical functions. All those employees were obliged to report once a year on setting goals for their jobs and outlining perceived job problems, setting goals for personal development and reporting on the results, and expressing personal wishes related to reassignment. The supervisors who received the reports met directly with each employee, and through daily work operations provided guidance for developing them and steering them in the proper direction for the future.

Once into the 1960s, Nippon Electric also promoted diversification of the training and education program and systemized it. The education system by job level for middle managers, such as department and section managers, was put in order in 1966, and various courses were established by job function, such as technical, sales/marketing, purchasing, and production control. The fundamental approach to training and education was placed on personal enlightenment through daily work operations. In order to have all employees understand this approach, a voluntary learning system was set up in 1967. Various programs were offered, based completely on voluntary participation by the employees.

Chapter 8

C&C Concept and Globalization: 1977 – 1989

1. Emergence of Information Society

Yen's Appreciation and Japanese Industry

After the dollar shock and the First Oil Crisis in the first half of the 1970s, and then the yen's rapid appreciation and higher oil prices following the Second Oil Crisis that broke out in 1979, the international competitiveness of Japanese industry shifted away from labor-intensive industries such as textiles, and industries highly dependent on oil and consuming great amounts of energy, such as the steel, shipbuilding, and chemical industries, to assembly-centric machinery industries consuming less energy. Among the assembly industries were automobiles, electrical machinery, and electronics. Japanese corporations in those industries increased their international competitiveness by taking steps to ensure high product quality and low cost, and they moved ahead of their counterparts in the advanced Western countries.

In the mid-1980s, however, NEC (as mentioned later, Nippon Electric changed its English name to NEC Corporation in April 1983) and other companies that became increasingly export competitive had to face a new ordeal. After the Plaza Accord of September 1985, the Japanese yen suddenly appreciated rapidly. The yen's exchange rate versus the U.S. dollar prior to the Plaza Accord was 242 yen to the dollar. But by January 1988, the yen appreciated to 120 yen to the dollar. That sharp appreciation dealt a major blow to exports, and Japanese industry was affected seriously by the resultant recession. In response to strong demands from inside and outside Japan for countermeasures to stimulate business, the Japanese government implemented a series of three emergency economic measures between 1985 and 1987. The Bank of Japan, meanwhile, lowered the official discount rate five times from January 1986, to reach 2.5 percent in February 1987, one the world's lowest levels. These economic measures stimulated industrial activities, and once into 1987 the economy moved toward recovery. While introducing measures to offset the yen's appreciation, the Bank of Japan also continued supplying a tremendous amount of yen until early 1988. Between fiscal 1986 and fiscal 1989, Japanese corporations raised 218 billion yen. It is estimated that two-thirds of those funds was used to invest in land and the stock market. Prices for land and stock both continued to rise steadily without stopping, resulting in a huge economic "bubble."

Liberalization of Telecommunications

In 1974, the U.S. Department of Justice filed an antitrust suit against AT&T for anticompetitive behavior. The suit was dropped in January 1982 after AT&T accepted the government's divestiture proposal. In January 1984, when the U.S. telecommunications market was liberalized, AT&T broke up its 22 local telephone operating companies, and organized them into seven independent regional telephone companies providing local telephone service. Prior to this, in December 1983, AT&T dissolved Western Electric Company and reorganized it into AT&T Technologies Inc. (became Lucent Technologies Inc. in 1996). Events also occurred in the U.K. telecommunications industry as well, and in August 1984 the state-run British Telecom (BT) was privatized. Privatization of

Nippon Telegraph and Telephone Public Corporation (NTTPC) and liberalization of the telecommunications market were discussed widely in Japan, and in October 1982 the Public Telecommunications Law was revised. One result was liberalization of the business of providing Value-Added Network (VAN) service to small and medium enterprises. That was followed in December 1984 by the Diet passing three pieces of legislation called the "Three Laws to Reform Telecommunications Services." These laws went into effect in April 1985. From that same month, NTTPC began to be operated as a private company, called Nippon Telegraph and Telephone Corporation (NTT). At the same time, the telecommunications business, until then a monopoly of NTTPC and Kokusai Denshin Denwa Co., Ltd. (KDD), was liberalized.

Three new companies were quickly established in the newly liberalized telecommunications market. Called New Common Carriers (NCCs), they were Daini Denden Incorporated (DDI), Japan Telecom Co., Ltd. (JT), and Teleway Japan Corporation (TWJ). They introduced toll telecommunications services between Tokyo, Nagoya, and Osaka in September 1987. Besides those three NCCs, various types of telecommunications carriers were established, such as those providing regional communications, international communications, satellite communications, and mobile communications for car telephones, cellular phones, and pagers (pocket bells).

Meanwhile, the trade deficit between Japan and the U.S. continued to increase in Japan's favor from the second half of the 1970s and eventually brought about a deterioration of U.S.-Japan trade relations. In 1977, the U.S. government began demanding that the Japanese government, especially NTTPC, open its procurements of materials and equipment to overseas suppliers. The Japanese government objected to the demands, basing its arguments on the integrated nature of telecommunications systems in Japan. In December 1980, however, the two governments reached an agreement, and the Japanese government promised that from January 1981 NTTPC would implement an "open" competitive procurements system "equally fair to foreign and domestic manufacturers."

U.S.-Japan trade frictions became especially heated in the semiconductor field. In June 1985, the U.S. Semiconductor Industry Association (SIA) filed a suit with the Office of the United States Trade Representative (USTR) asking for countermeasures, referring to Section 301 of the U.S. Trade Act and citing the closed nature of Japan's domestic semiconductor market. Following that, U.S. semiconductor manufacturers initiated dumping charges against Japanese-made 64Kb (64 Kbits) DRAM and EPROM (Erasable & Programmable Read-Only Memory). The two governments held a series of discussions to resolve the arguments, and in September 1986 signed the Japan-U.S. Semiconductor Agreement. The two main features of the agreement were promoting the expansion of procurements of foreign-made semiconductors in the Japanese market and monitoring export prices of semiconductors as an antidumping measure. Japan-U.S. trade in the semiconductor field thus changed to become government-controlled trade.

Liberalization of the telecommunications market also had a great impact on the telecommunications equipment market. Different from the days when NTTPC placed the greatest priorities on reliability and product quality in its procurements, NTT and the NCCs placed increased emphasis on price. As well, in response to trade frictions, more overseas manufacturers began competing in the communications market, because NTT began making procurements without discriminating between foreign and domestic manufacturers, and because overseas companies were participating with equity in some of the NCCs and international telecommunications formats were being introduced in Japan. NEC, viewing the changes occurring in the information and communications market as a rare opportunity for expanding its business, responded aggressively to the new market demands. The company met the challenges concerning price competition by developing and applying new technology. In particular, it drew on technology it had already accumulated in the communications field, such as digital technology and optical communications technology.

Microelectronics and Digital Revolutions

Two major changes in the technological environment during this period were the onset of the so-called microelectronics revolution, referring to the rapid progress in the electronics industry, centered on microcomputers, and the digitalization of communications. Minicomputers, office computers, personal computers, and numerical control (NC) devices fitted with microcomputers provided the foundation for factory automation (FA) technology and promoted the development of office automation (OA).

In its fiscal 1975 Annual Report, published in April 1976, Northern Telecom Ltd. (today's Nortel Networks Corporation), of Canada wrote about "The Digital World, a New Era in Telecommunications," explaining that the world of communications was shifting to digital technology. In May 1976, Northern Telecom also hosted a three-day seminar on the theme of "It's a Digital World" in Disney World in Florida, creating a major stir worldwide.

The digital offensive of Northern Telecom helped drive communications technology to turn rapidly toward digitalization, and digitalization became an urgent task of the worldwide telecommunications industry. In May 1978, the "Telematique Concept" was announced in France, and in November 1978 NTTPC introduced its Information Network System (INS) concept of digitalizing Japan's entire domestic communications network. In November 1980, the International Telegraph and Telephone Consultative Committee (CCITT: Comite Consultatif Internationale de Telegraphique et Telephonique) introduced its Integrated Services Digital Network (ISDN) concept, thus completing preparations for digitalizing international telecommunications networks as well. In many countries around the world the idea thus emerged of a new telecommunications network that linked computers and communications, and anticipation increased concerning the possibility of turning that idea into reality. The "C&C" concept that Chairman Koji Kobayashi of NEC introduced at INTELCOM 77 in 1977 was a pioneer concept for building a foundation for that network.

INTELCOM 77 was held in Atlanta, Georgia. Chairman Koji Kobayashi gave a memorable keynote address.

The first NEAX61 digital switching system was installed in the Manteca Central Office of Continental Telephone Co. in California in 1979.

Besides being a technical center for digital communications equipment and OA equipment, the Abiko Plant, northeast of Tokyo, began operations in October 1982 as a model plant of "C&C office systems."

In August 1978, NEC received an unprecedented large order from Satellite Business Systems Corp. of the U.S. to supply 100 small-size earth stations for satellite communications for use with the domestic communications satellite.

Tadahiro Sekimoto
Sekimoto was president from June 1980 to June 1994, and chairman from June 1994 to October 1998. After serving in the Central Research Laboratories for many years, he was seconded to COMSAT in the U.S. where he played a key role in developing digital satellite communications technology. Prior to becoming president, he also bolstered NEC's domestic sales operations.

Atsuyoshi Ouchi (1919-1996)
Ouchi was chairman from May 1988 to June 1990. Heading the semiconductor and personal computer businesses for many years, he was nicknamed "Mr. Semiconductor" during the difficult period of U.S.-Japan trade frictions in the 1980s.

NEC established the Foundation for C&C Promotion in March 1985 to commend persons who contributed to promoting C&C-related technologies around the world and to provide grants for projects undertaken by young researchers. Annual C&C Prize Awards have also been presented.

NEC made maximum use of the interplay between its overseas subsidiaries. In supplying 256Kb DRAM, for example, design work was done in Japan, front-end production in the U.S. (left), and back-end assembly in Singapore (above).

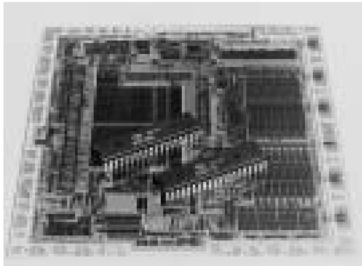
The Momo-1 marine observation satellite, supplied by NEC to NASDA, was launched in 1987 as the nation's first full-scale earth observation satellite.

The ACOS System 1000 was marketed as an ultra-large computer that formed the nucleus of networks. The first system was installed in Tohoku University. From 1984, this system, renamed the NEC System 1000 for overseas markets, was supplied to HIS in the U.S. on an OEM basis.

The multi-purpose street monitoring system NEC delivered to the Osaka Prefectural Government in 1988 indicated the current status of the urban environment. It applied technology that NEC accumulated in the areas of measurement, monitoring, and control.

The first export of the automated fingerprint identification system was to San Francisco Police Headquarters in 1983. Another system, installed in the California Department of Justice, was credited with helping to solve the Night Stalker serial murder case in 1985.

CMOS technology was used extensively in the V Series of original microcomputers. The first models, the V20 and V30 16-bit machines, were introduced in 1983. In January 1985 NEC signed second-source agreements for the V Series with Sony and Sharp.



The integrated production of VLSI began at the Roseville Plant of NEC Electronics in California in June 1984.

The first NEC overseas research institute was NEC Research Institute, established in June 1988 in Princeton, New Jersey, to conduct basic and physical science studies.

2. Development of C&C

C&C Declaration

On October 10, 1977, at the start of INTELCOM 77 in Atlanta, Georgia, Chairman Kobayashi gave a keynote address titled "Shaping the Communications Industry to Meet the Ever-Changing Needs of Society."

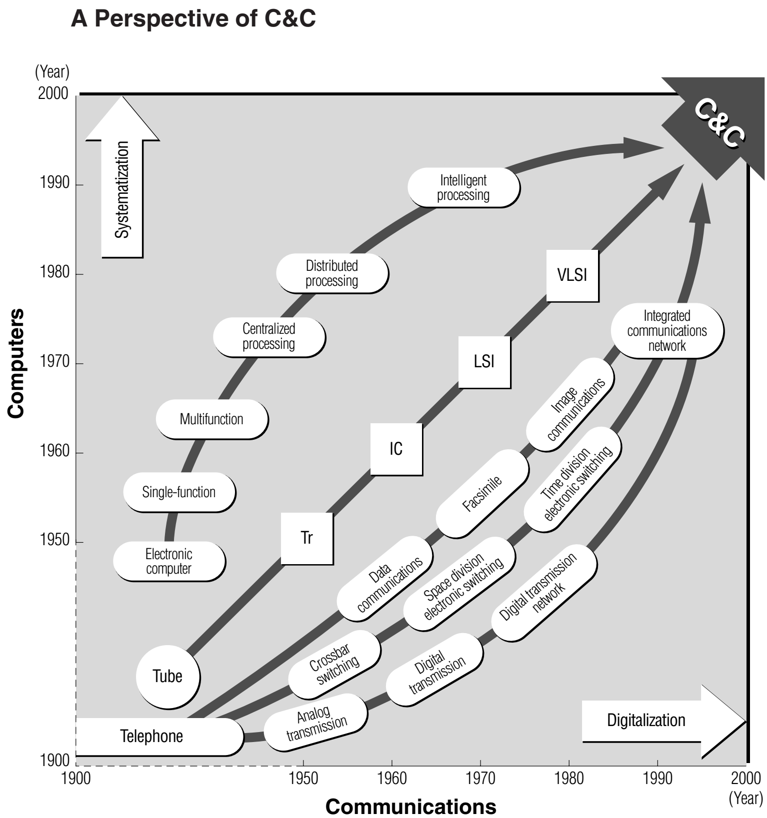
Chairman Kobayashi began his address as follows. "Today, in most developed countries, telephone and broadcasting services are so much a part of daily life that these nations are already in the information-oriented era. Communications technology and computer technology are beginning to merge, and the new terminology of computer communications is becoming popular." That was the origin of C&C, the integration of computers and communications, the principal slogan for NEC's business.

In his speech, Chairman Kobayashi reflected on the role NEC played over the years in the telecommunications industry, and offered advice to the developing economies concerning the nurturing of their telecommunications industries. Chairman Kobayashi did not mention the abbreviation or clearly explain the concept of C&C at this time. In concluding his speech, however, he said: "If I am asked about my vision for communications in the future, and if I am allowed to talk beyond my ability, my imagination goes to such an extent that social needs for communications might be 'to talk and see between any persons, at any time, at any place on the earth, in the early days of the next century.' Assuming that this comes true, all technology, communications, computers, and television will be, and should be, integrated for such needs at such time." Chairman Kobayashi thus offered a glimpse of the future image of the information and communications industry. Today, of course, the integration of computers and communications has become a fact. A typical example is how the Internet has entered the home. That says much for the foresightedness of Chairman Kobayashi's vision.

C&C System Developed and Put into Order

At the end of 1977, two months after the C&C declaration in Atlanta, Chairman Kobayashi called together a group of NEC's directors and business division heads to discuss C&C. He spoke about how the concept of distributed processing of information had emerged in the field of computers and how communications networks had become necessary. In the communications field, meanwhile, digitalization occurred, essentially the equivalent of computers, and it then became easier for computers and communications to be integrated. Although it was still not clear at that time what kind of interface would tie the two fields together, the seeds of that new technology had to be already planted. Chairman Kobayashi wanted NEC's directors and business division heads to discuss C&C closely and decide on the direction in which the company had to move to realize the integration of computers and communications. Other meetings followed that first one, and it came to be called the "C&C Orientation Meeting." In June 1978, the C&C Committee replaced the C&C Orientation Meeting. Tadahiro Sekimoto, newly appointed as executive vice president, was appointed committee chairman. The C&C Committee's mission was to formulate and implement a specific strategy for the C&C business, and to evaluate the results. As necessary, the C&C Committee could appoint subcommittees and expert working groups.

The first time that Chairman Kobayashi spoke outside the company specifically about the C&C concept was in May 1978 in Tokyo during his keynote address at the Twentieth Anniversary of the Japan Electronic Industries Development Association (JEIDA). Overseas, Chairman Kobayashi introduced the C&C concept in his keynote address titled "The Japanese Computer Industry: Its Roots and Development" at the Third U.S.-Japan Computer Conference held in San Francisco in October 1978. In these speeches, Chairman Kobayashi used a C&C Chart to demonstrate how the C&C concept comprises three lines—representing the fields of computers, semiconductors, and communications. The chart showed how the three fields became gradually more inte-



During numerous presentations he made domestically and overseas, Chairman Kobayashi used the C&C Chart to explain how the three lines of computers, semiconductors, and communications merged to comprise the C&C concept.

grated as they were systematized and digitalized. The chart became popular for how it enabled audiences to understand the C&C concept at a glance.

In order to ensure that as many ordinary people as possible would understand the C&C concept, NEC placed a four-page advertisement in the national Asahi Shimbun newspaper on New Year's Day in 1979 titled "The First Year of C&C." The advertisement also introduced the slogan "Meshing the globe with reliable technology"; it had a major impact on readers.

Through energetic public relations activities, including widespread introduction of the C&C Chart, the C&C concept gradually came to be widely appreciated in society. The name recognition of NEC (Nippon Electric Company) also increased accordingly. Overseas as well, the name "NEC" came to be recognized around the world. In April 1983, the company changed its English name from Nippon Electric Co., Ltd., to "NEC Corporation."

NEC applied C&C not only in the business arena but also in the area of social contributions. In March 1985, for example, the company established the Foundation for C&C Promotion. The foundation's mission was to recognize people who contributed to promoting C&C, and to help to promote C&C-related technology around the world by providing grants for research projects. Next, in June 1987, the NEC Foundation Inc. was established in the Philippines as an education foundation for assisting students studying in the computer or communications fields. A similar foundation, the C&C Education Foundation, was established in Thailand.

Tadahiro Sekimoto Assumes Presidency

Even as NEC was developing its C&C strategy, President Tadao Tanaka left the presidency in June 1980 to become a counselor and director, and Executive Vice President Tadahiro Sekimoto assumed the presidency. Sekimoto, 53 years old, was selected from among many other directors.

After joining NEC in 1948, Sekimoto was assigned to the Central Research Laboratories until 1965. In August 1965, he was seconded to COMSAT in the U.S. As a department manager in COMSAT, he played a key role in developing digital satellite communications technology. In 1974, at just 49 years of age, Sekimoto was appointed an associate senior vice president and director in NEC, and in 1978 was promoted to executive vice president. In that position he headed the domestic sales business group. In his first greetings to NEC's employees, President Sekimoto spoke about his management philosophy as follows.

> NEC's basic approach to management is that a corporation must continue to expand indefinitely as a going concern. No matter what foreign companies might do, NEC must continue in business far into the future. In fact, it will continue in business forever. To do so, however, it must, first of all, be in harmony with society. Through C&C technology, NEC must continue to contribute to Japanese society, and to all other societies around the world. The company must also earn a profit, and return that profit to society and to the company's shareholders and employees.

That thinking expressed President Sekimoto's basic management philosophy, a philosophy always visible in his subsequent managerial stance.

In his New Year's Greetings to NEC's employees in 1981, President Sekimoto said that the 1980s could be expected to be a period of radical change. He emphasized the need for the company to become a "leader in reform" and to promote the company's C&C strategy domestically and overseas in order to navigate safely through the period. He asked for the cooperation of the company's employees as follows to accomplish that most important task.

> The 1980s will see tremendous changes in the very nature of things, with unexpected phenomena possibly occurring one after the other. For example, the issues of natural resources and energy shook the roots of the world's political and eco-

> nomic systems and brought about issues such as country risk and wildly fluctuating exchange rates. Keeping C&C in mind, let us work together to overcome quickly, forcefully, and precisely the challenge of this approaching period of radical change.

Mesh-Globalization

The continued rapid appreciation of the yen and the expansion of trade frictions served to promote the development of globalized business operations across national borders by Japanese corporations, especially companies in manufacturing industries with high export ratios. NEC's globalization unfolded rapidly during this period, turning it into a world enterprise in business scale and business content. The company's globalization from the second half of the 1970s developed mainly as a response to trade frictions. Toward the end of the 1970s, for example, around the time of trade frictions between Japan and the U.S. in the semiconductor field, Chairman Kobayashi said the only way to resolve the problem was for NEC to take the first step by building a plant in the U.S. and becoming a U.S. citizen. He then directed that steps be taken to secure a semiconductor production plant in the U.S. This took concrete form in 1978 with the company's acquisition of Electronic Arrays, Inc. (EA), a semiconductor manufacturer located in California. EA was later renamed NEC Electronics, Inc.

Overseas production plants also became necessary for mass-production items such as communications equipment and home electric appliances as a response to the highly appreciated yen. NEC America, Inc., played a major role in the communications equipment field. The Dallas Plant was NEC's first plant in the U.S., built in 1978 for producing PBXs and key telephone sets. Next, in 1985, the Oregon Plant began manufacturing products in leading-edge fields, such as optical communications equipment, digital microwave communications equipment, very small aperture terminals (VSATs) for earth stations, car telephones, and facsimiles. Once into the second half of the 1980s, the building of overseas production plants turned brisk, and NEC established local production companies in many countries. For example, it established NEC Technologies (UK) in 1987 to produce VTRs and printers, and established NEC Technologies (Thailand) in 1988 to produce key telephones and facsimiles. As of April 1989, NEC had 22 local production companies in 12 countries, and 34 sales and service companies and 24 liaison offices in 20 countries.

In the midst of this expansion and bolstering of the company's international business, President Sekimoto announced an international business strategy he called "mesh-globalization."

> Our company's international expansion today covers just about the entire globe, and our production and marketing activities have become greatly diversified. Also, our approach to globalization has changed. In the past, no matter how much we expanded our business, we concentrated the basic management functions in Tokyo. From Tokyo we tied together all our overseas subsidiaries and affiliates and controlled their activities in what was called 'line globalization.' Today, however, we must tie together our worldwide network of subsidiaries and affiliates in 'mesh-globalization.' Each production unit, for example, must show initiative in realizing its most appropriate level of output.

By mesh-globalization, President Sekimoto referred to "area" rather than "line" expansion, and to a mesh-like integration of all human, physical, and financial management resources. Between 1978 and 1979, around the time of the yen's sharp appreciation, NEC strengthened its purchasing system by reorganizing the Import Section inside its Purchasing Department into the International Purchasing Department. It also established an International Purchasing Office in Boston, Massachusetts (renamed the North America IPO in 1979), and another in London (renamed the EU IPO in 1980). Later, in 1988, NEC also established the Asia IPO in Hong Kong and the Taiwan IPO in Taipei. The Tokyo IPO was established in 1989. This network of IPO offices promoted the mesh-globalization of procurements.

3. Digital Revolution, and Telecommunications Business

Development of Digital Switching Systems

The environment surrounding NEC's telecommunications business changed drastically from the second half of the 1970s into the 1980s. As a result of completion of the five five-year expansion plans of NTTPC that began in 1953, the two principal goals of installing telephones immediately upon application and allowing nationwide direct dialing were achieved, respectively, in March 1978 and March 1979. As the telecommunications industry waited for NTTPC's next step, the move toward digitalization of telecommunications accelerated. Japan's telecommunications market was liberalized in 1985, including the privatization of NTTPC as NTT.

In May 1976, as related earlier, Northern Telecom introduced a digital switching system. Afterward, the U.S. market for telephone switching systems began quickly shifting to digital systems. Sales personnel of NEC America reported to Tokyo that they could not do business without offering digital systems. In the past, Japan's telephone switching system manufacturers worked closely with NTTPC to develop new products. Then, equipped with the same technology, they developed their business in other markets. In the new situation, NEC was faced with the decision of whether to develop digital switching systems on its own. Top management decided that the company's only choice was to flow with the current, and NEC thus began developing original digital switching systems. A project development team was quickly formed, headed by Associate Senior Vice President Toshiro Kunihiro (later, senior executive vice president), and development work began in earnest on digital switching systems destined for overseas markets. In October 1977, even as INTELCOM 77 was being held in Atlanta, NEC unveiled in New York its NEAX61 digital switching system for telephone offices.

The response to the NEAX61 was tremendous, and Continental Telephone Co., with whom NEC had previous business relations, immediately placed orders for NEAX61 digital switching systems for three telephone offices. The first NEAX61 system was installed in the Manteca Central Office in California, and services began there in May 1979. Improvements were later added to the NEAX61, and by 1981 orders for it were received from New Zealand, Malaysia, Colombia, Argentina, and 13 other countries for a total of 2.78 million lines installed in 395 telephone offices. NEC thus gradually became one of the world's top suppliers of digital switching systems. After the NEAX61E was developed, an order came from the Tianjin Post and Telecom Bureau in the People's Republic of China in 1983, marking NEC's entrance into the Chinese market. In the U.S., meanwhile, the company received orders for digital switching systems for ISDN applications from several Bell-related telephone companies. The first ISDN switching system for commercial use went into service in 1987. In those circumstances, NEC's competitiveness in the marketplace increased rapidly. Large orders were subsequently received from Thailand, New Zealand, and other countries. The NEAX61's fine sales performance earned it a reputation as a switching system of global recognition. As of the end of 1989, orders for the NEAX61 were received from 60 countries and totaled over 20 million lines.

In 1978, NTTPC approached the four main Japanese communications equipment manufacturers with a proposal for joint development of digital switching systems. Research moved forward first on a digital switching system for toll call offices, and in 1981 the D60 digital switching system for commercial use was completed. NEC installed the first D60 system in the Otemachi Telephone Office in central Tokyo. Next, development of the D70 system was completed in 1982. The D70 could be used for toll calls, local calls, or both, and was flexible enough to respond to the diversified needs of ISDN in the future. In July 1982, NEC installed the first commercial-use D70 for toll calls in the Aomori Telephone Office, and in the following month installed the first commercial-use D70 for local calls in the Daido Telephone Office in Nagoya.

The installation of digital switching systems led to the digitalization of Japan's overall telecommunications network. It gradually became possible to utilize the same media to transmit voice and other data, and to retain the transmission quality regardless of distance, making it possible to build an information communications network for providing sophisticated and diversified information services. In 1978, NTTPC announced its INS concept, and in 1981 introduced the general framework of INS. As a step toward commercializing its ISDN service, NTTPC field-tested the service in 1984 in the Mitaka area west of Tokyo. In response to those moves, NEC cooperated energetically in the development of an ISDN switching system. In September 1987, after NTTPC was privatized as NTT, NEC installed a switching system in NTT's Marunouchi Office in central Tokyo to support an INS-Net system. From April 1988, NTT began offering INS Net64 service in Tokyo, Nagoya, and Osaka.

NEC also played important roles in the digitalization of KDD's international switching system and the start of international ISDN services. For example, the XE-10 international switching system that the company installed in the Tanimachi Central Office in Osaka began providing services from March 1984. Ahead of the two NCCs that specialized in international telecommunications services, KDD moved forward with providing international ISDN services. NEC developed the ISDN switching system for KDD, contributing substantially to the start of that service from April 1989.

From the start of their operations, the NCCs moved forward with construction of digital telecommunications networks. NEC added functions and interfaces that the NCCs required to the systems it had developed with NTT and KDD, as well as to the systems it had developed for overseas markets, and provided network systems responsive to the needs of the NCCs.

Concerning overseas PBX systems, NEC had already introduced the NEAX12 analog electronic PBX (EPBX) system in 1976. In 1978, the company shipped to the U.S. the NEAX22, the first digital EPBX system for overseas markets. From 1982 NEC also started exporting to the U.S. the NEAX2400IMS digital EPBX, developed specifically to meet the needs of that market. The timing coincided with reorganization of the U.S. telecommunications market, including the breakup of AT&T, and the NEAX22 and NEAX2400IMS both became best-selling products in the U.S. In the domestic market, meanwhile, the NEAX2400IMS was marketed as the APEX2400IMS. It was followed by the 400-line capacity APEX2000 series in 1987, thus covering the PBX market for small- and medium-capacity systems.

It was around this same time that NEC moved forward with construction of a new domestic plant it had been planning. The plant site was in Abiko, Chiba Prefecture, northeast of Tokyo. Besides being a technical center for digital communications equipment and OA equipment, the Abiko Plant was designed as a model plant of the "C&C office systems" that NEC was promoting. It began operations in October 1982.

Development of Optical Communications Business

Early in February 1985, Japan's newspapers carried articles reporting that NTTPC had completed laying a fiber optic cable across the Japanese archipelago. In effect, the articles raised the curtain on the optical communications era in Japan.

In 1975, NEC and Tokyo Electric Power Company successfully conducted the world's first comprehensive field test of a fiber optic cable system. NTTPC conducted its first field test in 1978 by laying a fiber optic cable over a 21-kilometer route in Tokyo. Next, between 1980 and 1981, fiber optic cables for practical use were laid in 12 areas around Japan. Then, as mentioned, in February 1985 NTTPC completed laying fiber optic cables across Japan from Asahikawa in Hokkaido to Kagoshima in Kyushu. NEC cooperated in developing the technology for all those fiber optic cable projects.

The first commercial-use optical communications system NEC developed on its own was the system Vista Florida Telephone Co. ordered in 1977. This system used fiber optic cable to tie together the roughly 9 kilometers between telephone offices inside Disney World in Florida. It began operating in July 1978 as the world's first optical communications system for practical use. Next, in March 1980, NEC successfully responded to a call for bids from ENTEL in Argentina for a digital telecommunications network for use in Buenos Aires. The company's quotation was for an optical communications system. Under that contract, NEC completed a 320-kilometer optical communications network. The project was the world's largest of its kind at the time, and ENTEL immediately switched 1.6 million subscribers to the new system when it was completed. After completing that network in 1982, NEC won successive orders for optical communications systems from countries such as the U.S., Canada, Saudi Arabia, Ireland, Switzerland, Austria, and Brazil. Orders from the U.S. were particularly brisk. Around 1990, NEC's share of the U.S. optical communications systems market reached about 30 percent.

Concerning submarine cable communications as well, coaxial cable was steadily replaced by fiber optic cable. The largest-scale submarine coaxial cable system NEC participated in was the 2,670-kilometer system completed in 1985 that stretched from Medan in Indonesia to Colombo in Sri Lanka. The company's total production of submarine coaxial cable repeaters reached 1,247 units. NEC's production of coaxial cable repeaters ended in July 1986; that also marked an end to the era of coaxial cable.

NTT was also active concerning domestic submarine fiber optic cables. Its first project was a 290-kilometer submarine fiber optic cable laid between Tomakomai in Hokkaido and Hachinohe in Aomori Prefecture. Another fiber optic cable, about 1,000 kilometers in length, was laid between Miyazaki (Kyushu) and Okinawa. By September 1986, NEC provided repeaters for both of these systems. Concerning Trans-Ocean fiber optic cable systems, KDD, AT&T, and others were finalizing a plan in 1983 to build the third transpacific cable (TPC-3) around the same time that the eighth transatlantic cable (TAT-8) was planned. NEC received orders from KDD for repeaters and terminal equipment for use with the TPC-3 Trans-Ocean fiber optic cable system. Service using the TPC-3 system was inaugurated in April 1989.

From Analog to Digital Microwave Communications

In the field of microwave communications, from the second half of the 1970s analog systems matured even as digital systems rapidly entered the market. Multiplexing was promoted in analog microwave communications, and NEC cooperated with NTTPC in 1982 to develop transmitter-receiver equipment with a large capacity of 5,400 channels. The 500 Series, a new series of analog microwave communications systems developed for overseas markets, helped to expand NEC's overseas microwave communications systems business. The company moved all-out to develop that series in 1978, and then successfully introduced it to the U.S. market. The 500 Series sold well from the start, and orders were received from other overseas markets as well, including Australia, India, Mozambique, and countries in Latin America. The series steadily won a larger share of the world's microwave communications systems market and became a best-selling product. Gradually, however, the market shifted toward digital microwave communications systems; analog systems matured to their maximum and then faded.

NEC's digital microwave communications equipment earned favorable microwave test results in 1977 at Bell Laboratories in the U.S. Afterward, in 1979, the company completed development of the world's first digital-type microwave transmitter-receiver equipment, with the equivalent of 1,334 channels. Orders for this equipment subsequently came from Bell Laboratories and Bell-related telephone companies. In that background, NEC tackled the mass production of this equipment, naming it the digital microwave 500 Series, and began energetic sales activities mainly in the North American market. Besides sales there, many orders for projects were also received from countries such as Thailand and Australia. The 700 Series, meanwhile, developed in 1985 for export to Europe, became the company's mainstay digital microwave communications product in the European market. From 1982, NEC began delivering 2,880-channel digital microwave communications systems to NTTPC for use as long-distance digital microwave communications circuits. The first systems were installed between Sendai in Miyagi Prefecture and Aomori in Aomori Prefecture. NEC continued afterward to develop and install large-capacity digital microwave communications equipment throughout Japan.

In the 1980s, due to rapid progress in fiber optic communications technology, digital microwave communications lost its superiority in terms of capacity to fiber optic cable communications for use in long-distance trunk transmission lines. Digital microwave communications systems thus had to coexist with fiber optic cable communications systems or else new applications had to be discovered. In that situation, NEC promoted systems offering much greater capacity and higher rigidity in specifications for trunk lines while moving to expand the applications for microwave communications in short-distance spur lines, private communications networks, and rural radio stations. One example was the PASOLINK-50 simplified radio system marketed in 1983. This system was well received at the time by corporations aggressively building private communications networks. It sold especially well in the U.K. NEC was also awarded a contract from Egypt to build a rural communications system for providing telephone service along a desert highway. That was a digital radio multiple access subscriber system (DRMASS), and served to expand the application of microwave communications to remote areas.

Satellite Communications Market, and Space Development

From the second half of the 1970s, the satellite communications field was marked by the introduction of diversified communications formats and technological innovation.

Up to the late 1970s, Intelsat had monopolized international satellite communications services. Once into the 1980s, however, and in the context of the U.S. open sky policy, other corporations began entering the international satellite communications service business. In the U.S., based on the VSAT concept of Federal Express Corporation (FedEx) in 1983, private corporations launched a series of communications satellites. In Europe as well, Eutelsat launched the European Communications Satellite (ECS) in 1983. In Japan, the Sakura (CS) experimental communications satellite was launched in 1977, and the Yuri (BS) experimental broadcasting satellite was launched in 1978. Following further research, Japan's first communications satellites for practical use, the Sakura-2a (CS-2a) and Sakura-2b (CS-2b), were launched in 1983, and the broadcasting satellite Yuri-2a (BS-2a) was launched in 1984. In that background, and after the Sakura-2 (CS-2) satellites began providing service, NEC responded to the demand from the domestic satellite communications business by developing mobile stations and equipment for fixed earth stations. The company delivered numerous earth station systems for satellite communications to the Ministry of Posts and Telecommunications, the National Police Agency, the Fire and Disaster Management Agency, the National Land Agency, the Japan National Railways (privatized and divided into six JR companies in April 1987), electric power companies, and many other public agencies and private corporations. In 1982, Intelsat designated NEC as the sole supplier of Time Division Multiple Access (TDMA) base stations.

In the field of commercial-use communications satellites, which entered the practical-use stage with the Sakura-2 satellites, longer life was aimed for with launching of the Sakura-3a (CS-3a) and Sakura-3b (CS-3b) satellites in 1988. Next, in 1989, Japan Communications Satellite Co., Inc. (JCSAT; later, JSAT Corporation), and Space Communications Corporation (SCC), two private companies, launched commercial satellites, signaling the entrance to a period of all-out competition in Japan in the satellite communications service market. NEC participated in building earth stations for NTT and other satellite communications companies. Private broadcasting companies, meanwhile, competed to introduce Satellite News Gathering (SNG) systems and to offer new information services utilizing communications satellites. With their great mobility and immediate responsiveness, SNG systems provided news broadcasts from distant areas such as mountainous regions and remote islands. NEC succeeded in receiving large contracts from private broadcasting companies and their affiliated stations, delivering 62 such SNG systems by 1990.

NEC conducted energetic sales activities in overseas markets as well. In 1978, for example, the company won an order from Satellite Business Systems Corporation (SBS) in the U.S. for 100 small-size earth stations for satellite communications. Next, in 1980, the company won an order from China for a large-size earth station for satellite communications. As a result of winning an exclusive contract from Intelsat for TDMA base stations for use with Intelsat satellites, and winning other orders for satellite communications earth stations from a wide range of other customers, including the International Maritime Satellite Organization (Inmarsat) and Intelsat-affiliated entities that operated domestic communications satellites (DOMSAT), NEC's cumulative deliveries of earth stations passed the 1,000-unit mark in 1984.

Intelsat eventually reviewed the standard earth stations it used previously for providing public network services, established new standard earth stations for specified customers, and came to provide a wide range of services. In 1985, NEC developed a small-capacity earth station for rural communications, later called the VISTA, and exported it to Australia. The company also developed a new standard earth station for providing intra-enterprise international business telecommunications service for export to Denmark. In the second half of the 1980s, a market developed in the U.S. for VSAT systems, and their use soon spread around the world. NEC had already successfully conducted VSAT experiments, and in 1987 was awarded a contract from Kmart Corporation for 1,000 VSAT systems. Next, in 1989, NEC received an order from Hughes Network Systems, Inc., for 10,000 VSAT outdoor units. Other orders were received from Mexico, Australia, Indonesia, Norway, Brazil, and other countries as the VSAT market spread worldwide.

Of the total number of satellites launched in Japan between 1977 and 1989, NEC participated in 31 satellite projects. The company was awarded a contract from the National Space Development Agency (NASDA) for the Himawari (GMS) geostationary meteorological satellite launched in 1977. That success was followed by the launching of the Himawari-2 (GMS-2) in 1981, Himawari-3 (GMS-3) in 1984, and Himawari-4 (GMS-4) in 1989, all of which played important roles in providing accurate data for weather forecasts. The Sakigake (MS-T5) and Suisei (PLANET-A) scientific satellites launched in 1985 by the Institute of Space and Astronautical Science (ISAS) of the Ministry of Education were Japan's first probe satellites sent into planetary orbit. Their mission was to observe Comet Halley. The Ginga (ASTRO-C) satellite launched in 1987, meanwhile, was aimed at the detailed observation of black holes. At the time, the Ginga was the only satellite in orbit observing space using X-rays. In the same year, the Momo-1 (MOS-1) marine observation satellite was launched. At 740 kilograms, it was the heaviest satellite launched by Japan up to that time, and the country's first full-scale earth observation satellite. In 1982, NEC built an exclusive plant inside the Yokohama Plant for producing these satellites.

The company also developed and installed transponders for use aboard the Intelsat VI and Inmarsat 2 satellites. These transponders won high praise for their reliability and superior technological level. An equivalent model of the transponder used aboard Inmarsat 2 is on permanent display at the British Science Museum in London.

NEC also participated in the international project to build a space station. After being informed of the U.S. proposal to build a permanent manned space station, the Japanese government decided to build a Japanese Experimental Module (JEM), with NASDA in the center and with various companies being assigned project tasks. In 1985, NEC worked jointly with Mitsubishi Heavy Industries, Ltd., and Ishikawajima-Harima Heavy Industries Co., Ltd., to prepare a preliminary design and was in charge of the communications control system.

4. Expansion of Computer and Information Processing Businesses

New Applications for ACOS Series

As related earlier, the ACOS Series of computers that NEC and Toshiba jointly developed was marketed until 1976 as a series of systems. Even after 1976, however, the two companies continued the further development of, and improvement to, the Operating System (OS) of the ACOS Series. Because HIS had terminated its development work on these computers, NEC assumed the lead role in developing further and improving the ACOS-2, the OS for small-size machines, and the ACOS-4 for medium-size machines, and Toshiba assumed the lead role in developing further and improving the ACOS-6 for large-size machines. In February 1978, Toshiba withdrew from working further on the medium- and large-size machines, and NEC assumed the development work for the ACOS-6 as well. The company was thus faced with the task of developing multiple OS simultaneously, causing a shortage of software engineers. The company overcame this difficulty in various ways, such as by providing the maximum compatibility between the OS for the ACOS-4 and ACOS-6 machines. As well, the sales force for handling the ACOS Series was bolstered by transferring 500 sales personnel from Toshiba to NEC-Toshiba Information Systems, Inc., and reassigning 700 persons from the engineering departments to the sales departments within NEC.

In late January 1979, IBM introduced its 4300 Series of medium- and small-size machines. Just a week later, in early February, NEC introduced the ACOS System 250 to compete with the IBM 4331. The ACOS System 250 thus raised the curtain on an era in the mainframe business of NEC. Using LSIs, its performance was superior to the IBM 4331. In June 1981, the cumulative sales of ACOS System 250 systems surpassed the 1,000-unit mark, the first time for a small computer to reach such a sales level. In the first four years after its introduction, a total of 2,146 units of the

ACOS System 250 were sold, making it an all-time best-selling product. Among the customers, moreover, 57 percent were first-time accounts, including many purchases to replace other brands of computers. Development also moved forward at that time on medium- and large-size processors, and from 1979 to 1983 NEC marketed models ranging from the ACOS System 350 to the ACOS System 950.

In April 1983, the small-size ACOS System 410 was marketed as an advanced version of the ACOS System 250 for use in building comprehensive integrated OA systems. Next, in February 1984, the medium-size ACOS System 430, fitted with a 256Kb DRAM, was marketed. The ACOS System 3000 Series later succeeded both of those machines. The small-size ACOS System 3300 was marketed in July 1987, and the medium-size ACOS System 3400 was marketed in July 1988.

As the trend toward the networking of information systems became clearer, demand increased for the ultra-large computers that formed the nucleus of networks. In order to respond to that demand, NEC in September 1980 marketed the ultra-large general-purpose ACOS System 1000 computer. It boasted of a processing speed of 15 MIPS (million instructions per second), the world's fastest at the time. Next, in February 1985, NEC marketed the ACOS System 1500 Series, then the world's largest and fastest computer, followed in February 1986 by the ACOS System 2000 Series. The latter series was fitted with a very fast logic LSI, very high-density packaging technology, and a fault-tolerant function enabling 24-hour operation. Its maximum processing speed of 170 MIPS made it the world's fastest ultra-large general-purpose computer at the time.

NEC came to develop its entire line of computers, from small to ultra-large machines, completely with original technology. In that background, the technical agreement that NEC and Honeywell originally signed in 1962 and revised in 1972 came up for its second revision in 1983. In October 1983, NEC and Honeywell exchanged a memorandum of understanding concerning a new relationship and signed a contract for cross licensing in the ultra-large-size computer field. Up to then, NEC had imported technology from Honeywell, but in the new relationship the situation was reversed and NEC began providing technology to Honeywell. In March 1984, six months after signing the agreement with Honeywell, NEC began shipping the ACOS System 1000 (NEC System 1000) to Honeywell on an OEM basis. Next, in August 1984, NEC began supplying Compagnie Internationale pour l'Informatique Honeywell Bull (CII-HB), a joint venture between Honeywell and Compagnie des Machines Bull (Bull), with the same NEC System 1000 on an OEM basis. Next, in March 1987, NEC, Bull, and Honeywell established Honeywell Bull Inc. in the U.S. to maintain and strengthen their worldwide competitiveness in the large-size computer market. In 1989, however, Honeywell decided to withdraw completely from the computer business, and sold its holdings in Honeywell Bull to Bull. Honeywell Bull's name was then changed to Bull HN Information Systems, Inc. As a result, the business ties between NEC and Honeywell, which had continued since 1962, came to an end.

As mentioned, the ACOS System 250 marketed in 1979 became a best-selling product. The ACOS System 1000 announced in 1980 was also well received in the domestic and overseas markets. During fiscal 1980 NEC held the market's third highest share in Japan and during fiscal 1986 moved back into second place, a position it had held up to 1970. After Honeywell withdrew from the computer business, NEC gradually established a computer business network covering Japan, the U.S., and the countries of Europe.

Development of Supercomputers

The Cray 1 that Cray Research Inc. introduced in April 1976 was the pioneer supercomputer, with a peak performance of 133 megaflops (floating-point operations per second). In February 1982, Fujitsu was the first Japanese company to develop a supercomputer. That machine had a peak performance of 500 megaflops. Next, in August 1982, Hitachi introduced a supercomputer with a peak performance of 630 megaflops. NEC ended up following those two companies but in April 1983 announced the SX-1 supercomputer with a peak performance of 570 megaflops, and the SX-2 with a peak performance of 1.3 gigaflops. No other supercomputer offered a processing speed over 1 gigaflops, making the SX-2 the world's fastest computer at the time. Demonstrating that performance capability proved to be a difficult task, however, and in January 1985 Fujitsu introduced another supercomputer and succeeded in demonstrating a peak performance of over 1 gigaflops, thus moving ahead of NEC. NEC finally succeeded in December 1985 to demonstrate a performance capability of 1.3 gigaflops, the world's fastest speed at the time. After delivering the first SX-2 to Osaka University in June 1985, NEC subsequently installed machines in other universities and government agencies, such as Tohoku University and the Port and Harbour Research Institute of the Ministry of Transportation. Overseas, the SX-2 recorded the world's fastest processing speed at the time in benchmark tests conducted at the Houston Advanced Research Center (HARC) in 1986. HARC subsequently purchased that system. In Europe, in 1987, NEC competed closely with Cray Research and was awarded the contract for a supercomputer from the Nationaal Lucht-en Ruimtevaart-laboratorium (NLR), the national space research center of the Netherlands. Around this same time, the U.S. government became increasingly concerned about the entrance of Japanese supercomputers into the U.S. market and also applied strong pressure on the Japanese government to open supercomputer procurements in Japan to U.S.-made machines. As a result, an agreement was reached between the two governments to allow for open competition in public bids for the procurement of supercomputers by Japanese government agencies.

NEC introduced the SX-3 Series of supercomputers in April 1989. The SX-3 was the first Japanese-made computer to allow parallel processing using multiprocessors. The top-end model of that series provided a peak performance of 22 gigaflops, the world's fastest processing speed at the time. After installing the first SX-3 in the University of Köln in Germany in December 1990, NEC also installed SX-3 models in Tohoku University and Osaka University in Japan. Other installations overseas included the Meteorological Service of Canada and the Swiss Supercomputer Centre in Switzerland.

From Office Computers to Office Processors

During this period, NEC maintained the top share of the office computer market in Japan. In October 1978, following the results of a U.S. market survey, NEC marketed interactive-type office computers, Models 40, 60, and 80 of the NEAC System 100. These models were marketed from March 1979 in the U.S. market as the ASTRA series. In April 1981, the NEAC System computers were renamed the NEC System computers, and a new family of computers called the NEC System Series was marketed. This new series completed NEC's lineup of office computers, covering the range from top-end personal computers to bottom-end small-size general-purpose computers. The main features of these models were their orientation toward distributed processing systems and their bolstered Japanese-language processing functions.

NEC recognized from early on the importance of computer terminals, and in 1973 marketed the Intelligent Terminal N6300 Series. That series was developed further and in April 1983 was marketed as the Multi-Functional Workstation N6300/55, enabling the processing of text, graphs, and images. As the performance of NEC's lineup of office computers and workstations was improved, their performances became closer. NEC then changed their overall name to "office processors," and in October 1985 introduced the Office Processor VS Series and the Office Processor N6500 Series. Later, in 1987, the VS Series was upgraded to the NEC System 3100 Series, and the N6500 Series to the NEC System 3050 Series, with both series having improved performance.

The Personal Terminal N5200/05 that NEC marketed in July 1981 was the world's first personal terminal loaded with a 16-bit microprocessor. Personal computers were finally starting to be used widely at the time, and even computers for business use were generally being called personal computers. In that background, NEC in May 1982 changed the name "personal terminal" it had been using to "personal computer," and marketed a LAN Series of OA software for the business-use Personal Computer N5200/05 that integrated word processing, spreadsheet, and database software. Under the name Advanced Personal Computer (APC), the company marketed the N5200/05 in the U.S., and later marketed it also in Europe and Australia. The company later added new models to the N5200 Series. The N5200/03L marketed in 1988 was the company's first laptop personal computer for business use.

During this period, NEC developed and marketed various exclusive-use terminals, including automatic teller machines (ATMs) and point of sales (POS) terminals essential for use in convenience stores for inventory control. Engineering workstations (EWS) loaded with computer-aided design (CAD) software were also developed for use in areas such as new product development. In September 1986, NEC marketed the EWS4800 Series, the first domestic-made EWS. New models in the EWS4800 Series were developed and marketed later, and the series came to hold the largest market share among domestic-made EWS.

Expansion of Information Processing Systems Business

NEC's systems business during this period developed in two directions. One direction was the information processing systems business, in which the company analyzed the needs of customers purchasing computer systems and provided them with the ideal combinations of hardware and software. The other direction was the industrial systems business, in which the company provided industry and general customers with systems to fit their various needs for automation, measurement, and control.

In the information processing systems business, customers began demanding larger-scale, more sophisticated systems from around the mid-1980s. Because of the use of international networks and the integration of in-house systems and systems between companies, it became necessary to build systems that included hardware made by different manufacturers, the so-called multivendor trend. From this trend emerged two customer demands. One was for total solutions, i.e., the overall solution of various problems that customers faced with their hardware and software. The other was for system integration, i.e., where management consultants provided a comprehensive service by designing a system, developing the necessary software, and operating the system. NEC responded to these new demands by training and educating solution provider-oriented system engineers for providing customers with the solutions they required.

A typical system NEC developed around this time was the automated fingerprint identification system (AFIS). The first system was delivered to the National Police Agency in October 1982. NEC also exported this system to the U.S. A system delivered to the California Department of Justice won high praise in August 1985 for contributing substantially to solving a serial murder case. NEC's AFIS systems eventually secured a two-thirds share of the world's market. In another project, initiated by the Ministry of Posts and Telecommunications when it began developing a nationwide integrated postal services communications network (P-NET) from 1984, NEC's information processing business group worked with other NEC business groups and contributed toward building a data communications network in a mammoth C&C system that tied together about 70,000 terminals throughout Japan by high-speed digital circuits.

In the hospital-use information systems business, NEC developed the Laboratory Information System (LIS), and installed it in the Kanto Teishin Hospital in 1980. This system comprised an MS50 minicomputer, 20 CRT terminals, and ten automatic analysis devices. It allowed the distributed processing of laboratory tests.

The information systems business for private corporations expanded rapidly around this time, supported by favorable OA- and FA-related business. NEC developed and delivered a wide range of systems, including online production control systems, online materials handling systems, total hotel management systems, and aboard-vehicle control systems for trucking firms.

The industrial systems business, meanwhile, focused on areas that demanded technology related to computers, communications, control, and automation. During the period of high economic growth, NEC had contributed much toward the automation of industry in areas such as postal automation systems. While continuing to provide such systems, in 1985 NEC added a function that allowed the automatic postal code recognition and sorting system it originally developed for the domestic market to read handwritten characters. As a system for the overall automation of mail handling, operation began of a new NEC system in the Oita Post Office (Kyushu) in 1979, followed by other systems in the Yokohama Sorting Office in 1982, and the Nagoya Sorting Office in1984. In 1985, NEC was awarded a contract from the Hong Kong postal authorities for an automated postal system, including a ZIP code system. Hong Kong had not previously used a ZIP postal code. The system, covering all of Hong Kong, began operating in 1990.

NEC was also active in developing the Supervisory Control and Data Acquisition (SCADA) system for functions such as the automatic control of dam water and water for agricultural use. NEC delivered a large-scale agricultural water control system to Iraq in 1979, for example, the Iraq-Turkey interstate gas pipeline system in 1983, and an air pollution monitoring system for Sodegaura, Chiba Prefecture, in 1985. In 1988, NEC also developed an automatic AC power distribution system for Kyushu Electric Power Co., Inc., and a multipurpose street monitoring system for the Osaka Prefectural Government.

Concerning communications control systems, NEC developed and delivered various telecommunications network control systems to NTT, the NCCs, NHK Broadcasting, and the Japan National Railways. NEC was also commissioned to develop supervisory equipment for satellite communications base stations for Intelsat. The company also developed the Butics Series of building automation systems. NEC developed the large-size Butics GX Series in 1988 to coincide with construction of the NEC Super Tower Building in Tokyo, completed in January 1990. The

Butics GX Series made it possible to construct a building control system appropriate for an intelligent building.

In the field of education, NEC developed COLL-100, a classroom network system utilizing personal computers, in 1983. The system was well received in the marketplace. Its name was changed to PC Semi in 1984, and NEC subsequently installed many systems every year afterward. As of March 1989, a total of 1,300 sets of this system were sold.

5. Emergence of Personal Computers, and Development of Related Business

Emergence of Personal Computers

NEC was the earliest domestic manufacturer to commercialize personal computers, and quickly acquired an overwhelming share of the domestic market. The opportunity to move into personal computers was provided by the TK-80 training kit for microcomputers, prepared as a tool for expanding the sale of microprocessors.

In the mid-1970s, when microprocessors were first being marketed, it was difficult for potential customers to understand how to use them. Their applications were thus limited to machines such as cash registers and sewing machines. In August 1976, NEC marketed the TK-80, an assembly training kit for microcomputers. The CPU had an 8-bit microprocessor, a light emitting diode (LED) display, and a hexadecimal keyboard. Programming was also possible by using a machine language. NEC made special efforts to expand sales of the TK-80. A service center called Bit-INN, for example, was set up in the Akihabara section of Tokyo, where a great many discount home appliance stores were located. Technicians stationed there responded to technical questions from customers. Seminars were also held around Japan. Sales of the TK-80 proceeded at a faster pace than initially expected, with over 1,000 units being sold every month. The people visiting the Bit-INN were not only technicians, including those working with sewing machines and cameras. It soon also became a gathering place for university students and hobbyists as well, all searching for information. In a background of listening to the opinions of knowledgeable persons visiting Bit-INN, NEC moved forward with development of a personal-use computer loaded with the programming language BASIC. The code name for the computer was the PCX-1.

In September 1979, NEC marketed the PC-8001, its first personal computer. It retailed for 168,000 yen. The machine was the same one developed under the code name PCX-1. The PC-8001 was loaded with NEC's μ PD780 8-bit microprocessor, compatible with the Z80 of ZiLOG, Inc. The machine also used a version of BASIC developed for NEC by Microsoft Corporation. To appeal to a wide variety of customer applications, NEC also offered peripheral equipment such as a display monitor, data recorder, and floppy disk drive unit. From March 1978, NEC began opening NEC Microcomputer Shops—like a nationwide version of the Bit-INN concept—throughout Japan. The PC-8001 was marketed through the network of NEC Microcomputer Shops and the sales channels of New Nippon Electric Co., the company in charge of manufacturing the machine. The PC-8001 proved to be a very popular product. It recorded cumulative sales of about 250,000 units in the first three years after it was introduced. In effect, it raised the curtain on the personal computer era in Japan, and raised NEC to the leader's position in the domestic personal computer market.

Fine Sales Performance of PC-98

Once into 1981, domestic computer manufacturers such as Mitsubishi Electric and Fujitsu recognized that the personal computer boom would continue, and they began to enter the market. In the U.S. as well, in August 1981 IBM announced the IBM PC, a personal computer loaded with a 16-bit microprocessor, thus signaling that company's entrance to the personal computer business. As related previously, in July 1981 the Information Processing Business Group of NEC marketed the Personal Terminal N5200/05, the world's first computer terminal loaded with a 16-bit microprocessor. Then, in November 1981, New Nippon Electric marketed the home-use 8-bit personal computer PC-6001, and the Electron Device Business Group of NEC marketed the 8-bit PC-8801, the top-end model in the PC-8000 Series.

The 16-bit personal computer developed in two directions. One was the N5200 Series mentioned above, for business use. It was positioned just below office computers. It was a "closed" machine, and the company developed everything connected with the machine, from application software to peripheral equipment. The second direction was a higher rank 16-bit machine of the 8-bit PC-8000 Series. It could use abundant software assets written for the PC-8000 Series and its peripheral equipment was compatible with that series as well. Moreover, the development of application software and peripheral equipment could be commissioned to third parties. It was thus an "open" 16-bit machine.

The Information Processing Business Group was in charge of developing a 16-bit machine compatible with the PC-8000 Series. The main problem the group faced was the development of a version of BASIC for use with a 16-bit machine. Microsoft Corporation was approached at first, because it had developed the version of BASIC used with the PC-8001. But Microsoft could not respond immediately because of a shortage of programmers. Development of a compatible version of BASIC thus posed tremendous difficulties. In September 1982, however, the development work was completed. Fifty units of a prototype machine were loaned to third-party developers, and Microsoft agreed to allow NEC to use a compatible version of BASIC.

In these ways, the PC-9801 was introduced on October 13, 1982, as a high-speed personal computer equipped with the 16-bit microprocessor μ PD8086 (5MHz) compatible with Intel's i8086, and having 128K bytes (128KB; maximum of 640KB) of CPU memory. It could process Japanese language and had a color graphics display function. It retailed for 298,000 yen. Although initial expectations were for sales of 70,000 units/year, shipments proceeded at a monthly pace of 10,000 units.

If the PC-9801 were to tie to the company's later success, however, one more hurdle had to be overcome. The developing mainstream approach to personal computers was to load application software on top of the OS. The IBM PC, for example, was a BASIC machine using the BASIC programming system, and was also a DOS machine operated using MS-DOS developed by Microsoft. NEC decided to configure the PC-9801 so that ordinary customers could use it without being concerned about the OS. It did this by bundling MS-DOS on a floppy disk that contained the application software, thus making the PC-9801 a de facto DOS machine. There was concern about whether Microsoft would allow MS-DOS to be bundled, but Microsoft gave its permission through Vice President and Board Director Kazuhiko Nishi of Microsoft, without requesting any payment in return. It was in that background that the PC-9801F was marketed on October 13, 1983, with the standard model fitted with two 5-inch floppy disk drives and Chinese character ROM (Read Only Memory). The PC-9801 was thus introduced as a BASIC machine that maintained the advantage of compatibility with lower-end machines while also running as a DOS machine. That architecture enabled the PC-9801 to win an overwhelming share of the domestic personal computer market during the 1980s.

The PC-9800 Series was originally introduced as a desktop model. Later, however, laptop and notebook models were added to the line. As well, 32-bit models were introduced, and more peripheral equipment was made available, thus improving the product lineup. In October 1986, NEC marketed Japan's first laptop computer, the PC-98LT. As a world's first, it used a 640 x 400 dots, large-size LCD (Liquid Crystal Display). The PC-98XL[2] marketed in September 1987 was Japan's first 32-bit machine.

Although NEC thus assumed the lead in Japan's overall personal computer market, it fell behind other companies for the first time in the area of notebook computers. In July 1989, Toshiba marketed a notebook computer called the DynaBook. NEC, however, made a company-wide effort afterward to quickly develop a notebook product, and in November 1989 marketed the 98NOTE. Next, in May 1990, it marketed the 32-bit 98NOTE SX, and successfully assumed the lead position in the domestic market for notebook personal computers.

As of the end of March 1987, four-and one-half years after being marketed, the PC-9800 Series surpassed the mark of 1 million units in cumulative shipments. Since total shipments of personal computers of the dozen or so domestic computer manufacturers other than NEC were just over 1.5 million units, shipments of models in the single PC-9800 Series were tremendous. Among 16-bit machines, the PC-9800 Series held an overwhelming 90 percent share of the market at the time.

NEC had entered the U.S. personal computer market in 1981. After IBM marketed the IBM PC/AT in 1984, that machine assumed the position of de facto market standard in the U.S. personal computer market. Because NEC followed the PC-98 line domestically, there was concern in the company that marketing a PC/AT compatible machine overseas might have a negative influence on its domestic personal computer business. But in 1986, top management in NEC decided on a policy of using the standard architecture in each market. In April 1986, therefore, NEC marketed the APC IV, a PC/AT compatible machine, in the U.S., and in November 1986 also marketed a PC/AT compatible laptop, the MultiSpeed.

Home Electronics: Handling New Markets

New Nippon Electric had been in charge of the home electronics business of NEC, but had begun to lag behind other companies specializing in home electric appliances. In 1981, however, New Nippon Electric marketed the PC-6001, an 8-bit personal computer for hobbyists, thus opening the way to a new business area. In fiscal 1982, New Nippon Electric's sales of personal computers exceeded its sales of color television sets, its mainstay product up to then. Meanwhile, the information society was gradually developing and expectations were high for business opportunities in the area of "new home electronic appliances," the area in the home where systems interfaced with humans. NEC introduced the slogan "C&C in Every Home" in 1981, and began calling the former home electric appliances business the "home electronics business." Then, in July 1983, the name of New Nippon Electric was changed to NEC Home Electronics Co., Ltd., and in December of the same year, all of NEC's 8-bit personal computer business was integrated into NEC Home Electronics.

The MultiSync color display monitor for use with personal computers that NEC marketed in the U.S. in 1985 met the marketplace's needs precisely and became a best-selling product. With the technology available at the time, every time a display's resolution or other aspect of its graphic display function was improved, a new monitor was then needed to respond to the new graphic mode. The MultiSync color display monitor was developed with the concept of providing a monitor that would respond to any graphic mode. In the U.S., where the use of personal computers was expanding rapidly, 200,000 units of the MultiSync monitor were sold within only one year after introduction. In Europe as well, 140,000 units were sold in 1988, and the MultiSync monitor won an 80 percent market share.

6. Semiconductor Business Flourishes

Rapid Progress of Semiconductor Industry

In the second half of the 1970s, semiconductor memory underwent a change of generations from 4Kb to 16Kb DRAM. Once into 1980, Japanese-made 16Kb DRAM accounted for a 40 percent share of the world market. The balance in semiconductor trade between Japan and the U.S. shifted in favor of Japanese exports. This was a reversal in the previous semiconductor supply relationship between the two countries.

In a presentation at a seminar held in Washington, D.C., in the spring of 1980, a representative of Hewlett-Packard Company

(HP) said that Japanese-made 16Kb DRAM was being bought because "it is overwhelmingly superior in quality to U.S.-made DRAM." As that statement attested, the quality of Japanese semiconductor technology had steadily increased. In the background of the strong advance of Japanese semiconductor manufacturers was the establishment in 1976 of the VLSI Technology Research Association with capital provided by seven Japanese companies, including NEC, Toshiba, Fujitsu, Hitachi, and Mitsubishi Electric. Over a period of four years, some 70 billion yen was invested in a national effort to develop advanced technology.

After having taken the lead in 16Kb DRAM, Japanese companies assumed a position of superiority in the next-generation 64Kb DRAM market. In 1983, Japanese companies increased their share of the world 64Kb DRAM market to as high as 70 percent. In fact, from 1983 to 1984, the world semiconductor market experienced an unprecedented expansion, and semiconductor manufacturers invested aggressively in plant and equipment, which triggered a major negative effect. Besides a business recession in the U.S. from the summer of 1985 into 1986, the demand for VTRs cooled off at the same time that a shift was occurring to 256Kb DRAM. The price of memory fell rapidly, with the price of 64Kb DRAM drastically falling to about 20 percent of its peak price. Afterward, as 256Kb DRAM penetrated the market, demand increased again from 1987 to mid-1989 to a new peak. In these ways, the semiconductor industry in the 1980s, especially the DRAM market, underwent a series of phenomena called "silicon cycles," with companies investing aggressively in plant and equipment, a product oversupply occurring in the market, and then prices falling. Amidst this series of silicon cycles, companies in the Japanese semiconductor industry continued their capital investments at the same time that they tackled the development of new technology. As a result, the share of the world semiconductor market—in value of production—held by Japanese companies expanded from 30 percent in 1980 to 50 percent in 1989. The expansion of NEC's semiconductor business was particularly noteworthy. In 1985, it held about an 8 percent share of the world market, placing it in number one position among all semiconductor manufacturers. The company maintained that top position for the next six years.

Balanced Product Line Strategy

From the 1970s, NEC established local manufacturing companies in Ireland, Singapore, and Malaysia, and the company's production of semiconductors became more globalized. In the 1980s as well, NEC Electronics in the U.S. began the integrated production of 256Kb DRAM from October 1985, and NEC Semiconductors (UK) completed construction of a diffusion plant in 1987 and began producing 1Mb DRAM. Incidentally, NEC Semiconductors (UK) had a particularly auspicious beginning, for Her Majesty Queen Elizabeth II was the guest of honor at the ceremony marking the start of operations in 1983. NEC thus strengthened an integrated production system, centered on plants in Japan, the U.S., and Europe. In Singapore, NEC Electronics Singapore began producing 1Mb DRAM at its Ang Mo Kio Plant. NEC thus also bolstered its semiconductor production capabilities in Southeast Asia.

NEC also moved forward in putting its domestic semiconductor production system into order. Beginning with establishment of NEC Fukuoka and NEC Fukui in 1979, NEC established production companies one after another between then and 1988 in Kumamoto, Shiga, Yamaguchi, Oita, and Hiroshima prefectures.

Concerning new product development, a wide product line was developed in line with a balanced product line strategy. One of the new products that NEC tackled around this time was the system LSI. Demand had increased for application specific ICs (ASICs), which differed by customer, and it became an important task to promote system LSIs. Based on the approach of producing a "System on a Chip," NEC began the all-out development of system LSIs. From 1980, with the aims of providing the equipment essential for developing ASICs for each type of customer, and to support the efficient development and design of ASICs, the company established LSI design centers in Japan and overseas. By

1989, NEC had established seven design centers in Europe, six in the U.S., and four in Southeast Asia. The first center in Japan was the Kansai LSI Design Center established in 1984. By 1989, a total of nine design centers were opened, thus responding to the increase in demand for ASICs.

In the memory field, the move toward denser integration proceeded at an accelerated pace. Concerning DRAM, for example, five generations of products appeared between 1980 and 1989, starting with 64Kb in 1980, 256Kb in 1983, 1Mb in 1985, 4Mb in 1986, and 16Mb in 1989. Besides DRAM, NEC developed and marketed a wide variety of other memory products. A 256Kb Video RAM (VRAM) marketed in 1985 was used in personal computers for producing graphics and quickly became the de facto industry standard.

By 1974, NEC had developed 4-bit, 8-bit, and 16-bit microcomputers. The company promoted a line of original products and machines compatible with Intel products. Intel products, however, were fast becoming the de facto industry standard and Intel began adopting a strategy of preventing the entrance to the market of competitor companies by asserting its copyright on the microcode in microcomputers. In that situation, NEC signed a second-source agreement concerning microprocessor units (MPU) with Intel in 1976. In 1977, the company then developed the 8-bit μ COM-84 Family of microcomputers compatible with Intel's MCS-48 Family. NEC also continued promoting the development of original products. In 1979, for example, it introduced the 8-bit μ COM-87 Family, and in 1980, earlier than other companies, it used complementary MOS (CMOS) technology to develop the 4-bit μ COM-75 Family. In the field of 16-bit microcomputers as well, NEC introduced original and second-source products. Because of the market make-up, the demand was greater for compatibility in 16-bit than in 8-bit microcomputers.

In the second half of the 1970s, on the other hand, 16-bit microcomputers represented leading-edge technology, and it was thus necessary for NEC to develop original technology in order to raise its development capabilities. The μ COM-1600 Family that

NEC developed in 1978 realized a single chip 16-bit microprocessor, placing it at the world's highest technological level at the time. In 1982, NEC became the largest microcomputer manufacturer in the world in terms of units shipped, thus becoming one of the world's top suppliers. In that context, and because Intel became more hesitant concerning the second-source agreement between the two companies, NEC decided to concentrate on developing original products. In 1983, the company introduced the V20 and V30 16-bit microcomputers, the first models in the V Series of original microcomputers. From then until 1988 the company introduced a succession of new products in the V Series, and in January 1985 signed second-source agreements with Sony and Sharp. In 1986, it introduced Japan's first 32-bit microcomputer, the V60 model.

Two years previously, in 1984, an argument surfaced about the interpretation of intellectual property rights concerning the microcode stemming from the second-source agreement between NEC and Intel. In December 1984, NEC filed an appeal with the U.S. District Court for the Northern District of California asking for confirmation of the fact that its Models V20, V30, V40, and V50 did not infringe on Intel's copyright on the i8088 and i8086 microcodes. Intel filed counter charges, and the case became prolonged. In February 1989, the court finally ruled that NEC had not infringed on Intel's copyright. The court ruling that copyrights existed even in microcodes, however, made it impossible to manufacture Intel-compatible MPUs. The ruling thus had a major impact on the microcomputer industry. Immediately after the court ruling, NEC signed a technical agreement with MIPS Computer Systems, Inc., of the U.S. concerning the development, manufacture, and marketing of microcomputers using the Reduced Instructions Set Computer (RISC) OS for carrying out almost all instructions in a single clock cycle. NEC's aim was to cooperate with MIPS Computer Systems on a global scale. The company's first product using the RISC OS was the 32-bit VR3000 microcomputer marketed in September 1989.

Independence of Electronic Component Business Group

NEC's electronic components business originally started much as the semiconductor business did, to respond to in-company demand from the communications and other divisions. The business divisions that handled the electronic components business were the electron devices, switching systems, and R&D groups. In order to clarify the identity of the electronic components business, NEC in April 1982 introduced organizational reforms that included establishing an electronic component subgroup within the Electron Device Business Group, thus integrating the company's electronic components business. As the business expanded afterward, the subgroup was made independent in April 1988 as the Electronic Component Business Group. NEC then began conducting its business activities with three main business pillars: the electronic display business, the circuit technology appliance business, and the discrete component business.

Around this time, the greatest expectations in the electronic component business were placed on color liquid crystal displays (LCD). In 1986, Matsushita Electric Industrial Co., Ltd., Sharp Corporation, and Toshiba Corporation introduced color LCD television sets, and NEC thus was forced to catch up with them. In that situation, NEC decided to concentrate its color LCD business on efforts to develop a display for use with personal computers, and it moved quickly to develop a product. In July 1988, the company succeeded in developing a large-size color LCD. The next step was to develop the technology required for mass-producing the displays. In the Tokyo Business Show held in May 1989, NEC exhibited a laptop computer with a thin film transistor color LCD (TFT-LCD) panel that garnered much attention. The company later resolved the remaining technical problems related to mass-production, and in July 1990 began mass-producing TFT-LCD panels at a newly built plant in NEC Kagoshima.

In the circuit components business, NEC's tantalum solid electrolytic capacitors were highly regarded for their reliability, and NEC became one of the world's top manufacturers of that product. In 1989, NEC Technologies (Thailand) began producing the tantalum capacitors. Meanwhile, as the trend in printed wiring boards (PWBs) moved toward multi-layers, NEC Toyama increased its production five-fold, and moved all-out to enter the private-sector market.

Demand for the chip-in-glass fluorescent indicator panel (CIGFIP) with a built-in driver IC that NEC developed in 1987 increased rapidly for use aboard vehicles. In the area of microwave tubes, NEC developed a traveling wave tube for use aboard the CS-2 communications satellite in 1983. That product marked the company's entry into the traveling wave tube field in the satellite market. In the picture tube or CRT business, demand fell tremendously after restrictions were introduced on the export of television sets to the U.S. In 1984, NEC halted all domestic production of television picture tubes and concentrated instead on producing display monitors for products such as personal computers. In 1990, NEC transferred all its picture tube business to NEC Kansai.

Concerning laser products, based mainly on laser oscillators utilizing YAG (Yttrium Aluminum Garnet) optical crystals, NEC developed laser oscillators for medical use and commercialized laser equipment for practical applications such as welding and the processing of various electronic components. The company continuously maintained its top share in this market in Japan.

7. R&D System, and Management Reforms

"Dispersal and Concentration" of R&D Resources

As the integration of computers and communications progressed, NEC's R&D system came to require organizational reform. Key words that emerged during that discussion were "dispersal and concentration." Previously, R&D had been performed in three stages in NEC—in the Central Research Laboratories, the development divisions of the business groups, and the business divisions. As the company's business expanded, however—and as seen in C&C system products—as some business themes bridged several divisions, comprehensive R&D of multiple technologies came to be required. As well, the more effective use of dispersed resources became a critical issue. In that situation, the responsibility and activities for promoting R&D were dispersed, on the one hand, and some of the dispersed R&D activities were concentrated, on the other hand, through an intra-company research contract system and Core Technology Program that made them more efficient and provided them with direction.

In order to realize the greatest possible effect from the company's limited R&D resources, the Core Technology Program clarified the company's policy for R&D and the criteria for selecting R&D themes that the entire company should be involved in horizontally. This program was implemented starting in 1975. It was agreed that the technology that should be nurtured for the future was core technology, and it should be reviewed about every ten years.

In the second half of the 1980s, NEC moved forward with establishing new R&D bases domestically. In June 1987, for example, it relocated the ULSI (Ultra LSI) Research Laboratory to the Sagamihara Plant and established the Sagamihara Research Center. Next, in July 1989, it built the Tsukuba Research Center in Tsukuba Gakuen, Ibaraki Prefecture. Overseas, NEC Research Institute was established in Princeton, New Jersey, to conduct basic scientific research related to intelligence, such as human thought processes, language, and ways of expressing knowledge, as well as research into the physical sciences from an international perspective.

Sales System

Around the time that the long-term goals of NTTPC—to respond quickly to the demand for telephones, and to improve the quality of telephone service—were just about accomplished, NEC's principal market shifted from the public to the private sector, and then to overseas. As a result, sales of mass-produced items to meet private sector demand came to exceed sales of system products. NEC responded flexibly through a matrix organization to the need for sophisticated and specialized production and technology, on the one hand, and the need to produce different products for different markets for large-scale projects and mass-produced items. And for responding to domestic and overseas private sector demand, the company adopted a policy different from the one it formerly embraced when dealing with the public sector. The new approach emphasized drawing close to the particular regional society. Up to 1980, the company opened sales offices in every prefecture in Japan. As of the end of March 1984, NEC had 90 domestic sales offices organized into ten blocs. Overseas, meanwhile, the former system of conducting sales through agents was replaced by a system of sales subsidiaries. Between 1977 and 1984, a total of 20 sales subsidiaries were established in countries around the world.

From 1985, the nature of demand from the public sector changed. After NTTPC was privatized, it became necessary to conduct all-out sales activities by providing price discounts in addition to the regular quality service. For NEC this also meant quickly changing its approach to sales and breaking away from the mentality of a traditional NTT market vendor that emphasized competitiveness in performance over cost. From 1986, NTT began aggressively investing in telecommunications equipment, and in response NEC moved forward in strengthening its NTT Sales Group.

In private-sector sales, meanwhile, from 1985 the emphasis shifted from the previous sales of system products to corporations and large-volume customers to mass sales of products such as personal computers. The sale of telephone sets was also liberalized. Market characteristics changed to dealing with unspecified customers, satisfying diverse needs, competing aggressively in price, and providing products with short lifecycles. In order to respond to these market changes, NEC moved to reform its sales behavior. In 1987, NEC conducted a Check All the Customers Campaign to survey the degree of customer satisfaction toward the company's sales and service. After analyzing the results of the survey, the company then introduced measures to improve both sales and service activities. In that background, domestic sales to the private sector increased in 1989 to about double what they were in 1984. The percentage of total sales accounted for by domestic sales to the private sector also rose from about 50 percent in 1984 to about 67 percent in 1989.

Management Improvement Campaign

NEC's consolidated sales increased from 700 billion yen in fiscal 1977 to 1.76 trillion yen in fiscal 1983, a more than 2.5-fold increase. The company's organization also expanded rapidly, and capital investments became tremendous. In that situation, it became necessary to make the company's management even more efficient. In April 1983, NEC implemented a company-wide management improvement campaign called Challenge 200. The campaign's main goal was to strengthen the corporate structure and improve management efficiency by at least 200 percent by fiscal 1986. NEC carried out the campaign by appealing to all the companies in the NEC Group, including its local companies overseas. The aim was overall management improvement through a movement to make expenditures more efficient and through the annual NEC International ZD Convention, first held in 1982. Because of the rapid appreciation of the yen and sluggishness in the semiconductor market in 1985, the company experienced reduced profit for the first time in eight years as its business performance worsened. In those circumstances, NEC aimed for still greater efficiency and implemented Challenge 200 Part II from April 1986. Later, a Reduce the Overhead Cost Campaign and a New Champion Product Idea Contest were added to Challenge 200 Part II. Also, in 1989, as part of celebrating the company's 90th Anniversary, a "STEP UP 90 (Plus 10)" Campaign was introduced. Aimed mainly at increasing income, a goal was set of at least a 10 percent increase (Plus 10). As the company prepared to move into the 1990s, this new management improvement campaign was aimed at strengthening its management base.

The SWQC (Software Quality Control) Program implemented from 1981 aimed at improving the productivity of software development in the context of its increased importance as the company's C&C business developed. The SWQC Program was begun initially with 4,000 employees participating. By 1984, however, the number of participants had increased to 10,000, making it a large-scale, company-wide campaign. The campaign spread to affiliated companies from 1983. This campaign was effective as a policy for holding down software development expenses, making it possible to provide software that precisely met the needs of customers.

At the end of fiscal 1970, NEC had 14 subsidiaries in charge of sales, service, and production. By the end of fiscal 1980, that total increased to 47 companies, including six software companies, and at the end of fiscal 1985 the figure rose to 85 companies. Twenty-five of these companies were in charge of production, 28 were software companies, and 32 were sales/service companies. Overseas, meanwhile, the seven local companies in 1970 increased to 43 companies in 1985. Because of the increase in the number of subsidiaries, the total number of employees in the NEC Group increased from 56,000 at the end of fiscal 1975 to 96,000 at the end of fiscal 1985, more than a 70 percent increase. During the same period, the number of NEC employees increased by about 5,000, roughly a 15 percent increase. The percentage of total NEC Group employees accounted for by employees in the subsidiaries thus rose considerably. The increase in the number of subsidiaries brought advantages to the management of NEC, on the one hand, but also brought about certain problems, such as educational disparities depending on region and company, and non-conformity in information related to business planning and corporate behavior. In order to resolve such problems, NEC undertook a fundamental review of its system of training and education. In 1984, for example, the company clarified its basic philosophy for human resource development. It emphasized that the key to personal growth was to develop oneself, i.e., self-development. While expecting employees to make efforts to improve themselves through normal on-the-job development, the company supported those efforts through training and education and various other human resource systems.

The foundation of the C&C business of NEC that began with introduction of the C&C Concept in 1977 was firmed up by the late 1980s. The company's consolidated sales in fiscal 1980 were 1 trillion yen. They surpassed 2 trillion yen in fiscal 1984, and increased to 3.44 trillion yen in fiscal 1989, the year that NEC celebrated its 90th Anniversary. Profit for the year marked an all-time high of 85.2 billion yen.

Chapter 9

Development of C&C Business in Multimedia Society: 1990 – 1998

1. Burst of Bubble Economy, and Progress of Multimedia

Burst of Bubble Economy, and Borderless World Markets

The 1990s in Japan began with the burst of the bubble economy. At the end of 1989, the Nikkei average on the Tokyo Stock Exchange closed at 38,915 yen, its highest closing price in history. Beginning with the first trading day in 1990, however, stock prices fell rapidly. By August 1992 the Nikkei fell to 14,309 yen, roughly one-third of its peak level. Land prices also began declining from the summer of 1990, and by 1995 the official listed price of commercial property in Tokyo and Osaka had fallen to less than half of its peak level. In these ways the bubble economy, which had expanded premised on the seemingly increased value of assets, burst. Financial institutions shouldered huge amounts of irrecoverable debt and turned extremely prudent when lending to ordinary companies. Corporations curtailed their capital investments and began introducing workforce reductions. Although the Japanese economy recovered slightly in 1995-96, it recorded minus growth in 1997, only the second time since 1945, the first being in 1974. The economy thus decelerated again, and the sluggish economic performance became more prolonged than ever.

Around this same period, based on the Japan-U.S. Structural Impediments Initiative talks in June 1990, progress was made toward the full opening of Japan's markets. Together with the yen's rapid appreciation, liberalization brought about a rapid influx into Japan of inexpensive imported products. The yen, trading at 160 yen to the U.S. dollar in April 1990, appreciated at one point in 1995 to 80 yen per dollar. Labor costs in Japan rose to the highest international level, weakening the export competitiveness of Japanese corporations and delaying Japan's business recovery. This worsening of the conditions for conducting trade, together with the opening of worldwide markets based on market-economy principles and the collapse of the socialist economic system, was a link in the chain process of world markets becoming unified. Market economy principles called for ending the practice of Japanese business customs in the domestic market and abolishing barriers to market participation by overseas companies. This applied not only to the manufacturing industries but also to the financial, communications, and service industries as well, shaking the very foundation of Japanese companies. Borderless markets signified the beginning of an era in which companies could join the competition from countries that had overwhelmingly low cost as their main weapon. In the 1990s, moreover, a phenomenon called "price collapse" occurred in Japan, brought about by the appreciated yen and increasingly borderless competition. Many Japanese corporations restrained their domestic capital investments and shifted their production activities overseas, leading to a hollowing out of the Japanese economy.

Toward Multimedia, and Internet

New movements occurred in the information and communications markets as well. Although the economy was generally depressed, the domestic communications market continued to expand, supported by a rapid increase in the demand for cellular phones and expectations for the multimedia communications business. Especially notable moves were seen in the mobile communications market. In 1991, the personal digital cellular (PDC) system that utilized new frequency bands was specified as the unified standard for digital mobile telephony. In July 1992, the mobile communications division of NTT was made independent as NTT Mobile Communications Network, Inc. (today's NTT DoCoMo, Inc.), which from March 1993 began offering wireless voice and data communications services via the PDC system. During 1994, all the new common carriers (NCCs) also began offering PDC services. The number of mobile phone (cellular phone and car telephone) subscribers then increased tremendously every year, expanding from just over 2 million in March 1994 to over 20 million in March 1997, over 30 million in March 1998, and over 40 million to 41.5 million in March 1999. The even simpler Personal Handyphone System (PHS) service began in July 1995 from two groups—the NTT Personal Group and the DDI Pocket Group. By August 1997, the PHS service had 7 million subscribers. Eventually, the number of subscribers leveled off after PHS lost its competitiveness as mobile phones became smaller and their prices fell. From April 1994, moreover, mobile phones were sold outright rather than leased, and a large number of home appliance and other manufacturers entered the market. After NTT DoCoMo introduced its i-Mode mobile platform for wireless Internet connection in February 1999, the number of subscribers increased again, and competition became more severe.

From about 1985, the asynchronous transfer mode (ATM) backbone was introduced in the United States as a new communications technology appropriate for use with broadband integrated services digital networks (B-ISDN) for transmitting voice, video, and data information after dividing it among small, fixed-size cells and then re-assembling it at its final destination. It made possible the transmission of various types of information at ultra-high speeds. From 1989, NTT began developing a new switching system called the New Node System, centered on ATM switching equipment. Five years later, in 1994, NTT conducted joint-use multimedia communications experiments using ATM. Then, in 1995, the Telecommunications Standardization Sector of the International Telecommunications Union (ITU-T, formerly CCITT) recommended that ATM technology be used for realizing B-ISDN. In these ways, the conditions for promoting all-out multimedia communications were put into order.

In the computer marketplace, open systems were gradually offered to make it easier to connect different types of machines, and the networking of information systems moved a step forward. The downsizing of computers accelerated, and most newly built information systems moved away from concentrated to distributed systems centered around users and utilizing servers and personal computers. Between 1991 and 1995, the production value of general-purpose computers decreased tremendously from 1,457 billion yen to 515 billion yen. But the number of personal computers shipped increased from 1.9 million to 5.7 million units, and the production value of personal computers increased from 923 billion yen to 1,481 billion yen.

In the personal computer market, Compaq Computer Corporation of the U.S. introduced a computer in the Japanese market retailing for less than one-half the price of machines already on the market, thus signaling the start of a period of "price collapse." Microsoft Corporation marketed Windows95 in 1995 and use of that software quickly spread around the world, establishing it as the de facto global standard OS. The Internet, meanwhile, which tied together a mere 200 host computers in 1981, rapidly expanded as more people began using personal computers. In particular, use of the Internet expanded tremendously after Microsoft marketed Windows95. The number of host computers connected to the Internet, for example, roughly doubled from 6.6 million units in July 1995 to 12.88 million units in July 1996, the same month that NEC began providing its BIGLOBE multimedia service. The number of host computers linked in the Internet continued growing afterward as well, and in July 1999 surpassed 56 million units. The times became much more than a multimedia age upon arrival of the Internet society.

During this same period, the semiconductor market experienced a series of business fluctuations. In June 1991, Japan and the U.S. signed a new semiconductor agreement that set a clear numerical goal of 20 percent as the share of the Japanese market to be held by overseas companies by the end of 1992. Japan was thus requested to cooperate positively in avoiding trade frictions. In that situation, Intel Corporation, which had established an overwhelmingly strong position concerning MPUs for personal computers, passed NEC in share held of the world's semiconductor market and from 1992 moved into number one position. The share of the Japanese semiconductor market accounted for by overseas products increased to almost 30 percent in the fourth quarter of 1995. In the improved situation, the Japan-U.S. Semiconductor Agreement ended in July 1997. The principal reasons for the business fluctuations in the semiconductor market were the violent shifts in the demand for, and prices of, memory, centered on DRAMs. As Japanese semiconductor manufacturers struggled with the rapid fluctuations in the market, South Korean manufacturers rapidly increased their share of the memory market.

2. Management Strategy for Global Corporation

Corporate Philosophy and Management Commitment

Remnants of the bubble economy still permeated society in 1990: major negative factors affecting the business situation emerged, including sharp drops in the stock market and land prices. As one undertaking in the celebration of its 90th Anniversary in 1989, NEC had moved forward with construction of its new head office building, the NEC Super Tower, located in the Mita section of Tokyo, where the company was founded. The move to the new offices began in January 1990. The NEC Super Tower had 43 stories aboveground, and four stories underground. In order to resolve the wind problem always associated with high buildings, a huge wind hole called a "wind avenue" was provided in the center of the structure. The building gradually narrowed toward the higher-level floors, in a shape resembling a three-stage rocket. As an "intelligent building," fitted with state-of-the-art technologies and functions, the new building attracted much attention.

July 17, 1990, marked the 91st Anniversary of the company's founding. NEC kicked off the NEC Super 21 Campaign on that day, simultaneously introducing a new Corporate Philosophy and a Management Commitment, basic guidelines for conducting its business. The following is the exact wording used at that time and still in use when this history was written.

Corporate Philosophy

NEC strives through "C&C"
to help advance societies worldwide
toward deepened mutual understanding
and the fulfillment of human potential.

Management Commitment

NEC is committed to:

- Giving top priority to customer satisfaction through relentless efforts to provide better products and better services.
- Creating value and usefulness for society through the active exploration of new frontiers in the areas of science and technology.
- Tapping the individual uniqueness of each employee and realizing his or her fullest potential.
- Fostering the autonomous spirit of each group and affiliate, which adds to the integrated strength of the organization as a whole.
- Fulfilling its responsibilities as a corporate citizen.
- Increasing profitability to facilitate dynamic growth internally and to contribute to society at large.

C&C with built-in human elements was at the core of the corporate philosophy. Through the provision of information and communications systems, C&C would contribute to deepening a mutual understanding of how people around the world think. Realizing a deeper mutual appreciation of how other people think by helping them communicate with one another would then lead to creation of a more humanistic, more affluent society. NEC's Corporate Philosophy expressed the company's determination to contribute to humankind in those ways.

Based on the new Corporate Philosophy and Management Commitment, President Sekimoto emphasized "Holonic Management." He coined the word "holonic" by combining the Greek word "holos," meaning "whole" or "entire," and "on," meaning "one" or "individual," with the suffix "-ic," meaning "the art of," i.e., the art of management combining the one into the whole. NEC's business faced the contradicting trends of increasing diversification on the one hand and globalization on the other. The concept of holonic management thus expressed President Sekimoto's strong belief that it was essential for the individual components comprising the NEC Group—employees, subsidiaries, and overseas companies—to firmly grasp their individuality and then to integrate and harmonize themselves into the overall group.

In July 1992, NEC announced a new corporate identity (CI) program. Up until then, besides its registered Japanese name, "Nippon Electric," newspapers, magazines, and other media referred to NEC in various ways. The company decided in that situation to adopt a single "communications" name—"NEC." The names of the local production companies were also unified as "NEC" plus the location, such as NEC Tohoku, NEC Kagoshima and so forth. The company also changed the C&C slogan and the NEC logo, and adopted "C&C for Human Potential" as the C&C slogan. Whenever the NEC logo appeared it used the identical typeface and color. Blue was chosen because of the image it represented of the future, intelligence, and the environment, embracing water, air, and outer space.

After setting up NEC foundations in 1987 in the Philippines and Thailand, in March 1991 NEC established the NEC Foundation of America in the U.S. and began offering a wide range of support activities, including an international exchange program for middle- and high-school students, education grants in the areas of science and technology, a program for rehabilitating disabled persons, university scholarships in the areas of science and technology, and research grants. Also, because social expectations toward corporations were growing increasingly stronger in the areas of the global environment and preservation of the natural environment in regional societies, NEC in November 1991 introduced a set of "NEC Environmental Principles," and created a related set of behavioral guidelines.

C&C Business Structure

On a consolidated basis, NEC's sales in fiscal 1977 were about 700 billion yen. In fiscal 1990, they increased to about 3,700 billion yen, more than a five-fold increase. Viewed by product, sales of communications equipment increased four-fold and semiconductors increased five-fold while sales of computers increased by over 12-fold. From fiscal 1984, in fact, the percentage of total sales accounted for by computers also was higher each year than that for communications equipment. At any rate, the promotion of C&C business brought about a wide and deep expansion of NEC's business competences.

In response to the expansion in business scale and the changes in the types of business it was conducting, NEC introduced wide-scale organizational reforms in 1991 and 1993. In July 1991, the vertical structure that previously comprised its business groups and in which the company had conducted its business with emphasis on products and technology was changed to a horizontal structure with emphasis on markets and customers. The aim was to avoid structural inefficiencies resulting from several divisions being involved in servicing the same customer, and an overlapping in the investment of management resources, especially in new product development. Based on the foregoing approach, all the business groups except those for semiconductors and electronic components were reorganized by market. The C&C Product Technologies Business Group resulted from the merger of mainly the switching, transmission, radio, and industrial systems groups concentrated on NTT and other government markets; the C&C Systems Business Group, mainly comprising the systems business and computer business of the information processing business group, concentrated on private sector corporations; and the Personal C&C Business Group, formed by consolidating the private-sector, mass-volume sales divisions, specializing in such products as personal computers and mobile phones, concentrated on the mass-volume sales market.

NEC introduced an Operations Unit System in July 1993. By this time, the company had shifted a large portion of its production activities to domestic subsidiaries and overseas production bases. Most of those plants handled products for several of the company's business divisions, and it was thus difficult to control production operations based on the thinking of a single business division. There were close to 300 divisions at the business division level, moreover, making business management increasingly difficult throughout the company. Under the Operations Unit System, closely related business divisions were grouped together as operations units and made into profit centers. Each business group had several operations units. The head of each operations unit set business goals for the unit and was given authority and responsibility for the unit's personnel, organization, and management resources. Initially, 18 operations units were established; by March 2000, the number was increased to 22.

Hisashi Kaneko Assumes Presidency

Changes in top management were introduced in May 1988. Koji Kobayashi, president from 1964 to 1976 and chairman from 1976, was appointed counselor and member of the board. At the same time, the Board of Directors recognized his tremendous contributions to the company and conferred on him the title of Chairman Emeritus, a lifetime title. Vice Chairman Atsuyoshi Ouchi, who headed the semiconductor and personal computer businesses for

Kenzo Nakamura
Nakamura was chairman from June 1990 to June 1994. He headed NEC's administrative functions, including finance, controller and subsidiary management, and contributed to the improvement of the NEC Group's financial strength.

Hisashi Kaneko
Kaneko was president from June 1994 to March 1999. He studied at the University of California with a Fulbright scholarship from 1960 to 1962, was a researcher at Bell Telephone Laboratories in the U.S. from 1968 to 1970, and from 1989 to 1993 was president of NEC America. Kaneko demonstrated his rich international experience during his leadership.

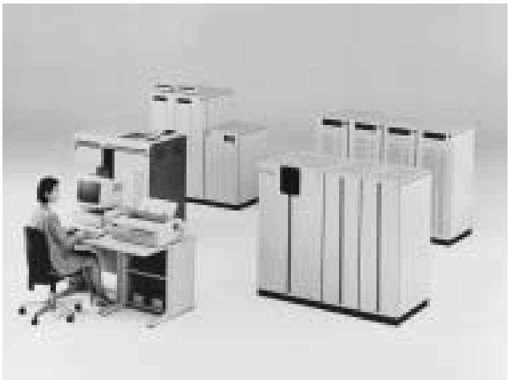
The new Head Office of NEC, the NEC Super Tower, was completed in early 1990 as the core of the company's 90th anniversary commemorative projects.

NEC began from 1992 to develop the NEAX61Σ as a new platform, in order to provide greater system openness and to support the demand for multimedia service for an advanced information age.

NEC actively established joint ventures in China to contribute toward modernizing Chinese industry. In 1994, President Jiang Zemin (left) visited the joint venture Tianjin NEC Electronics & Communications Industry Co., Ltd. (above).

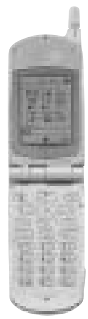
In 1994 NEC was awarded a contract from Sprint in the U.S. to build a large-scale synchronous optical network (SONET), the American version of SDH.

In 1993 a multinational consortium that included NEC was awarded a contract to build a 7,746-kilometer SDH digital microwave communications line linking Moscow and Khabarovsk.



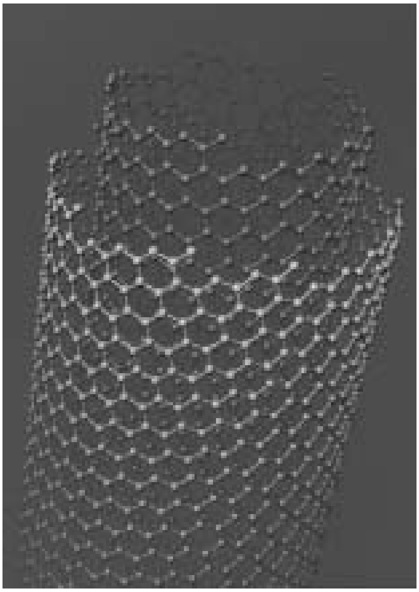
NEC announced in 1994 the Model PX7500 of the Parallel ACOS Series. This series featured reduced cost by using a single-chip CMOS processor, and high speed by using several processors to conduct parallel processing.

In 1997, NEC marketed the VALUESTAR NX Series, within the family of PC98-NX Series personal computers, which incorporated specifications listed in the PC97 and PC98 publications.



After NTT DoCoMo began its i-Mode Internet access service for cellular phones, NEC developed the Digital Mova N501i HYPER in February 1999. A folding type phone with a large display for showing more information than previously, the new phone became a best-selling product.

NEC's semiconductor business group introduced a series of management streamlining movements that aimed for product quality control and improved productivity. Its efforts resulted in NEC being presented in early 1997 the first Japan Quality Award, established by the Japan Productivity Center for Socio-Economic Development.



Dr. Sumio Iijima, Senior Research Fellow of NEC, discovered the carbon nanotube in 1991. Because of its ultra-fine crystal structure (left), the carbon nanotube is expected to contribute to making electronic devices smaller. Dr. Iijima gave a Friday Evening Discourse lecture (above) about carbon nanotubes at the Royal Institution of Great Britain in 1997.

NEC people throughout the world started in 1999 to join a proactive annual volunteer program called "NEC Make a Difference Day." Popular activities include Christmas visits with presents to orphanages (top: NEC Chile) and environmental cleanups (bottom: NEC Australia employees at the Manton Dam).

many years, was promoted to chairman. Next, in June 1990, Chairman Ouchi was appointed counselor and Vice Chairman Kenzo Nakamura was promoted to chairman.

June 1994 saw further top management changes at NEC. Executive Vice President Hisashi Kaneko assumed the presidency, and Chairman Nakamura was appointed counselor and member of the board. Tadahiro Sekimoto, president for 14 years from 1980, became chairman. President Kaneko joined NEC in 1956. He studied at the University of California with a Fulbright scholarship from 1960 to 1962, and from 1968 to 1970 he was a researcher at Bell Telephone Laboratories in the U.S. He was appointed associate senior vice president and member of the board in 1985, senior vice president in 1989, and executive vice president in 1991. From 1989 to 1993 he also served as president of NEC America, Inc.

Is his first greeting to NEC's employees, President Kaneko prefaced his speech with a discussion of how the trends toward multimedia and networking were proceeding on a global scale. He then introduced five priority policy items he intended to emphasize as president: (1) a great leap forward in the information and multimedia fields; (2) all-out efforts oriented toward improved customer satisfaction (CS); (3) strengthened technological innovations; (4) becoming a global corporation; and (5) constant pursuit of reforms in management.

International Business, and Strategic Alliances

Several negative factors affected NEC's international business, including the yen's rapid appreciation in the second half of the 1980s and excessive investments during the years of the bubble economy. In 1990, many of NEC's overseas companies reported deficits in their business operations, affected by the stagnant business situation in the Western countries and a global computer recession. NEC thus faced the urgent task of strengthening the management of those companies.

The International Business Group moved to reduce the overseas workforce by 30 percent by fiscal 1992 compared to what it was at the end of fiscal 1989. It also moved to slim its organization considerably by reducing the number of divisions inside the business group from 31 in 1990 to 23 in 1993. As well, to unify its control over international operations, it established regional headquarters companies such as NEC USA in the U.S. in 1989 and NEC Europe in the U.K. in 1993. As a result of taking these steps, the overseas companies all returned to profitable operations from 1994.

From 1993 to 1995, NEC's overseas companies once again marked a powerful expansion in their business. The motive power for that expansion, in the background of favorable demand for OA equipment and personal computers that began in 1993, centered on the U.S. market, was the semiconductor business. Personal computers and related peripheral equipment also sold well in the U.S. Asian markets, meanwhile, expanded rapidly in the context of moves toward deregulation, and NEC invested aggressively in China-related business undertakings. In scale of business as well, consolidated international sales were 794 billion yen in fiscal 1991, exceeded 1 trillion yen in fiscal 1994, and expanded in fiscal 1997 to about 1.16 trillion yen.

In the 1990s, NEC placed special emphasis in its international operations on business in China. On the occasion of a request from China in 1985 for technical cooperation related to electronic switching systems and LSIs, NEC signed joint agreements in 1988 with the Tianjin and Beijing municipal authorities concerning, respectively, electronic switching systems and LSIs. Based on those agreements, NEC and Beijing Shougang Co., Ltd., established the joint venture Shougang NEC Electronics Co., Ltd. (Shougang NEC), in December 1991 for producing and marketing LSIs. A month later, in January 1992, NEC and Tianjin Zhonghuan Electronics Computer Corporation established the joint venture Tianjin NEC Electronics & Communications Industry Co., Ltd., for producing and marketing electronic switching systems and related components. Afterward, business operations in China expanded into various fields. As of the end of 1998, NEC had 19 local companies in China, including NEC (China) Co., Ltd., established in November 1996 as a regional headquarters company located in Beijing.

Increasingly severe competition and rapid changes in the market environment negatively affected businesses related to communications, computers, and semiconductors. Once into the 1990s, companies in those fields began actively promoting global strategic alliances as a strategy for responding to the tougher competition. For its part, NEC also aggressively promoted strategic alliances with influential overseas companies in various business fields. One of the earliest such alliances was in the semiconductor business, a business field faced with a need to ease trade frictions. In March 1990, NEC agreed with AT&T Microelectronics Inc. (AT&T-ME, later Lucent Technologies, Inc.), the electron devices division of AT&T, to cooperate over a wide area concerning semiconductor products and technology, including some commissioned production. NEC also moved forward from 1994 with Samsung Electronics, Co., Ltd., to exchange and provide technology related to DRAMs and microcomputers. In China, besides the previously mentioned joint venture, Shougang NEC, NEC also established two other joint venture companies: Shanghai Hua Hong NEC Electronics Co., Ltd., was established in July 1997 for producing and marketing LSIs; and Beijing Hua Hong NEC IC Design Co., Ltd., was established in June 1998 for designing LSIs.

In the computer field, NEC strengthened its business relations with Groupe Bull of France. In response to a request from Bull to have NEC convert the shares it held of Bull HN into equity in Bull, in July 1991 NEC released its shares in Bull HN and participated in Compagnie des Machines Bull (CMB, the holding company of Bull) with 4.7 percent equity. Next, in December 1993, NEC entered into a strategic partnership with Bull in the fields of computers, communications, and semiconductors. During Bull's first stage of privatization in September 1995, moreover, NEC responded positively to a capital increase and raised its equity to 17 percent, thus becoming a major shareholder in Bull along with Motorola, Inc., and France Telecom. NEC also participated in the second stage of Bull's privatization in February 1997, providing more capital and raising its equity to 18.6 percent. NEC and Bull agreed during this same period, in February 1995, to jointly develop a next-generation general-purpose computer. NEC also began providing Bull with ATM switching systems on an OEM basis from February 1997.

In the personal computer field, NEC agreed with Packard Bell Electronics, Inc. (PB), of the U.S. in July 1995, to establish a strategic alliance, and participated in PB with equity. At the time, PB maintained extensive retailer channels and held almost a 50 percent share of the home market for personal computers. It had grown rapidly and was approaching number one position in the overall personal computer market. Bull was particularly strong in the European market, and PB established a business relationship with Bull in the personal computer field. NEC, meanwhile, had a firm foundation in the Japanese personal computer market with its PC-98 Series, and enjoyed a degree of success in the U.S. market for business-use personal computers. NEC thus already had a complementary relationship with PB in terms of products and markets. In July 1996, all the personal computer operations of NEC Technologies, Inc., in the U.S. were consolidated in PB, and the company's name was changed to Packard Bell NEC, Inc. (PBN). The partners held great expectations that this worldwide business relationship in the major personal computer markets of Japan, the U.S., and Europe would strengthen them in developing their overseas personal computer business. In the U.S. personal computer market, however, new companies such as Compaq Computer and Dell Computer brought about rapid market changes in what can be called production and distribution revolutions. Because PBN depended on traditional production and distribution systems, it was forced to fight a tough battle. Despite a series of new capital investments, and NEC eventually taking over complete control of the company, the company's business performance continued to falter and the company was forced to record an enormous loss.

3. C&C Product Technologies Business

Switching and Mobile Communications Business

NEC's product strategy for the switching systems business in the 1990s was to use the NEAX61 digital switching system, installed widely around the world in the 1980s, as a common platform and promote its further use in the domestic and overseas markets by energetically developing products applying new technology that anticipated customer needs.

The first system using the NEAX61 as its platform was a paging system delivered to a local NCC in 1987. During the 1990s, NEC also used the NEAX61 for the platform in developing systems for mobile phones for long-distance NCCs as well as systems for use with PHS.

As foreign governments introduced liberalization policies in the telecommunications field, overseas markets expanded. In that context, NEC marketed new products to bolster the functions of the NEAX61 and succeeded in increasing its market share. Orders increased from existing markets in China, Brazil, the Philippines, Argentina, and Malaysia, and other orders came from new markets in Iran, Russia, Indonesia, and Vietnam. NEC also established local production companies in Russia, Indonesia, and Vietnam. As a result of these various activities, by the end of 1997 NEC had delivered NEAX61 systems to customers in 77 countries, totaling 60 million lines.

Among the new products and systems that NEC developed and commercialized during this period were the Intelligent Network (IN) system and ATM switching system. The company developed the IN system in response to the increasing sophistication and diversification required for providing telecommunications services. In this system, the switching and service functions of traditional switching systems were separated so that an external computer provided the service function. Telecom New Zealand Limited awarded NEC a contract for an Advanced Intelligent Network (AIN) System that it delivered at the end of 1991. This system was used from July 1992 to provide commercial services such as free dialing. In the domestic market, NEC cooperated with Kokusai Denshin Denwa (KDD, later KDDI: DDI Corporation) to develop a new switching system using an IN system, and delivered it in January 1992. NEC also delivered an IN system in March 1995 to Japan Telecom (JT) to assist that company in responding to increased competition in providing services.

As multimedia became more popular, ATM technology took center stage. NEC began in 1986 to study the feasibility of developing an ATM switching system for export to the U.S. The company exhibited a prototype ATM switching system at Telecom 91 in Geneva where it attracted much attention. Based on that prototype, NEC then developed the small- to medium-capacity Model 10 ATM switching system in 1992 using the NEAX61 as the platform. The company delivered the first model to WilTel (Williams Telecommunications Company; later Williams Communications Group, Inc.) in the U.S. NEC next developed the large-capacity Model 20 in 1995 and delivered it to Sprint Corporation in the U.S. as the ATOMNET/M20 model.

Domestically, NTT promoted development of an ATM switching system in joint research with Japanese telecommunications equipment manufacturers. In 1994, NEC delivered the first commercial-use model of the ATM switching New Node system. NTT, meanwhile, promoted the development of a Multimedia Handling Node (MHN) system capable of responding to various types of services. The MHN system was commercialized as the NS8000 Series. NEC delivered its first such system in 1996.

As a successor to the NEAX61, NEC began to develop the NEAX61Σ as a new platform from 1992, in response to the demand for multimedia service and the personal communications age. The principal features of the NEAX61Σ were its expanded functionality because it used a RISC processor, reduced cost, and greater system openness from using a UNIX-based OS. It also used an ATM node system for communication between processors, thus providing support for multimedia services. The first NEAX61Σ model was shipped in March 1994 to DDI (later KDDI).

Besides the domestic market, the NEAX61Σ also won a fine reputation in China and other overseas markets.

Competition Intensifies in Transmission Market

In the transmission market, where optical communications had become much more common, the Synchronous Digital Hierarchy (SDH) had become the international standard for multiple transmission and it was used widely around the world. As NEC moved to expand its business in this market, it also promoted its response to the newly emerged ATM transmission system.

In 1988, with an eye on future services such as B-ISDN, CCITT defined SDH as the international standard connection protocol for synchronous digital transmission between networks. NEC developed new synchronous digital transmission equipment in the short period of about two years and delivered it to NTT in 1989 as the world's first commercialized system conforming to SDH standards. NTT purchased many of these systems for use in its trunk transmission lines. That system was actually the first step taken in Japan toward construction of a B-ISDN. In 1995, NEC delivered an F-10G optical multiplexer with a 10Gb per second transmission capability.

In the U.S., customers began introducing synchronous optical networks (SONET), the American version of SDH, from 1989. NEC ran into difficulties in developing a synchronous digital system for export to the U.S. As a result, it lost much of its share of the U.S. optical communications systems market. NEC moved energetically to construct SDH networks in countries other than in the U.S., however, and was awarded SDH contracts in countries such as Australia and Kuwait in 1992 and in Brunei and Brazil in 1993. In 1994, the company was awarded a long-term, comprehensive contract in Singapore, and a contract from Sprint in the U.S. for a large-scale SDH network covering the entire country. That contract allowed NEC to recover its U.S. market share. Afterward as well, NEC won large-scale contracts for SDH networks in Poland in 1995, and in Russia in 1995 and 1997. Also in 1997, AT&T awarded NEC a contract for a similar large-scale SDH network.

NEC also tackled the development of ATM systems, a new type of transmission method. The company also cooperated with NTT by supplying the necessary equipment when NTT began its multimedia communications common-use experiment in 1994. In 1996, it delivered to NTT a commercial-use ATM cross-connect system called the ATM-XC.

From 1994, the private-sector market expanded considerably, especially demand from the NCCs and private corporations. To respond to that demand, NEC redesigned an SDH system originally developed for NTT so that it could be used for small stations. It also developed and marketed a Network Operation System (NOS) for controlling and operating SDH systems and dedicated line transmission equipment. In the PHS market as well, where demand had rapidly increased, NEC developed and marketed a star-type PHS access system comprised of PHS switching equipment and radio base stations connected via optical transmission.

Submarine cables, meanwhile, had shifted to using optic fibers. Laying of the SEA-ME-WE2 (Southeast Asia-Middle East-West Europe) fiber optic submarine cable across the Indian Ocean in 1994 tied the East and West together and completed an around-the-world fiber optic cable connection. Around this same time, private cables were being laid one after another, and competition intensified among system suppliers to win contracts. NEC participated from the beginning in the fiber optic North Pacific Cable (NPC) plan, completed in 1991. NEC was awarded the contract jointly with STC of the U.K. and built a system 8,400 kilometers long with a capacity of 17,000 lines. In the FLAG Cable project, meanwhile, which connected the U.K. and Japan through 11 landing points on three continents, NEC worked jointly with KDD Submarine Cable Systems Co. as a member of the supplier group.

NEC also developed an optical amplifier cable system utilizing optical amplifiers in the repeaters. After delivering optical amplifier repeaters to NTT in 1994, NEC delivered similar equipment to KDD for a series of international submarine cable projects, including TPC-5, the fifth transpacific submarine cable network.

Wireless Communications Systems

In the 1990s, SDH became the mainstay system in the microwave communications business as well. In Japan, NEC delivered numerous SDH microwave communications systems not only to NTT but also to DDI, one of the main NCCs. In 1992, after developing entrance-line radio equipment for DoCoMo, NEC used that equipment as the base and developed equipment for other mobile communications carriers to use for communications between base stations. For export as well, NEC developed equipment for SDH systems for long- and short-distance lines. From 1992, NEC exported this equipment to Brazil, Russia, Saudi Arabia, Sweden, the Philippines, and other countries. As of the end of March 1995, a cumulative total of over 3,400 units were exported. In 1993, a multinational group that included NEC, Sumitomo Corporation, and Siemens AG was awarded a contract from OAO Rostelecom of Russia to build a 7,746-kilometer SDH digital microwave communications line called the "Trans-Siberian Line," one of the world's longest, linking Moscow and Khabarovsk. The entire line was completed in 1996; NEC delivered a total of 1,582 transmitter-receivers to 92 stations between Novosibirsk and Khabarovsk.

Concerning satellite communications, Intelsat began commercial operation in 1990 of satellite communications using the Satellite Switched Time Division Multiple Access (SSTDMA) system. Between 1989 and 1991, NEC delivered SSTDMA systems to standard stations in Sweden, the U.S., China, Germany, and other countries. In Spain, where the 1992 Barcelona Olympics were held, NEC delivered a total of 185 earth stations by July 1992. NEC also built a large-capacity Intelsat satellite communications earth station in Brazil, completed in January 1995. In 1990, the International Maritime Satellite Organization (Inmarsat) announced its Inmarsat-M System plan to use mobile satellites (MSAT) to digitalize its service. NEC developed the M terminal, a very small mobile terminal, for use in the Inmarsat-M System, and by the end of March 1995 had shipped almost 1,000 terminals to Inmarsat. In Japan, because satellite communications systems are dependable even in disasters, a great many systems were installed following the Great Hanshin-Awaji Earthquake (the Kobe Earthquake) of January 1995. NEC won orders for 52 systems, including a distance education system for the Ministry of Education, a distance teleradiotherapy system for the Ministry of Posts and Telecommunications, and a satellite communications system for the National Police Agency. Most of those systems were completed within a short period of about six months.

In the space development business, the satellite market was liberalized in June 1990, and equal treatment was given to domestic and overseas suppliers concerning procurements related to practical satellites such as those used for communications, broadcasting, and observation. Besides making the most of its wealth of experience and accumulated technology, NEC also tackled the development of new leading-edge technology. That led to the development and delivery of many new satellites. The GEOTAIL launched in 1992, weighing about one ton, was Japan's largest scientific satellite at the time. Its objective was to observe the earth's magnetotail. Also, the Yuri-3a (BS-3a) and 3b (BS-3b) satellites launched in 1990 and 1991, were commercial broadcasting satellites, putting Japan ahead of other countries in this field and signaling the start of the all-out satellite broadcasting age in Japan.

In the broadcast and video field, digital terrestrial broadcasting began in Japan and other countries. In 1995, NEC developed a new type of digital television repeater equipment, the world's first, and delivered it to NHK. In 1997, NEC was also the first in the world to develop commercial-use digital terrestrial television broadcasting equipment. The company won an order from a terrestrial television broadcasting station in the U.K. Also, when Japan Satellite Broadcasting, Inc. (JSB, later WOWOW INC.), began providing a satellite broadcasting service in April 1991, a scramble system was used for pay-as-you-watch broadcasting. In February 1990, NEC delivered a prototype descrambler to JSB. Next, in October 1996, PerfecTV (today's Sky PerfecTV, SKY Perfect Communications Inc.) began providing Japan's first digital satellite broadcasting, and NEC developed the digital tuner for PerfecTV.

Control Systems Business

Together with organizational changes implemented in 1991, the C&C Product Technologies Group began handling NEC's business related to control systems. In the measurement and control systems sector, NEC entered the Intelligent Telecontrollers (ITC) market for supervisory control of electric power systems, a market formerly a monopoly of the heavy electric machinery companies. It delivered ITC systems to Tohoku Electric Power Co. in 1992 and Kansai Electric Power Co. in 1997. From 1994, meanwhile, the Ministry of Posts and Telecommunications began studying a new mail processing system, including the use of a seven-digit ZIP code and a bar code for reading the Japanese characters in delivery addresses. NEC and Toshiba cooperated with the ministry to develop the necessary technology. In 1997, NEC completed development of the NAS-100 mail-sorting equipment for use in the new system. In total, the company received orders for 100 units of the NAS-100.

The central equipment in communications control systems comprised Network Management Systems (NMS), building automation systems, and educational systems such as PC Semi that used personal computers. In 1990, NEC developed and marketed the Administration & Control System for C&C Networks (ACTNET), a series of control systems offering maximum expandability and conforming closely to international standards. Based on the ACTNET series, NEC developed a comprehensive mobile communications operation system for NTT DoCoMo and delivered it in 1991. The company also developed and marketed several advanced versions of its PC Semi series. In 1997, NEC introduced its PC Semi XE2 series for middle and high schools. That marked 14 years since the company introduced its first PC Semi system. At that point, the company had shipped a cumulative total of about 300,000 systems to about 11,000 customers.

4. C&C Systems Business, and Computer Business

Promotion of System Integration Business

Advances in networking and greater openness in the areas of information and communications during the 1990s turned the systems business, in which companies previously provided services based mainly on their proprietary computers, into a solutions business that provided solutions to customers in a multi-vendor environment. Customer requirements came first, in other words, and that might mean using equipment made by other companies as well as your own company's equipment. On the premise that it also improved the performance of its own equipment, the times forced companies to compete with overall capabilities for multi-vendor system configurations and software technology, i.e., with system integration (SI) technology.

One of the aims of the C&C Systems Group established during the company-wide structural reforms of 1991 was reinforcement of the SI business. And then in 1993, when NEC introduced the Operations Unit System, a solutions subgroup and a computer subgroup were set up—a clear statement that providing solutions was basic to the company's systems business. When the company reorganized the business groups again in July 1994, the C&C Systems Group and the Computer Business Group were split off, the former handling the solutions business and the latter handling computer products.

Once into the second half of the 1990s, NEC's SI business developed considerably through alliances and establishment of local companies in other countries. In April 1995, for example, NEC formed an alliance with Marcam Corporation of the U.S. NEC's aim in that alliance was to use Marcam's object-oriented technology (OT) in its SI business operations.

Next, in 1996, NEC opened a software development center in India in August, and in November established NEC Systems Integration (China) Co., Ltd., in Beijing for carrying out SI business.

In February 1997, moreover, NEC and Hewlett-Packard Japan, Ltd. (HP Japan), agreed to cooperate in the SI business related to constructing large-scale basic systems that were open and based on UNIX servers. This agreement also led to a closer business relationship between NEC and HP in the U.S.

NEC began moving all-out in the SI business after announcing its Solution 21 policy in April 1992, a policy that systematized the company's thinking about providing solutions in response to the age of client-server systems.

Based on guidelines outlined in Solution 21, NEC developed the business of providing various kinds of solutions to its customers. In particular, it commercialized six types of SI services in 1994, including an Internet construction service to support the construction and utilization of Internet systems for corporations and government offices, a security consulting service, and an Internet server construction service. The company marketed groupware called StarOffice in 1995. Within a year, StarOffice was being used with 2,500 servers and 140,000 clients. Next, in 1996, NEC marketed a series of software products for providing solutions, including StarEnterprise, next-generation corporateware for constructing corporate information systems in an Internet and/or intranet environment, and StarCommerce, a solution framework for Internet-oriented electronic commerce (EC).

In September 1997, at NEC Express World '97, President Kaneko introduced his vision of the next stage of the information age, emphasizing "Empowerment through WebComputing." He proposed the construction of a system that would make it possible to expand man's intellectual capabilities and creativity by gathering together and utilizing knowledge and know-how through networking. NEC's WebComputingFramework, a new system configuration constructed to make that vision a reality, merged Internet technology and distributed OT as it aimed for WebComputing that would make it possible to easily link all kinds of computer systems. NEC then began providing a series of products and system construction services comprising widespread solution packages based on WebComputingFramework.

Development of Computers in Age of Open Systems

In the computer field at the beginning of the 1990s, networking developed further and customers demanded easier connections and greater compatibility between systems, leading to more emphasis on a strategy of open systems. Downsizing also progressed further, and rather than concentrating the information processing function in the host computer, it became more efficient—and much more convenient—to have that function distributed among servers located near the end-users.

The strongest influence from networking, downsizing, and openness was felt in what formerly were called office computers. Client-server systems reflected all three of those elements. They took over the area of small-size computer systems in offices and rapidly replaced the former mainframes and the office computer systems used for concentrated processing. In November 1994, NEC marketed the Express5800 Series of high-performance servers, and won great success in the market for open servers. From 1995, this series maintained the top share of the domestic market for small servers, thus providing strong support for NEC's computer business.

As companies gradually moved toward using open client-server systems, the outlook was that those systems would also be introduced into their core operations areas, and expectations were great for an expansion of the demand for large-size UNIX servers offering performance on a par with general-purpose computers. Anticipating those market needs, NEC and HP signed an agreement in February 1995 for ties in the area of large-size UNIX servers. The two companies wanted to develop new business by mutually benefiting from each other's experience and technology. NEC had general-purpose computer technology and experience in marketing systems, and HP had open systems technology. Later, NEC expanded its relationship with HP further, and in June 1996 the two companies also agreed to ties in the field of distributed OT. NEC and HP also decided in March 1997 to jointly develop the HP-UX, for using the 64-bit UNIX OS. Then, in October 1997, Hitachi agreed to cooperate in a joint project with NEC and

HP to utilize mainframe-based technology in the HP-UX and increase its performance and reliability. Two months later, in December, NEC and HP agreed to new technical ties in developing a scientific-technical calculation server.

The ultra-large general-purpose computer, the ACOS System 3800, that NEC marketed in July 1990 had the world's fastest performance at the time and served to raise NEC's position in the ultra-large computer market in a single leap. The trend toward downsizing and openness, however, also affected the general-purpose computer field. Customers, moreover, in the context of the recession following the burst of the economic bubble, increasingly emphasized price. In that situation, NEC adopted a development policy for the next models in the ACOS Series that focused on a greatly improved price-performance ratio. In place of the bipolar device with its superior high-speed performance, therefore, NEC used a CMOS device with outstanding high-density, low power consumption, and low cost features. Besides using a single-chip CMOS processor to reduce cost, several processors were used to conduct parallel processing and thus develop the high-performance Parallel ACOS Series. After marketing the AX7300, the small model in the Parallel ACOS Series, in May 1994, NEC then marketed the large-size PX7800 in December. With introduction of the ultra-large PX7900 in March 1996, this series became the first general-purpose parallel computers in the world to offer a full product lineup. During this same period, NEC signed an agreement in February 1995 with Groupe Bull of France to jointly develop an ultra-large computer, and joint work on that project moved forward. For the Parallel ACOS Series, NEC developed a single-chip CPU, the NEC One-Chip ACOS Hardware Engine (NOAH). Using CMOS technology, this chip had a density of 1.53 million transistors with a line width of 0. 35μm.

Concerning supercomputers, meanwhile, emphasis was placed not only on high-speed performance but also on reasonable cost and response to diversified needs. In the SX-4 marketed in November 1994, CMOS technology was used to develop a CPU with a density of 4 million transistors with a 0. 35μm process that replaced the previous bipolar device. Although the maximum vector processing performance for 1 CPU was 2 gigaflops, a maximum of 512 CPUs connected together let the SX-4 reach a maximum performance of 1 teraflops, the fastest in the world at the time. During fiscal 1996, orders for 56 units of the SX-4 were received from universities, research laboratories, corporations, and other customers. NEC's supercomputer business, until then comprising sales of only a dozen or so machines a year, thus expanded considerably. Next, in June 1998, NEC marketed the SX-5 Series of supercomputers, providing a maximum vector performance of 4 teraflops, once again the world's fastest performance at the time. Earlier that year, in January, NEC was awarded a contract from the Science and Technology Agency, which had been moving forward with its Earth Simulator Program, to complete the basic design for an ultracomputer with a maximum performance of over 32 teraflops.

5. Personal C&C Business, and Home Electronics Business

From PC-98 to PC98-NX

Although NEC increased its shipments of personal computers considerably as the scale of the Japanese market expanded greatly during the 1990s, its market share gradually decreased.

In 1991, with IBM Japan in the center, the PC Open Architecture Developers' Group (OADG) was established. IBM Japan marketed the IBM PC/AT, and other computer manufacturers marketed compatible machines, all loaded with DOS/V for processing Japanese. Several overseas companies also entered the Japanese market at this time, and the personal computer market was divided into two competitive forces—the PC-98, and, surrounding it, the IBM PC/AT and compatible machines. Compaq of the U.S. introduced a low-price DOS/V machine in 1992, and price competition quickly heated up considerably between Japanese and overseas manufacturers. Windows 3.1 of Microsoft Corporation, marketed in 1993, did not depend on any particular architecture, and was becoming the global standard OS. Windows95, marketed in 1995, had a bolstered function for processing images, and was much easier to use than Windows 3.1. It won a wide range of users, and its use spread explosively. In that situation, NEC developed and marketed new models of the PC-9800 Series that operated smoothly with Windows95. The difference between the PC-98 and machines using DOS/V thus faded, and all the machines used Intel processors. The difference in hardware performance also disappeared.

In that backdrop, NEC adopted a basic strategy of reducing prices and responding to the trend toward multimedia, and pushed forward ahead of other companies in developing new products. The 98MATE desktop that NEC marketed in 1993, for example, responded to Windows 3.1 by using the i486 Intel CPU and greatly raising the price-performance ratio. NEC next marketed the 98MULTi CanBe in 1994, an all-in-one multimedia personal computer that included functions for television, a CD player, and facsimile. In 1995, NEC marketed the 98NOTE Lavie, the first notebook personal computer to be fitted with a CD-ROM drive. Next was the 98ValueStar, marketed in November 1995. This was an all-in-one type personal computer that came loaded with about 40 software programs, including Windows95, a wordprocessor, and a spreadsheet program.

From the time that the first-generation PC-9801 was marketed in 1982, the "PC-98" came to be synonymous with "personal computer." It became a long-running best seller in Japan, with cumulative shipments of the PC-9800 Series as of the end of July 1997 of over 17 million units.

In 1996, Microsoft published its "PC97 Hardware Design Guide" for new personal computer hardware specifications. And in 1997, Microsoft and Intel jointly published the "PC98 System Design Guide" that presented an image of personal computers of the future. These design guides listed the conditions necessary for a personal computer to be as user friendly as home electric appliances, allowing the personal computer to easily and pleasantly handle multimedia information in a networking environment. NEC was convinced that a personal computer developed along the design guidelines of those two publications could become the next-generation global standard, replacing the PC-9800 and PC/AT compatible DOS/V machines. As a result, in September 1997 NEC announced the PC98-NX Series that included specifications listed in the Microsoft and Intel publications. In October, NEC began marketing 26 models and 200 variations of the PC98-NX Series. One of those, the Mate NX desktop computer for use as a client machine, was aimed at the corporate market and comprised five series and 15 models, including the Mate NX Series. For the individual and SOHO (small office, home office) markets, NEC introduced two series and eight models. The VALUESTAR NX Series for individuals was an all-in-one type desktop and the LaVie NX Series for SOHO was a notebook. The PC98-NX Series used advanced technology to develop new markets. During the first year after being marketed, as of the end of September 1998, more than 2 million units of the PC98-NX Series were shipped.

Diversification of Personal Products

The advance of personal-oriented products was also noticeable in the communications market. In response to the rapid growth of the mobile communications market in the 1990s, NEC provided system products to companies in the communications business. It also made great efforts to expand its business by providing products to the mobile terminal (mobile phone) market. For NTT DoCoMo, which in 1993 began offering digital mobile phone services, NEC quickly supplied the company with the Digital Mova N. At roughly six-month intervals afterward, NEC developed new models of the Digital Mova for NTT DoCoMo. In April 1997, for example, NEC provided the company with the world's lightest digital mobile phone (92 grams), the Digital Mova N203 HYPER. Then, in February 1999, after NTT DoCoMo began its i-Mode Internet access service, NEC developed the Digital Mova

N501i HYPER for the company. It was a folding type cellular phone, with a large display for showing more information than previous models. It was a best-selling cellular phone, as were its successors. NEC also supplied the NCCs with various kinds of mobile phones.

After service for PHS began in July 1995, about 20 manufacturers marketed PHS terminals, leading to continuously severe competition. NEC provided cellular phones for use with PHS from the very start of service, but could not gain the same share it held in the mobile phone market, partly because the PHS market itself did not develop much.

In the market for pagers (pocket bells), meanwhile, NTT and the NCCs introduced various models as they competed for business in the first half of the 1990s. The market expanded, centered on young persons using the service as individuals. The sunfish-shaped MOLA model that NEC marketed in 1994 became a best seller, especially among high-school girls. Together with wider use of mobile phones and PHS, however, subscribers to pagers began to decline from 1997.

In overseas markets as well, the demand expanded for mobile phones and pagers. The world market for cellular phones expanded from shipments of 4 million units in 1990 to 81 million units in 1997. For pagers, shipments expanded from 7.6 million units in 1991 to 33 million units in 1996. NEC began producing mobile phones and pagers in Mexico in 1990, and established two joint ventures in China, one in 1993 and the second in 1994. The first joint venture was TCL-NEC Mobile Communication Equipment Limited, established to manufacture and market pagers; the second joint venture was Wuhan NEC Zhongyuan Mobile Communication Co., Ltd., to manufacture and market mobile phones.

One new communications terminal that entered the home market after communications were liberalized was the facsimile (“fax”). NEC had marketed a home-use fax machine called the “speax” in 1988. In 1995, the company marketed the speax22 Series, a telephone equipped with a fax for home use. The machine was fitted with functions needed in the home, such as a hand scanner and a cordless phone. This fax sold well and provided the motive power to raise NEC's share of the personal fax market and propel the company in a single leap into fourth position.

The rapid spread of Internet use also led to the development of new personal products in the area of communications terminals. As a terminal adaptor (TA), for example, for connecting personal computers to ISDN lines, NEC marketed the AtermIT35 adaptor in 1995. It allowed high-speed communications of 64Kb per second, and quickly gained a large share of the market. The inkjet printer business really got underway for NEC in 1994 after NEC and HP entered into business ties in that field. The PICTY300 color inkjet printer that NEC marketed in 1996 had a display image sharpness of 1200 dots per inch (dpi), the highest resolution quality level in the industry.

Structural Reforms in NEC Home Electronics

The burst of the economic bubble and the subsequent appreciation of the yen and the general collapse of prices seriously affected the domestic home electronics market. At the beginning of the 1990s, for example, NEC Home Electronics experienced deteriorating profitability in its television and VTR business, and the company introduced all-out structural reforms from 1991. Beginning with its business in North America, it switched from focusing mainly on AV products to focusing on information equipment, such as monitors. The company also halted production of home-use VTRs (VCRs) in 1992, and decided to relocate its production of color television sets overseas by 1993. Because the depreciation of the yen from the second half of 1995 became prolonged, however, and profits from the import and sale of those products deteriorated, NEC Home Electronics decided in 1998 to withdraw from selling traditional CRT color television sets. The company had previously also decided to withdraw from the so-called "white goods" home appliances market, including products such as washing machines and refrigerators. In its middle-range business plan announced in fiscal 1996, NEC Home Electronics clarified the relative importance of its various businesses. The company described its core competence as being the "Screen & Storage" business, referring to displays, CD-ROM drives, and other products used for information display or storage, thus implementing a policy of placing a priority on specific businesses.

6. Electron Device Business

Semiconductor Business

Until 1991, NEC maintained the world's number one position in the semiconductor market. Although Intel moved into the top position from 1992, NEC continued afterward to maintain its number two ranking. Compared to Intel, whose business specialized in microprocessors, NEC's semiconductor business strategy was to maintain balanced management concerning its customers, geographical areas, and products, and not lean toward any particular field. According to a survey conducted by Gartner Japan/Dataquest, in the 1997 world rankings of companies categorized by the value of shipments in selected product areas, NEC was ranked first in ASICs, second in memory, and third in microcomputers, thus demonstrating that its balanced management strategy was working. As for new overseas production bases, NEC built two integrated plants in China, thus completing a four-axis system of production tying together Japan, the U.S., Europe, and Asia, and further strengthening its globalization.

NEC's semiconductor business group introduced a series of management improvement movements that aimed for product quality control and improved productivity. Events worthy of note include being the first company—and the only company in January 1997—to be presented the first prestigious Japan Quality Award, established by the Japan Productivity Center for Socio-Economic Development. NEC also vigorously tackled the issue of environmental preservation, and ended the use of chlorofluorocarbons in all its production processes one year and nine months ahead of the date set as the international target.

In the area of memory, NEC successfully developed a 64Mb DRAM in 1992 and a 256Mb DRAM in 1993, and was the first in the industry to ship samples of both products. NEC was also the first in the world to develop a 1Gb DRAM using a CMOS 0.25µm process (1995) and a 4Gb DRAM in a 0.15µm process (1997). Concerning synchronous DRAMs (SDRAMs) as well, that made high-speed data transmission possible, NEC in 1993 was the first in the world to ship 64Mb SDRAMs with a maximum ultra-high-speed reading-writing performance of 10ns/cycle. In the area of video memory (VRAM), in 1993 NEC responded to the emerging needs for faster speeds and higher capacity by being the first in the world to market a 4Mb VRAM. In 1994, based on its ties with Rambus Inc., NEC developed and marketed a Rambus DRAM fitted with an interface for high-speed data transmission. In 1995, moreover, NEC was the first in the world to commercialize an 8Mb synchronous graphic RAM (SGRAM), standardized as the next-generation image memory.

Concerning microcomputers, where the need for customized products expanded, NEC shortened its development period by promoting the use of more sophisticated automated design technology, and developed new products that promised higher performances. Through its technical ties with MIPS Computer Systems, Inc. (MIPS), NEC developed the VR Series microprocessors, beginning with the world's fastest performance 64-bit VR4000 MIPS RISC microprocessor in 1991. The 64-bit VR10000 announced in 1995 had the ultra-high performance speed of 200MHz. In parallel with development of the VR Series, NEC also tackled development of original RISC processors. NEC commercialized its original microprocessors in 1992 as the V800 Series 32-bit RISC microprocessors that successfully combined high performance with low electrical consumption. Following that series, NEC developed and marketed the V810 Family, V830 Family, and V850 Family of new 32-bit RISC processors. The V853 marketed in 1996 was the world's first 32-bit RISC processor to use flash memory.

In the area of ASICs, where it held the world's top market share, NEC was able to develop in a comparatively short period the ASICs needed for realizing systems on a chip. This was made possible by considerable advances in the CAD environment for developing large-scale, complex LSIs. NEC promoted the improvement of CAD for the ASIC design environment, and commercialized it as the OpenCAD software package.

Electronic Components Business

During the 1990s, several trends made the domestic electronic components market tougher, including the shift of production overseas by set makers because of the yen's appreciation, and an increase in imported products. Price competition grew increasingly severe on a global scale. NEC strengthened its marketing capabilities concerning existing products and its development capabilities concerning advanced technology. The company restructured its business in various ways, transferring some operations to its local production companies, integrating other operations, and withdrawing from still others. It also strengthened strategic new business undertakings on a priority basis.

Among the business operations transferred to local production companies were the color display tube business transferred to NEC Kansai in 1993 and the fluorescent indicator panel (FIP) business transferred to NEC Kagoshima in 1994.

NEC Kagoshima had begun the mass-production of TFT color liquid crystal displays (TFT-LCD) from 1990. After demand gradually increased, additional mass-production lines were built in NEC Kagoshima in 1992 and 1993, and new lines were built in NEC Akita in 1993. As the demand for notebook personal computers started quickly switching to color, NEC tackled the issue of producing very low-priced TFT-LCDs while improving their performance. It also moved forward with providing a larger display, greater capacity, and a greater number of colors. For larger display size and greater capacity, besides the former 9.4-inch and 10.4-inch screens, NEC added 11.3-inch, 12.1-inch, 13.3-inch, and 14.1-inch displays between 1995 and 1997. Those products just about completed NEC's program to increase the display size for its notebook computers. In 1996, meanwhile, NEC developed a

20.1-inch large-size TFT-LCD, a size comparable to that of a CRT monitor. The product pulled together all of the company's TFT technology, including very wide viewing angle (160 degrees) technology. It was called super-fine TFT (SFT).

During the 1990s, one market in which NEC held the lead for developing new products was the market for color plasma display panels (PDP). The company's initial R&D efforts in color PDP were made in 1989, when it started a project to develop a large-screen television set. As early as 1990 NEC succeeded in developing a 10-inch panel providing a full-color display of moving pictures. Next, in 1994, the company developed a wide-panel 40-inch display and exhibited it at Japan Electronics Show '94 where it was received with great enthusiasm. The first commercial product using that technology was the 33-inch display marketed in 1996, widely recognized for providing images of superior contrast. Next, in 1997, a mass-production plant at NEC Kagoshima was completed, and a 50-inch color PDP was exhibited at that year's Japan Electronics Show, once again resulting in a tremendous response.

The spread in the use of mobile terminals such as mobile phones and notebook-type personal computers increased the need for rechargeable small, light, long-life, secondary batteries. NEC felt that lithium-ion secondary batteries held great future potential for development as small, light secondary batteries with high energy density. In that context, NEC jointly invested capital with Mitsui & Co., Ltd., in Moli Energy (1990) Ltd. of Canada in 1990 to develop a lithium-ion secondary battery. Then, in 1994, NEC and Mitsui & Co. jointly established Nippon Moli Energy Corporation. From 1995, while the production of cylindrical cells began at Moli Energy in Canada, a plant called the Nippon Moli Energy's Toyama Plant was built within the precincts of NEC Toyama. Production then began there of prismatic cells. In 1998, in order to bolster its business of having prismatic lithium-ion secondary batteries used in mobile phones and other mobile terminals, Nippon Moli Energy built a new plant in Tochigi Prefecture and changed its company name to NEC Moli Energy Corporation (today's NEC Mobile Energy Corporation).

7. Improving and Strengthening Internal Systems

Bolstering R&D Centers

During the 1990s, together with the increased globalization of its various businesses, NEC also bolstered its R&D system around the world. In 1991, for example, the NEC Group's second overseas R&D base, C&C Research Laboratories of NEC USA, Inc., was established in Princeton, New Jersey, as a division of NEC USA. R&D activities were begun there in areas such as multimedia systems, ATM networks, and VLSI. Next, in 1995, an R&D office was opened in San Jose, California, for research into multimedia software. The NEC Group's first R&D base in Europe was established in July 1994, when C&C Research Laboratories of NEC Europe Ltd. was established inside the Technopark of the German National Research Center for Information (GMD) in the outskirts of Bonn, Germany, as a division of NEC Europe. The main research fields at the new research labs were parallel processing and high-performance computing. NEC installed the parallel computer Cenju-3 in the labs, thus providing a platform for parallel processing research by the company's R&D partners in Europe. R&D offices were also opened in 1995 in Berlin and in 1997 in Heidelberg for promoting research related to multimedia communications.

Domestically, the Kansai C&C Research Laboratories was established in 1990 and the Kansai Electronics Research Laboratories was established in 1991. The Kansai C&C Research Laboratories was later bolstered and expanded, and in 1998 it was relocated to Kansai Science City (KSC) in Nara Prefecture and renamed the Kansai Research Laboratories.

An outstanding achievement recorded in the field of nanotechnology was the discovery in 1991 of the carbon nanotube by Dr. Sumio Iijima, Senior Research Fellow of NEC. The carbon nanotube was a new form of carbon, configurationally equivalent to a two-dimensional graphene sheet rolled into a tube with a diameter as small as 0.8 nanometers. One of its unique features was its helicity, with carbon hexagons arranged in a helical fashion on the tubule wall. By further discovering a technique to insert metal into the hollow of carbon nanotubes, Dr. Iijima created what could be the tiniest wire ever made, attracting considerable attention from the scientific community. Unlike conventional graphite, the carbon nanotube was expected to be semiconductive or metallic, depending upon helicity and diameter. Also, since the size of carbon nanotubes was close to that of a single molecule, research moved closer to the ultimate goal of modern microelectronics device technology, making devices smaller.

Production Innovation Movement, and ISO Certification

As market needs diversified during the 1990s and price competition intensified, the life cycle of products was shortened drastically. In order to respond to such changes in the marketplace, NEC introduced a Production Innovation Movement in its production divisions aimed at shortening lead times, reducing cost, and using inventories more efficiently. All companies in the NEC Group participated in the movement, begun in 1993 at the same time as introduction of the Lean Production System. Based on the idea that work that did not relate directly to the following processes—called the "customers" internally—was wasteful, thoroughgoing efforts were made to rid the product development, parts procurement, manufacturing, material handling, sales, and all other areas of the group's activities of waste and raise productivity considerably. Initially, model plants were selected in NEC Yonezawa for design and NEC Nagano, NEC Saitama, and NEC Tohoku for production. External consultants provided guidance as specific methods were introduced, learned, and systemized. Next, based on the know-how gained at the model plants, the movement was spread out horizontally to the companies in the NEC Group. The reform of production processes that followed introduction of the Lean Production System led to considerable positive results in lead-time reduction, per capita productivity, and floor productivity.

The set of international standards called the ISO series standards became synonymous with "superior plant" during the 1990s, and ISO certification became an important condition when conducting business. The International Organization for Standardization (ISO) developed in 1987 the original ISO 9000 series standard that certified a manufacturer's product quality control system. It was introduced in Japan in 1991 as the National JIS-Z9900 standard. Shortly after publication of the ISO 9000 series standard, British Telecom (BT) of the U.K. informed NEC that certification by the British Standards Institute (BSI) was required as a condition for purchase of the company's products. With that experience as a turning point, NEC moved to have all companies in the NEC Group, both domestic and overseas, and including affiliates, initiate the activities required for obtaining certification for conforming to the ISO 9000 series standard. As of the end of September 1993, 56 of the business entities in the worldwide NEC Group had been awarded certificates of conformity. Domestically, the NEC Group ranked first in terms of number of certificates awarded.

NEC also aggressively tackled the activities required for certification concerning the ISO 14000 series standard for environmental management systems and environmental control. The ISO developed the ISO 14000 series standard in 1996 in the backdrop of increased interest worldwide in preservation of the environment. In Japan, the Agency of Industrial Science and Technology of the Ministry of International Trade and Industry (MITI), conforming to the ISO 14000 series, developed the Japanese Industrial Standard "Environmental JIS." NEC Tohoku was the first domestic company in the NEC Group to be awarded a certificate of conformity with the ISO 14001 standard. By October 1997, all of NEC's domestic business offices, plants, and R&D facilities obtained certification, and by March 1998 all the local NEC production companies also were awarded certificates of conformity with ISO 14001. By the end of 1998, a total of 55 NEC entities were awarded certification.

Meanwhile, the NEC Tamagawa Renaissance City 21 that NEC had begun constructing in 1997 in the precincts of the

Tamagawa Plant was planned from the design stage to be a building that closely matched a recycling-oriented society. It pulled together NEC's rich know-how related to environmental control and an advanced ecology philosophy.

Human Resources System Centered on White-Collar Workers

The percentage of the total workforce in NEC accounted for by white-collar workers, which was 60 percent in the early 1970s, increased to over 90 percent in the mid-1990s. Including the domestic companies in NEC's consolidated report, there were 133,000 workers around the mid-1990s, and white-collar workers accounted for over 80 percent of the total. Because the duties of white-collar workers were diversified and subject to great change, as the percentage of white-collar workers increased, the former approach to managing human resources, i.e., controlling personnel as a group, or applying unified standards to all personnel, became gradually less efficient. In order to increase productivity, human resources management had to shift to performance-based evaluation guided by line management with emphasis on providing support for individuals to manage themselves and assume the initiative. A number of measures were introduced to ensure the success of this new approach.

Performance-based personnel evaluation systems were introduced concerning salaries and promotions. Depending on trends in its particular business areas, and as a reflection of the personnel needs that subsequently arose, each business line was given increased discretion and responsibility.

In 1989, NEC introduced a flexible working time system, and later introduced other measures of employee supervision that emphasized increased respect for the individuality of the worker. Next, in 1993, the company introduced a system of "discretionary work" for supervisor-level researchers. On the one hand, this system contributed to increased flexibility in the working hours for employees; on the other, in order to state clearly the return to an individual based on performance, the department manager could direct that an additional bonus be paid for individual performance. In order to apply the idea of discretionary work to the many other work categories, NEC developed the Vital Work System. In this system, by including consideration of individual performance in a worker's bonus evaluation, it became possible to reflect individual performance more effectively in a worker's total compensation. The system was introduced in the head office in 1997 to cover supervisor level workers; in 1998, it was applied to all supervisor level workers throughout the company.

The system of self-management emphasized the individual taking the initiative and accepting individual responsibility. This thinking was also applied to help workers choose their line of work. The intra-company job posting system introduced in 1988, for example, was expanded to include more categories of workers. It was also expanded in scale. In 1998, the company published two calls for specific job postings, a total of 283 job positions, and received 381 applications. As a result, 150 workers were posted to new lines of work. Also, as a reflection of the trend toward increased mobility of the overall labor market, and the fact that life expectancy in Japanese society had increased to about 80 years of age, NEC systemized a second-career support system in 1998 for managers 50 years of age and older. This system helped to open the way for workers to consider a career that included working in more than one company by adding a time factor and economic support to the future plan, life design information, and self-vision training programs the company previously introduced.

Trends in Business Results

NEC's sales increased on a consolidated basis from 3.7 trillion yen in fiscal 1990 to 4.9 trillion yen in fiscal 1997. With sales of 3.44 trillion yen in fiscal 1989 as an index, the increase in fiscal 1997 was 1.42-fold, a yearly average of 4.5 percent growth in sales. That was a considerable decrease compared to the average yearly growth from fiscal 1985 to fiscal 1989 of 8.8 percent. As well, business stagnated between fiscal 1991 and fiscal 1993, including minus growth in fiscal 1992. Although double-digit sales growth was recorded in fiscal 1995 and 1996, fiscal 1997 once again recorded minus growth on a consolidated basis. Business results thus fluctuated greatly in the 1990s.

Profit trends fluctuated even more than sales trends. Profit fluctuations on a consolidated basis were especially severe. In fiscal 1992, for example, besides a decrease in sales, business languished in the local production companies producing devices and in NEC Home Electronics, causing a sharp decrease in profits. NEC recorded a current loss of over 45 billion yen on a consolidated basis that year. That was the first time in 18 years, since 1974, the year immediately following the First Oil Crisis, that the company recorded a current loss in operations. Together with a recovery in sales afterward, profit also increased. In fiscal 1996, a current profit ratio of almost 2 percent was recorded. Although sales decreased in fiscal 1997, operating profit increased, mainly because of cost cutting. Restructuring costs, however, offset the operating profit and the current profit decreased.

Chapter 10

Toward Another Hundred Years of Business: 1998 – 1999

Unexpected Management Crisis

Just as the multimedia age started in earnest and it appeared certain that NEC would expand and grow further, and just prior to celebration of the company's 100th Anniversary, an unexpected incident occurred in September 1998 that shook the company at its very roots.

Over consecutive days in September, mass media in Japan reported that several NEC affiliates were being charged with overbilling in transactions with the Defense Agency. The incident developed to the point where several former NEC employees and directors were arrested. In the end, on October 23, Chairman Tadahiro Sekimoto, who had led NEC for 18 years since assuming the presidency in June 1980, resigned as chairman.

By coincidence, the incident occurred in the midst of the serious recession following the burst of the bubble economy. Until then, NEC's business had been affected relatively little by the recession. After the incident became a media topic, however, the company's business performance rapidly worsened. Besides noticeable stagnation in the semiconductor market, particularly concerning DRAM, the company's overseas personal computer business was the most pressing issue it faced. Rapid changes in the personal computer market, centered on changes in the U.S., rocked the company, and its subsidiary in the U.S., Packard Bell NEC, Inc., suffered huge losses.

Faced with this grave situation, President Hisashi Kaneko quickly established an Emergency Corporate Action Committee with himself as chairman. He urged the entire NEC Group of companies to initiate action to prevent such unfortunate incidents from reoccurring and to introduce thoroughgoing steps to ensure that their employees remain law-abiding at all times. Next, in January 1999, the company established a Corporate Auditing Bureau, also headed by President Kaneko, to ensure transparency in management and to strengthen the company-wide management auditing function. In that background, President Kaneko demonstrated to all concerned at home and abroad that the company was aiming for an early recovery by implementing fundamental reforms in its management structure to create a "new NEC." The measures for management reform that President Kaneko unveiled in February 1999 were large-scale yet basic, comprised of four pillars: management reorganization, structural reorganization, budgetary restructuring, and financial restructuring. After establishing the basic system for carrying out the necessary reforms in its management structure for creating a new NEC, President Kaneko turned over the feat of realization to his successor and then resigned.

Aiming for New NEC

On March 26, 1999, top management changes were introduced at NEC for accomplishing the task of realizing the new NEC. Senior Executive Vice President Hajime Sasaki became chairman, and Executive Vice President Koji Nishigaki became president.

Chairman Sasaki had been engaged in the semiconductor and electronic components businesses since entering the company in 1961. He was appointed associate senior vice president and a member of the board in 1988, senior vice president in 1991, and

Hajime Sasaki

Koji Nishigaki

executive vice president in 1994. He had served as senior executive vice president since 1996. President Nishigaki joined the company in 1961 and was engaged throughout his career in the information processing and computer businesses. He became associate senior vice president and a member of the board in 1990, senior vice president in 1992, and served as executive vice president from 1994.

In his first greeting to NEC's employees, titled "Toward a New Initiation," President Nishigaki explained how it was impossible to resolve the crisis the company faced without implementing radical management reforms, and he expressed his determination to carry through with the four basic reforms his predecessor President Kaneko had outlined. He also set a middle- to long-range goal of recreating NEC into a highly valued corporation that would set standards in global excellence. President Nishigaki then outlined four management policies for realizing that goal: (1) to accelerate the transformation into a solution provider; (2) to facilitate proactive management; (3) to shift to a profit-oriented mind-set; and (4) to develop the company's human capital by "fanning the sparks of individuality."

The first consolidated business results announced under the new management team were for fiscal 1998. Due mainly to the negative effect of the serious economic recession, sales were 4,759 billion yen, down 2.9 percent from the previous year, the third consecutive year of sales decline. Because of the decline in sales and a worsening of the prime cost ratio due to lower selling prices, operating profit declined considerably to 3.1 billion yen, a year-on-year decline of 98 percent. Also, because a special loss was recorded due to a reduction in the evaluation of the cumulative investments in Packard Bell NEC, the company was forced to record a net loss for the year of 157.9 billion yen, an unprecedented large sum.

Under those circumstances, NEC began moving toward recovery. The action it initiated included the restructuring and elimination of problem businesses. In March 1999, for example, the company sold Nippon Electric Industry Co., Ltd., to Nemic-Lambda K.K, in April it sold NEC Home Electronics Lease Ltd. to ORIX Corporation, and in June it announced ties with Hitachi Ltd. in the DRAM business. Besides thus quickly introducing various measures to reconstruct its business, NEC also announced in September worldwide management reform measures to be implemented from April 2000, including a proposal for management structural reform. Among the measures was a clear statement for carrying out the restructure of NEC Home Electronics, a major problem business in the NEC Group. In order to procure the funds needed to cover restructuring costs and to reduce the impact of interest-bearing debt, NEC in January 2000 transferred its head office building in a securitization scheme that enabled the company to procure capital in the form of securities supported by the profitability of the property.

Pushing Forward with Management Structural Reform

The Management Structural Reform Plan that NEC announced earlier was implemented from April 2000. The gist of the plan was to integrate its business management to further promote its Internet business operations while achieving a flexible business management structure capable of leading market developments to provide higher value-added solutions to meet customer needs ahead of its global competitors. In order to achieve these goals, the company abolished the previous business group system and reorganized and integrated all its businesses according to the special features of each market. On a consolidated worldwide basis, including affiliated companies, all operations were divided among three in-house companies, each provided with engineering development, production, and marketing functions. The three companies would conduct their operations independently.

The three in-house companies—NEC Solutions company, NEC Networks company, and NEC Electron Devices company—were organized along the lines of NEC's three business domains of computers, communications, and electron devices. NEC Solutions company would provide Internet solutions to the government, corporate, and consumer markets; NEC Networks company would provide Internet solutions to network operators; and NEC Electron Devices company would provide device solutions to support Internet infrastructure equipment vendors and information equipment vendors. Although the three in-house companies were not independent legal entities, they were provided wide-ranging authority and were allotted the management resources they required. They were essentially managed as independent companies.

Fundamental reforms were introduced in the area of corporate governance as well. The number of members on the board of directors was drastically reduced, for example, and the board was turned into a venue—from the eyes of shareholders—for thoroughgoing discussion, to increase its transparency and enable faster decision-making, and to control work operations as precisely as possible. Daily business operations were to be conducted under a newly introduced Corporate Officer System; the board of directors appointed associate senior vice presidents as corporate officers. The company thus clearly separated its functions for decision-making and controlling work operations.

Together with the introduction of the in-house company system, the head office's functions were reduced mainly to determining the NEC Group's fundamental business strategy and auditing how well the three in-house companies were performing.

Those became "Corporate" functions, and the staff division in corporate headquarters was divided into a top management support staff that supported top management and an operations support staff that provided specialized services for the infrastructure in corporate divisions and in-house companies. The size of the staff division was also reduced considerably.

In order to promote the development of new business domains in the future, a corporate business development division was positioned directly under corporate headquarters. Together with the newly established Internet Business Promotion Division, the NEC Laboratories—the reorganized R&D Group—was positioned inside the corporate business development division. A corporate sales division was also positioned directly under corporate headquarters to assist regional representatives and senior management, and to support and coordinate sales activities across the NEC Group.

Toward Another 100 Years of Business

In July 2000, NEC announced its "Management Strategy for the i-Society Era," a three-year business plan comprising the business strategy that would carry the company through to fiscal year 2002. Formulated in response to the approaching Internet society, it was an energetic plan that promoted the expansion of business while aiming to achieve the highest corporate values. At the time, business via the Internet, as represented by electronic commerce (EC), was expanding on a global scale. It was clear to anyone closely observing the situation that this revolutionary change occurring in the field of information/communications would bring about rapid changes in society.

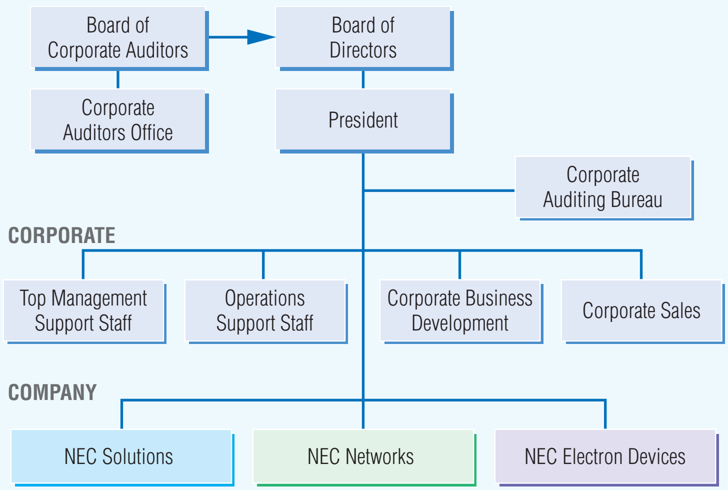
One hundred years previously, at the dawn of the telephone age, NEC started in business as Japan's first joint venture with foreign capital. Its main business at that time was the import and sale of telephone sets made by Western Electric Company of the U.S. NEC expanded tremendously over its first hundred years in business, developing to become one of Japan's foremost corporations. In 1977, it was the first company in the world to embrace and voice the C&C concept—the integration of computers and communications—thus predicting the emergence of the Internet society and writing a brilliant page in business history. The information/communications field is now preparing to enter an absolutely new era in its history. The paradigms are changing. In this fast-approaching new era for information/communications, NEC is being forced to fight for its very existence by competing for business on a global scale, and is prepared to meet that challenge.

As it approached its 100th Anniversary, NEC unexpectedly had to face an unprecedented management crisis, and top management was forced to steer the company in a new direction. Up to then, the company's strength had been in maintaining a careful balance in its three principal competences of communications, computers, and electron devices. Those three business fields had mutually complemented each other, and the company had expanded. To overcome the unexpected crisis it faced, NEC took bold action and divided its overall business into three in-house companies, providing them with widespread authority and allowing them to be managed as independent business entities. The company also changed its main business domain. Instead of calling itself "NEC, the C&C Company," it began calling itself "NEC, the Solutions Company." As well, the company changed its motto from "Multimedia-driven NEC" to the fresher, customer-oriented "Ever ready to be at your service, with an invitation to the Internet."

The twenty-first century has begun. In the midst of great turbulence, NEC has taken its first strong steps into its second hundred years of business.

Appendixes

Organization



CORPORATE

Top Management Support Staff
will be responsible for supporting top management and corporate planning and promotion of the NEC Group to maximize corporate value.
Promotion of Management Innovation, Corporate Strategic Planning & Business Development, China Business Development, Corporate IT, External Relations, General Affairs, Corporate Communication, Corporate Ethics, Legal, Human Resources Development, Corporate Controller, Corporate Finance & IR, Quality Administration, Environmental Management

Operations Support Staff
will be responsible for the infrastructure in corporate divisions and in-house companies by providing specialized services.
Production Management, Purchasing, HR Support, Advertising, Health Care, etc.

Corporate Business Development
will be responsible for R&D at the corporate level to promote growth businesses at in-house companies as well as the promotion of overall Internet strategies for the NEC Group.
Internet Business Development, Business Development, Intellectual Assets, NEC Laboratories

Corporate Sales
will be responsible for assisting regional representatives and senior management, and for supporting and coordinating sales activities across the NEC Group.
NTT Marketing Promotion, Domestic Sales Promotion, International Marketing Promotion, Customer Satisfaction Promotion, Security Trade Control

COMPANY

NEC Solutions
will be responsible for the Internet solutions business in corporate and consumer markets.
Solutions Sales, Network & Services, Systems, Software, Computers, Personal Products, etc.

NEC Networks
will be responsible for the Internet solutions business focused on the network operator market.
NTT Operations Unit, Domestic Operations Unit, International Operations Unit, Optical Network Operations Unit, IP Network Operations Unit, Mobile and Wireless Operations Unit, Mobile Terminals Operations Unit, Broadcast and Video Equipment Operations Unit, Control Systems Operations Unit, Aerospace and Defense Operations Unit, etc.

NEC Electron Devices
will target Internet infrastructure equipment vendors and information equipment vendors.
System LSI Operations Unit, General-purpose Devices Operations Unit, Display Device Operations Unit, Color PDP Operations Unit

As of July 1, 2002

In-house Company

NEC Solutions

Company President

- Staff
  - Planning Office
  - Human Resources Division
  - Controller Division
  - SI Business Coordination Division
  - Purchasing Division
  - Information Systems Division
  - Customer Satisfaction and Quality Management Promotion Division
  - International Business Promotion Division
  - Research & Development Unit, NEC Solutions
- Sales
  - IT Solutions Marketing Operations Unit
  - 1st Solutions Sales Operations Unit
  - 2nd Solutions Sales Operations Unit
  - 3rd Solutions Sales Operations Unit
  - East Japan Solutions Sales Operations Unit
  - Chubu Solutions Sales Operations Unit
  - Kansai Solutions Sales Operations Unit
  - West Japan Solutions Sales Operations Unit
  - Partner Business Sales Operations Unit
- Network & Services
  - Personal BIGLOBE Services Operations Unit
  - Business BIGLOBE Services Operations Unit
- Systems
  - Mission Critical Systems Operations Unit
  - 1st System Operations Unit
  - 2nd System Operations Unit
  - 3rd System Operations Unit
- Software
  - Systems Software Operations Unit
  - Computer Software Operations Unit
- Computers
  - 1st Computer Operations Unit
  - 2nd Computer Operations Unit
  - Computer Storage Products Operations Unit
- Personal

NEC Networks

Company President

- Staff
  - Planning Division
  - Technologies and Products Planning Division
  - Human Resources Division
  - Controller and Finance Division
  - Quality Management Promotion Division
  - Purchasing Division
  - Brazil Business Promotion Division
- Solution
  - NTT Operations Unit
  - Domestic Operations Unit
  - International Operations Unit
  - Network Solutions Operations Unit
- R&D
  - Development Laboratories, NEC Networks
- Product Operations
  - Optical Network Operations Unit
  - IP Network Operations Unit
  - Mobile and Wireless Operations Unit
  - Mobile Terminals Operations Unit
  - Broadcast and Video Equipment Operations Unit
  - Control Systems Operations Unit
  - Aerospace and Defense Operations Unit

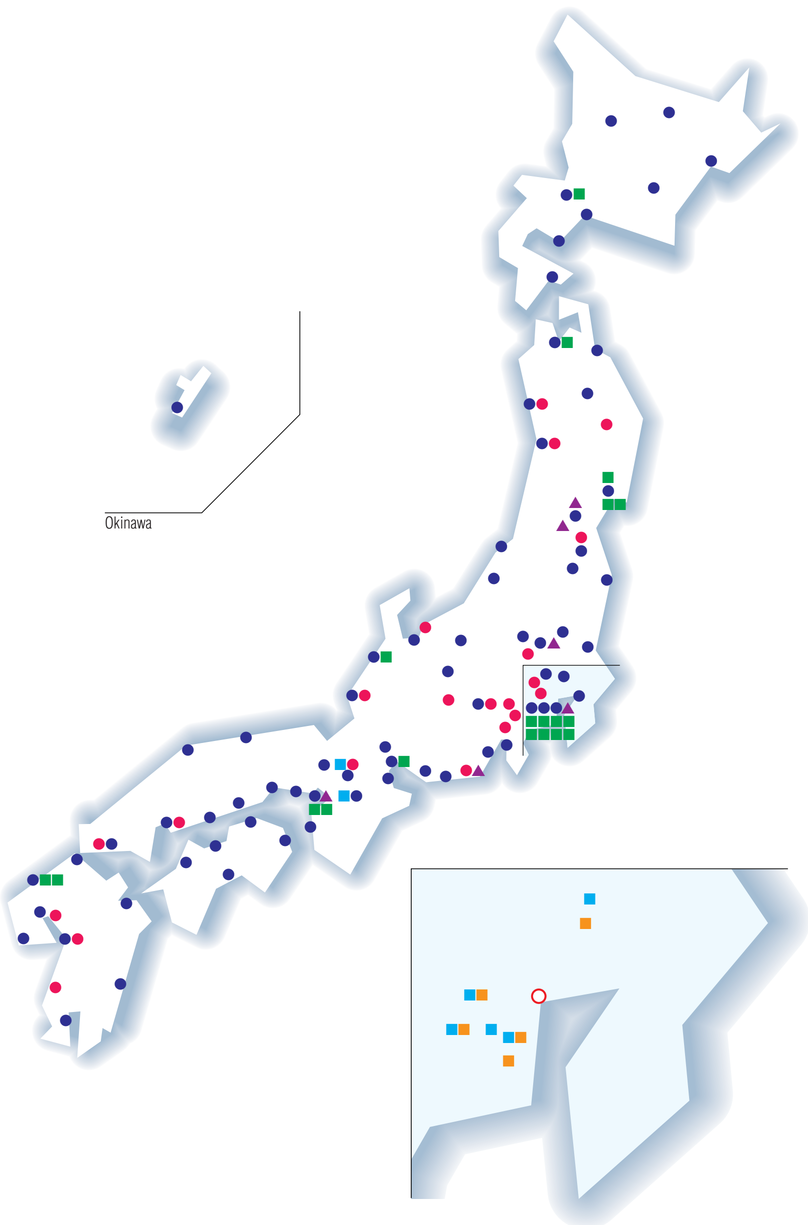
NEC Electron Devices

Company President

- Staff
  - Structural Reform Promotion Division
  - Strategic Planning Division
  - Technology & Production Planning Division
  - Human Resources Division
  - Controller Division
  - IT Division
  - Business Support Division
  - Environment Management Division
  - Purchasing Division
- Sales
  - Marketing Division
  - System LSI Solutions Engineering Division
  - System LSI 1st Japan Sales & Marketing Division
  - System LSI 2nd Japan Sales & Marketing Division
  - System LSI North America/Europe Sales & Marketing Division
  - System LSI Asia Sales & Marketing Division
  - General-purpose Devices Sales & Marketing Division
  - Device SI Business Development Division
- Technology & Analysis Development
  - Analysis Technology Development Division
  - Packaging and Testing Engineering Division
  - ULSI Manufacturing Engineering Division
- Operations
  - Foundry Business Promotion Division
  - System LSI Operations Unit
  - General-purpose Devices Operations Unit
  - Display Device Operations Unit
  - Color PDP Operations Unit
  - Printed Wiring Board Division
  - Microwave Tube Division
  - Automotive Electronics Division

As of July 1, 2002

Domestic Manufacturing, Marketing and Service Networks



BRANCH DIVISIONS /BRANCH AND SALES OFFICES

- Hokkaido
- Asahikawa
- Hakodate
- Tomakomai
- Kushiro
- Obihiro
- Okhotsk
- Muroran
- Tohoku
- Aomori
- Hachinohe
- Iwate
- Akita
- Yamagata
- Shonai
- Fukushima
- Koriyama
- Iwaki
- Kanto Shinetsu
- Niigata
- Nagaoka
- Ibaraki
- Gunma
- Ota
- Utsunomiya
- Nagano
- Matsumoto
- Kanto Minami
- Sagami
- Shonan
- Chiba
- Kashiwa
- Kofu
- Shizuoka
- Numazu
- Hamamatsu
- Chubu
- Mikawa
- Gifu
- Mie
- Hokuriku
- Toyama
- Fukui
- Kansai
- Nara
- Wakayama
- Kyoto
- Shiga
- Kobe
- Himeji
- Chugoku
- Fukuyama
- Tottori
- Matsue
- Okayama
- Yamaguchi
- Shikoku
- Kochi
- Tokushima
- Matsuyama
- Niihama
- Kyushu
- Kita Kyushu
- Saga
- Nagasaki
- Kumamoto
- Oita
- Miyazaki
- Kagoshima
- Okinawa

PLANTS

- Tamagawa
- Fuchu
- Sagamihara
- Yokohama
- Abiko

MANUFACTURING SUBSIDIARIES

- NEC Tohoku
- NEC Akita
- NEC Yamagata
- NEC Wireless Networks
- NEC Saitama
- NEC Network and Sensor Systems
- NEC CustomTechnica
- NEC Laser & Automation
- NEC Nagano
- NEC Yamanashi
- NEC Computertechno
- NEC Toyama
- NEC Fukui
- NEC Gotemba
- NEC AccessTechnica
- NEC Kansai
- NEC Hiroshima
- NEC Yamaguchi
- NEC Kyushu
- NEC Semiconductors Kyushu
- NEC Kagoshima

SOFTWARE SUBSIDIARIES

- NEC Soft
- NEC Software Hokkaido
- NEC Software Aomori
- NEC Software Tohoku
- NEC Software Hokuriku
- NEC Software Chubu
- NEC System Technologies
- NEC Software Kyushu
- NEC Engineering
- NEC Miyagi
- NEC Communication Systems
- NEC Communication Systems Tohoku
- NEC Communication Systems Kansai
- NEC Communication Systems Kyushu
- NEC Micro Systems
- NEC Informatec Systems
- NEC Telecom Systems
- NEC Aerospace Systems
- NEC Robotics Engineering

PC COLLEGE

- ▲NEC PC College Yamagata
- ▲NEC PC College Yonezawa
- ▲NEC PC College Ota
- ▲NEC PC College Ikebukuro
- ▲NEC PC College Kakegawa
- ▲NEC PC College Tennoji

○Head Office
■Research Laboratories

(As of July 1, 2002)

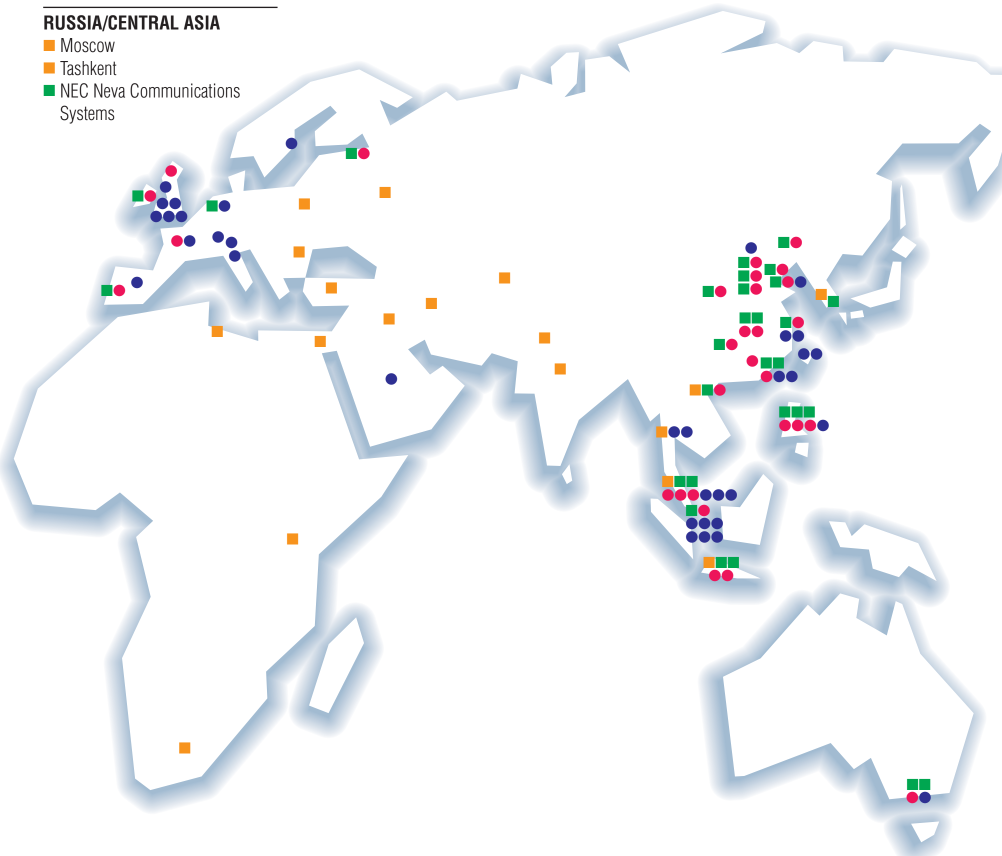
Overseas Offices and Plants

EUROPE
- ■ Warsaw
- ■ Budapest
- ■ NEC Computers International
- ■ NEC Semiconductors Ireland
- ■ NEC Portugal-Telecomunicacoes e Sistemas
- ● NEC Scandinavia
- ● NEC IndustrialSolutions
- ● NEC Electronics (Europe)
- ● NEC Deutschland
- ● NEC Italia
- ● NEC (UK)
- ● NEC Capital (UK)
- ● NEC Europe
- ● Telecom MODUS
- ● Mobisphere
- ● NEC Technologies (UK)
- ● NEC France
- ● NEC Ibérica

RUSSIA/CENTRAL ASIA
- ■ Moscow
- ■ Tashkent
- ■ NEC Neva Communications Systems

AFRICA/ THE MIDDLE AND NEAR EAST
- ■ Teheran
- ■ Ankara
- ■ Cairo
- ■ Tripoli
- ■ Baghdad
- ■ Nairobi
- ■ Johannesburg
- ● NEC Saudi Arabia

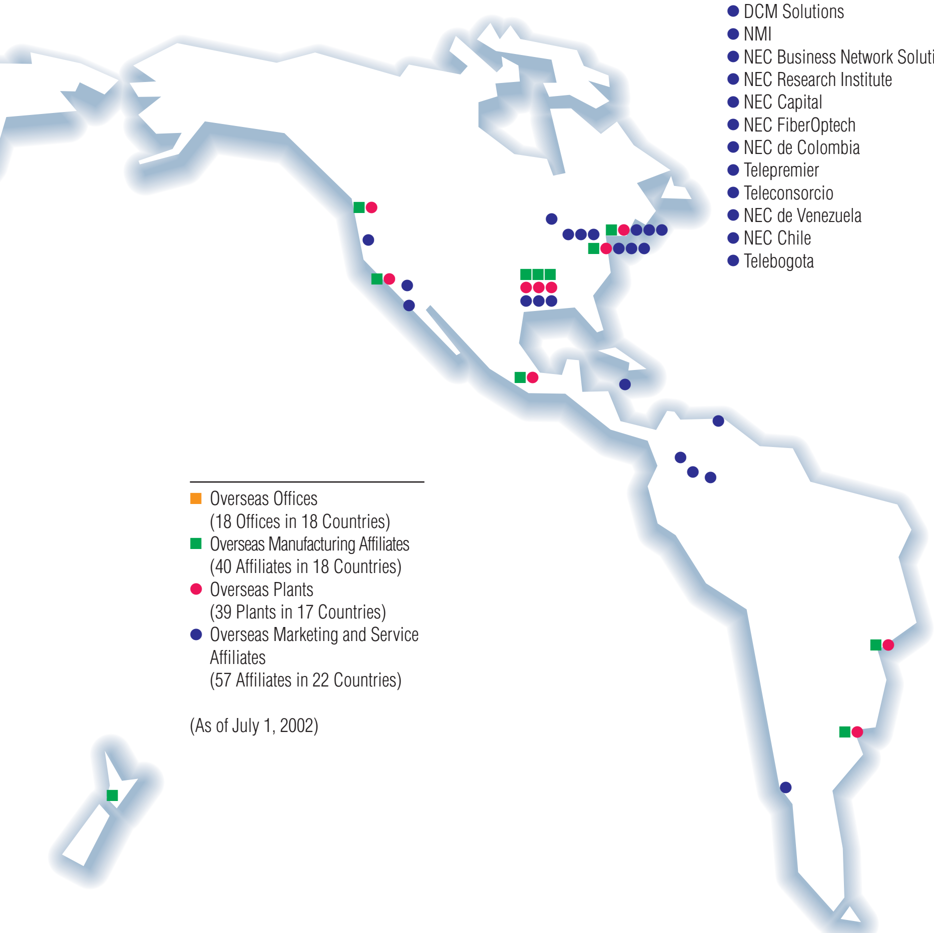
ASIA/OCEANIA
- ■ Bangkok
- ■ Jakarta
- ■ New Delhi
- ■ Islamabad
- ■ Hanoi
- ■ Seoul
- ■ Kuala Lumpur
- ■ Tianjin NEC Electronics & Communications Industry
- ■ Shougang NEC Electronics
- ■ Wuhan NEC Fiber Optic Communications Industry
- ■ Guilin NEC Radio Communications
- ■ Wuhan NEC Mobile Communication
- ■ NEC-CAS Software Laboratories
- ■ Benxi NEC Communications
- ■ NEC Systems Integration (China)
- ■ Shanghai Hua Hong NEC Electronics
- ■ Xi'an NEC Radio Communications Equipment
- ■ Beijing Hua Hong NEC IC Design
- ■ Samsung NEC Mobile Display
- ■ NEC Technologies Hong Kong
- ■ NPG Display



- ■ NEC Technologies Philippines
- ■ NEC Components Philippines
- ■ NEC Telecom Software Philippines
- ■ PERNEC
- ■ NEC Semiconductors (Malaysia)
- ■ NEC Semiconductors Singapore
- ■ NEC Nusantara Communications
- ■ NEC Semiconductors Indonesia
- ■ VNPT-NEC Telecommunication Systems
- ■ NEC Australia
- ■ NEC Business Solutions
- ■ NEC New Zealand
- ● Tianjin NEC Telecommunications Engineering
- ● NEC (China)
- ● NEC Electronics Shanghai
- ● COSMOBIC Technology
- ● NEC Electronics Taiwan
- ● NEC Taiwan
- ● NEC Philippines
- ● NEC Electronics Hong Kong
- ● NEC Hong Kong
- ● NEC (Thailand)
- ● NEC Communication Systems (Thailand)
- ● NEC Malaysia
- ● Biz Finds
- ● Orion Setia
- ● NEC Singapore
- ● NEC Business Coordination Centre (Singapore)
- ● NEC Electronics Singapore
- ● NEC Mobile Communications Development Singapore
- ● Obtech Asia Pacific
- ● Peppers and Rogers Group (Asia)
- ● Maxi Multimedia

AMERICA

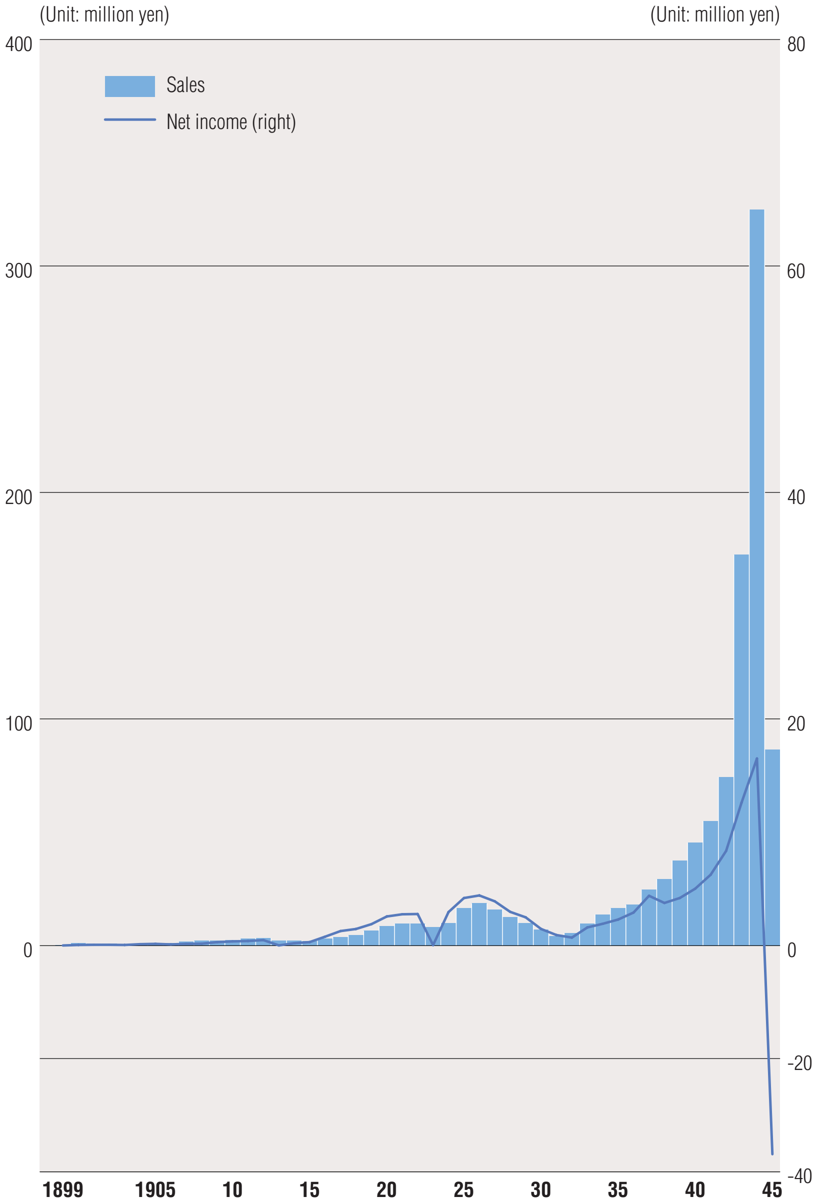
- ■ NEC America
- ■ NEC Electronics
- ■ Active Voice
- ■ NEC Eluminant Technologies
- ■ Vibren Technologies
- ■ Permeo Technologies
- ■ Micro Computer Systems
- ■ NEC de México
- ■ NEC do Brasil
- ■ NEC Argentina
- ● NEC Canada
- ● NEC USA
- ● NEC Logistics America
- ● NEC Solutions (America)
- ● NEC Financial Services
- ● Telecom Lease Funding
- ● HNSX Supercomputers
- ● Niteo Partners
- ● Suplicity
- ● Canopy International
- ● DCM Solutions
- ● NMI
- ● NEC Business Network Solutions
- ● NEC Research Institute
- ● NEC Capital
- ● NEC FiberOptech
- ● NEC de Colombia
- ● Telepremier
- ● Teleconsorcio
- ● NEC de Venezuela
- ● NEC Chile
- ● Telebogota



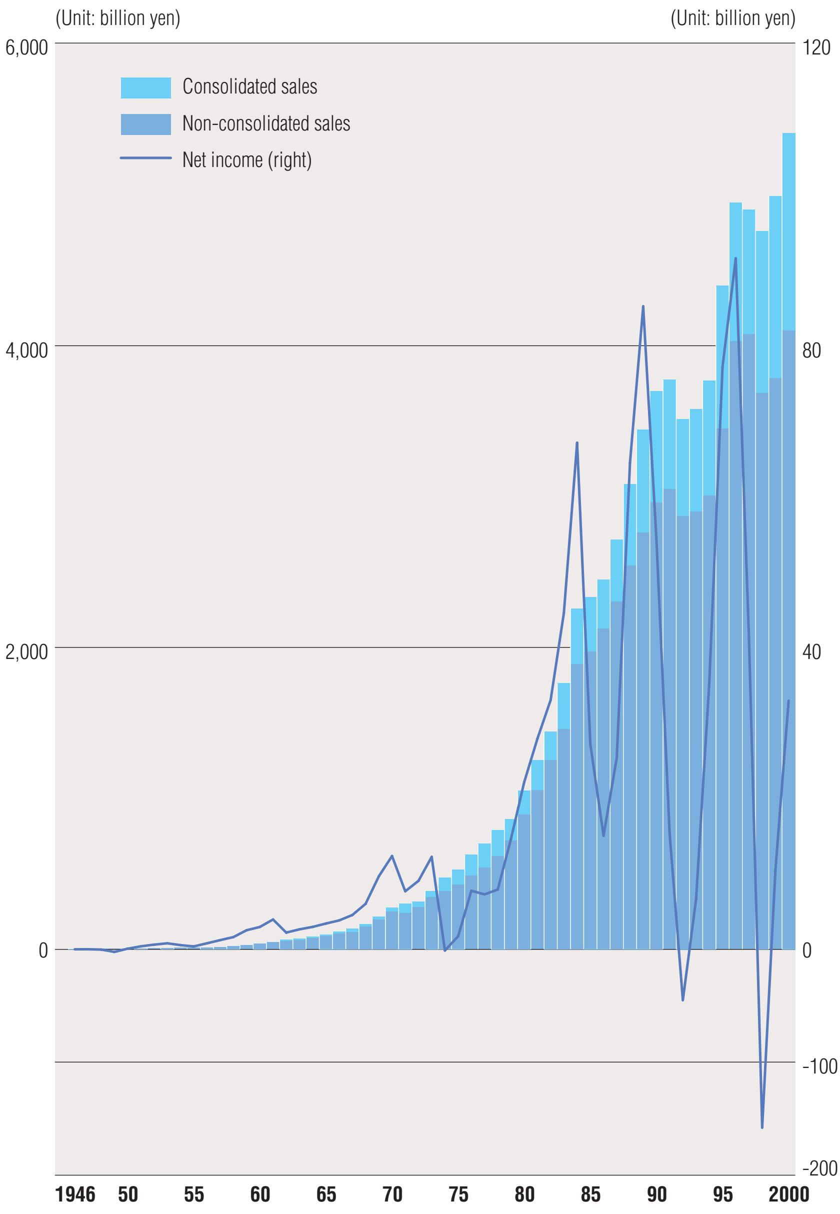
- ■ Overseas Offices (18 Offices in 18 Countries)
- ■ Overseas Manufacturing Affiliates (40 Affiliates in 18 Countries)
- ● Overseas Plants (39 Plants in 17 Countries)
- ● Overseas Marketing and Service Affiliates (57 Affiliates in 22 Countries)

(As of July 1, 2002)

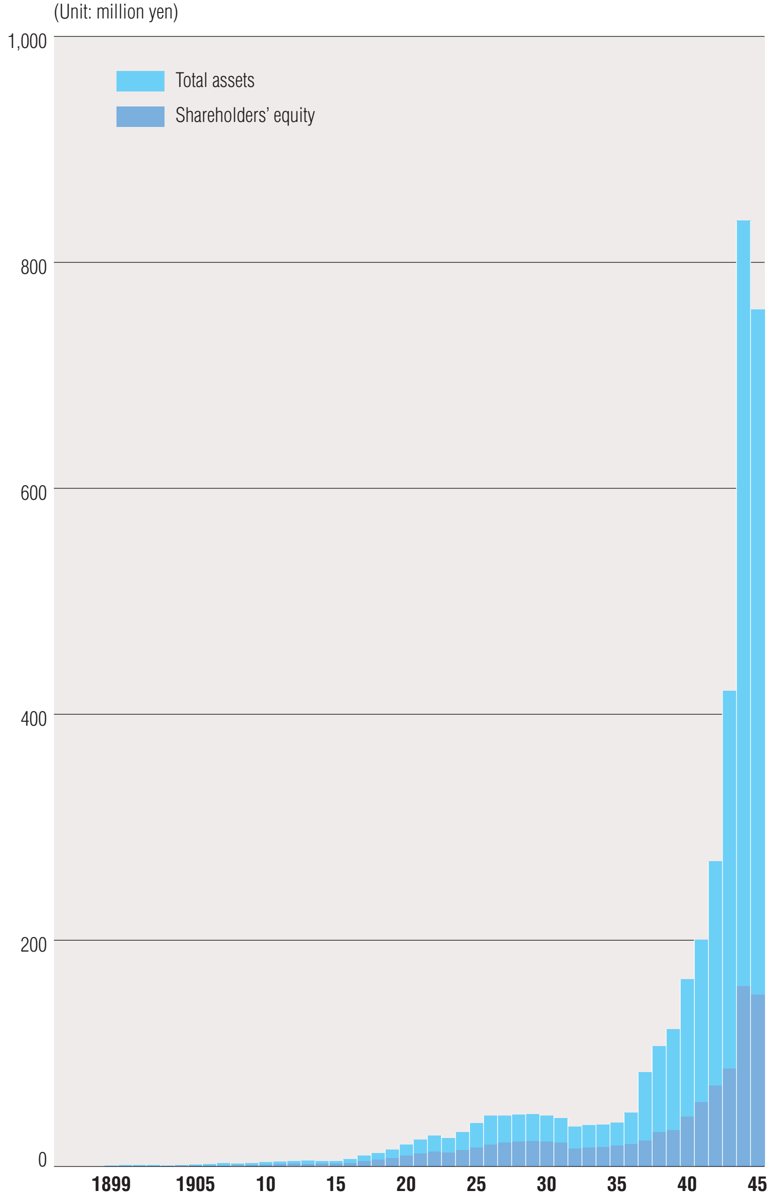
Trends in Sales and Net Income



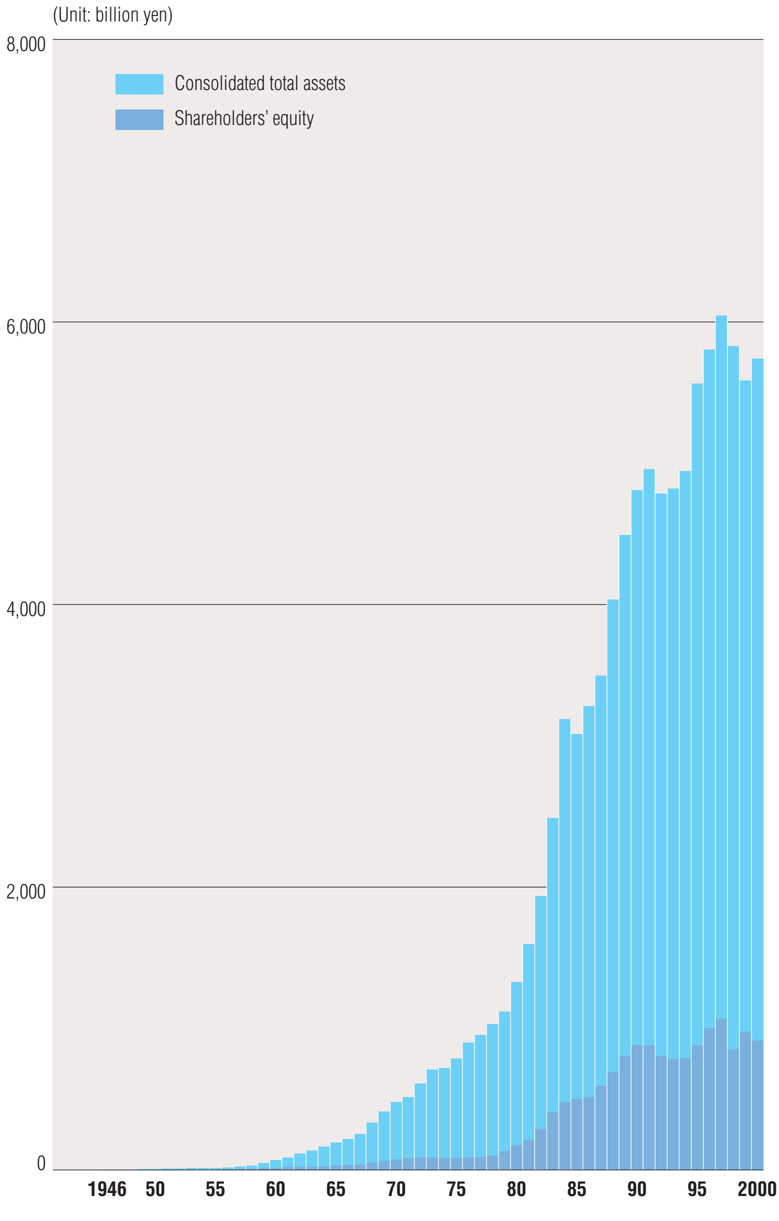
Note 1: Because the reporting period changed frequently over the years, the figures are as of the end of each fiscal year at the time.
Note 2: Net income until fiscal 1961 represents non-consolidated figures as of the end of each fiscal year.


(Unit: billion yen)
(Unit: billion yen)
6,000
4,000
2,000
0
120
80
40
0
-100
-200
Consolidated sales
Non-consolidated sales
Net income (right)
1946
50
55
60
65
70
75
80
85
90
95
2000

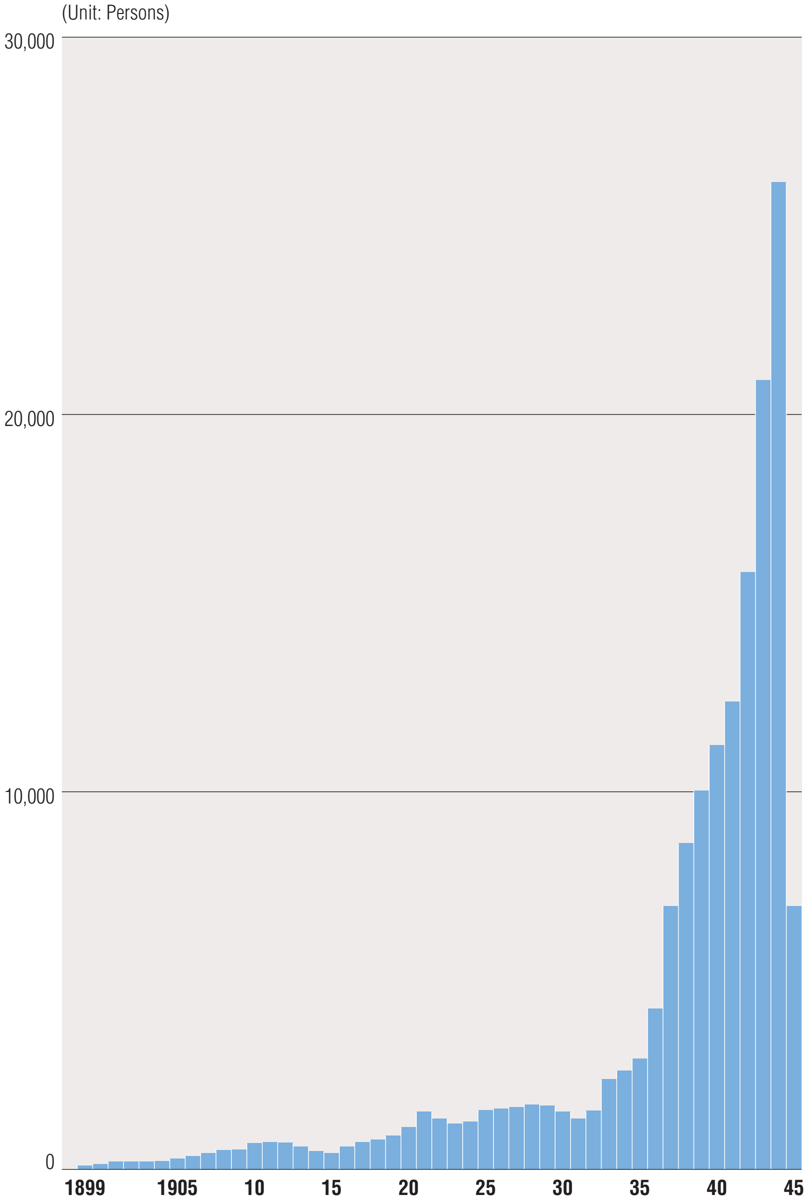
Trends in Shareholders' Equity and Total Assets



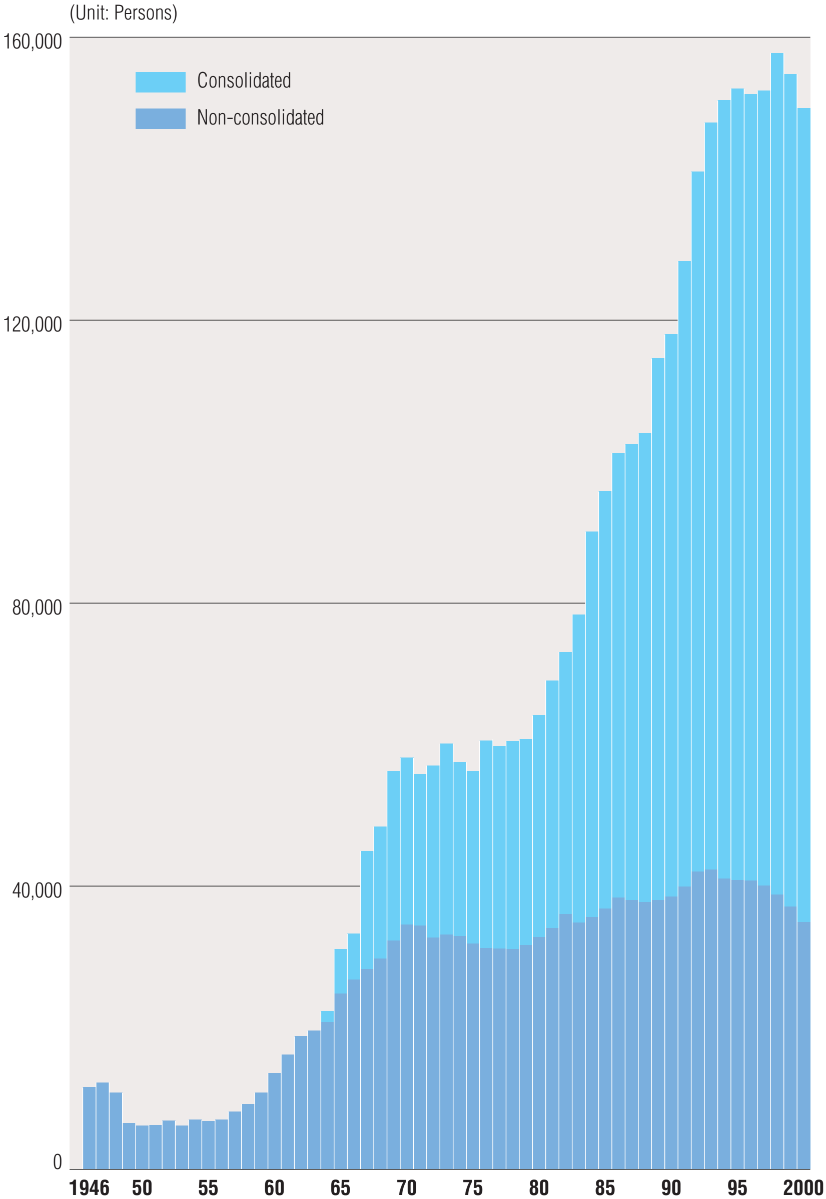
Note 1: Because the reporting period changed frequently over the years, the figures are as of the end of each fiscal year at the time.
Note 2: Total assets until fiscal 1961 are non-consolidated figures as of the end of each fiscal year.


(Unit: billion yen)
8,000
6,000
4,000
2,000
0
Consolidated total assets
Shareholders' equity
1946
50
55
60
65
70
75
80
85
90
95
2000

Trends in Number of Employees



Note: The figures up to and including fiscal 1963 are non-consolidated.


(Unit: Persons)
160,000
120,000
80,000
40,000
0
Consolidated
Non-consolidated
1946
50
55
60
65
70
75
80
85
90
95
2000

Chronology

1876	Mar	***Alexander Graham Bell invents telephone***
1877	Nov	***First Bell telephones imported to Japan from U.S.***
1885	Dec	***Ministry of Communications established***
1886	—	Kunihiko Iwadare leaves Ministry of Communications, travels to U.S., and joins Edison Machine Works (today's General Electric [GE])
1889	—	***Strowger invents automatic telephone switching system***
1890	Dec	***Japan's first telephone exchange business begins in and between Tokyo and Yokohama***
1894	Aug	***Sino-Japanese War begins***
1895	—	Kunihiko Iwadare becomes agent in Japan for GE and Western Electric (WE)
	—	***Guglielmo Marconi conducts successful test of radio-telegraphy***
1896	Dec	H. B. Thayer of WE visits Japan to establish joint venture
1898	Sep	With cooperation from Takeshiro Maeda, Kunihiko Iwadare establishes Nippon Electric Limited Partnership
1899	July	***Revised treaties with Western powers enforced (July 17)***
	July	Nippon Electric Company, Limited, established on July 17 as Japan's first joint venture with foreign capital (capital: 200,000 yen); Kunihiko Iwadare appointed managing director
1902	Apr	Completes construction of No. 1 Plant in Mita section of Tokyo
	May	Publishes first issue of PR magazine *Nippon Denki Geppo* (Nippon Electric Monthly)

1903	May	Imports Japan's first common-battery switchboard from WE and installs it in Kyoto Telephone Office
	Dec	Registers company logo: letters NEC inside diamond-shaped frame
	—	Exports telephone sets to China (company's first exports)
1904	Feb	*Russo-Japanese War begins*
	Dec	Wins exclusive rights to market WE products in Japan
1906	Aug	*Submarine cable telegraph service begins between Japan and U.S.*
	—	*Lee de Forest invents triode (three-electrode vacuum tube)*
1907	—	Introduces WE system of management controls
1909	—	Begins domestic production of common-battery switchboards
1910	—	Abolishes internal subcontracting system and introduces piece-work-rate system
1913	—	Enters cable business
1914	July	*First World War begins*
1915	—	Receives large order from Russia for portable telephones for military use
1916	Jan	Receives orders for telephone switching equipment from Hankou and Wuchang telephone offices in China
1917	Aug	Enters into capital ties with Mitsui and Company, Limited; allots portion of new shares to Mitsui and Company
1918	Jan	Establishes China Electric Company, Limited (CEC) as joint venture in China; holds 25 percent equity
	Apr	WE establishes International Western Electric (IWE) to oversee international operations; WE's equity in Nippon Electric transferred to IWE
	Nov	*First World War ends*
1919	Oct	Implements 8-hour workday
	—	Produces first domestic Type 1 common-battery switchboards for long-distance toll calls; installs them in Tokyo Toll Telephone Office
1920	Jan	*League of Nations established; Japan becomes member*
	Oct	Enters into capital ties with Sumitomo Electric Wire and Cable Works and transfers cable business to Sumitomo
	—	Begins import of loading coils from WE and delivers them to Ministry of Communications
1921	Dec	WE applies content of patent agreement and business ties with Siemens to Nippon Electric
1923	Sep	*Great Kanto Earthquake strikes; telephone system in Tokyo-Yokohama area demolished;* many buildings in Head Office Plant demolished; 105 employees killed at work
1924	Apr	Imports 500W broadcasting equipment made by WE for use in PR broadcasting

	Aug	Experiences large-scale labor dispute stretching over 52 days
	Dec	Together with government move to automate telephone offices, receives orders for Strowger-type automatic switching systems made by ATM for installation in Kyobashi and five other telephone offices in Tokyo
	Dec	*WE spins off R&D division as independent Bell Telephone Laboratories*
1925	July	*All-out radio broadcasting begins (Radio Tokyo, Shiba Atagoyama)*
	Sep	*International Telephone and Telegraph Corporation (ITT) buys out IWE and changes IWE's name to International Standard Electric (ISE)*
1926	Aug	*Nippon Hoso Kyokai (NHK) established*
	Dec	Kunihiko Iwadare appointed chairman; Gen-ichiro Ohata appointed managing director
1927	July	Delivers first domestic-made A-Type automatic PBX to Mitsukoshi Department Store
	—	Begins research into television
1928	Nov	NE-type phototelegraphic equipment transmits scenes of Imperial Accession Ceremony of Emperor Hirohito between Kyoto and Tokyo
1929	Feb	Develops NE-type remote supervisory control system
	July	Produces domestic A-Type automatic switching system for central telephone office; installs first system in Nakano Telephone Office in Tokyo
	Sep	Kunihiko Iwadare resigns as chairman
	Oct	*New York Stock Market crashes; Great Depression begins*
1931	Sep	*Manchurian Incident*
	—	Produces 500W broadcasting equipment for use at NHK radio station in Okayama
	—	Develops domestic-made C-type Three-Channel Telephone Carrier System
1932	June	ISE entrusts management of Nippon Electric to Sumitomo; ISE's equity in Nippon Electric reduced to slightly under 50 percent
	June	Takesaburo Akiyama appointed chairman; Fumio Shida appointed managing director
1933	Mar	*Japan quits League of Nations*
1934	Oct	Delivers Japan's first 100kW broadcasting equipment to Hsinking Broadcasting Station in Manchuria (northeastern part of China)
1935	—	Begins research into multiple ultrashort-wave communications
1936	June	Tamagawa-mukai Plant begins operations
	July	*Wireless photos successfully transmitted between Tokyo and Berlin*

	Dec	Establishes Manchurian Communications Apparatus Co., Ltd.
1937	Apr	Publishes first issue of in-house newsletter *Nippon Electric*
	July	***Sino-Japanese War begins***
1938	Mar	Chairman Takesaburo Akiyama passes away
	Apr	Managing Director Fumio Shida passes away
	May	Masatsune Ogura appointed chairman
	July	Takeshi Kajii appointed managing director
1939	Feb	Transfers shares of CEC to IWE
	June	Produces prototype television set
	July	Integrates R&D operations; establishes research laboratory
	Sep	***Direct call service using nonloaded cable begins between Tokyo and Mukden (today's Shenyang in China)***
	Sep	***Second World War begins***
	Dec	Tests radar device successfully
1940	Jan	Conducts successful television tests at Hankyu Department Store in Osaka
	Sep	Decides on official company song
	Sep	***Japan signs Tripartite Treaty with Germany and Italy***
1941	Apr	Shun-nosuke Furuta appointed chairman
	June	Establishes research laboratory annex in Ikuta, in Tokyo suburbs, as focal point for research of radio-wave weapons
	Dec	***Pacific War begins***
	Dec	Places shares held by ISE in trust as assets of belligerents
1943	Jan	Becomes major affiliate of Sumitomo
	Feb	Changes name to Sumitomo Communication Industries Company, Limited; introduces president system, and Managing Director Takeshi Kajii appointed president
1944	Jan	Most of company's plants designated munitions plants under Munitions Company Law
1945	Apr	Tamagawa-mukai Manufacturing Works heavily damaged in air raid
	June	Okayama Manufacturing Works completely destroyed in air raid
	Aug	***Atomic bombs dropped on Hiroshima and Nagasaki***
	Aug	***War ends;*** company has 28,000 employees; 12,000 are conscript laborers, students, and volunteer women
	Aug	***General Headquarters (GHQ) of Allied Powers established***
	Oct	***United Nations (UN) established***
	Nov	***Sumitomo Honsha, Ltd., announces dissolution of Sumitomo zaibatsu***
	Nov	Changes name back to Nippon Electric Company, Limited
1946	Jan	Takeshi Kajii resigns as president; Nagao Saeki appointed president
	Feb	***University of Pennsylvania builds ENIAC, world's first computer (vacuum tube type)***

	May	Signs first labor contract
	June	Nippon Electric Combined Labor Union established
	Oct	GHQ's Civil Communications Section (CCS) provides guidance to company on statistical quality control
1947	May	*Constitution of Japan comes into force*
	June	Toshihide Watanabe appointed president
	Oct	Labor struggle breaks out; employees strike for 45 days
	Dec	*William B. Shockley and others at Bell Telephone Laboratories invent transistor*
1948	Oct	Publishes first issue of *NEC*, new technical magazine
1949	Apr	*Dodge Line of anti-inflation measures introduced*
	Apr	Formulates corporate reconstruction and reorganization plan
	May	Closes Ikuta Research Laboratory and plants in provinces (Ogaki, Seto, and Takasaki plants)
	Oct	Government approves reconstruction and reorganization plan
	—	Restarts research into television
1950	Jan	Conducts first reevaluation of assets; financial content and business performance stabilize
	June	*Three radio wave laws promulgated; Nippon Hoso Kyokai (NHK) reorganized and private broadcasting slated for approval*
	June	*Korean War begins*
	Aug	Begins research into transistors
	Nov	Revives technical ties with ISE
	—	Begins producing No. 4 type telephone set
1951	Sep	*Japan signs San Francisco Peace Treaty*
	Sep	*Private radio broadcasting begins in Nagoya and Osaka*
	Nov	Revives equity ties with ISE
	Nov	Takeshi Kajii appointed chairman
	—	Exports medium-wave broadcasting equipment to Korea (first postwar exports)
1952	July	Begins mass production of cathode ray tubes for television sets
	Aug	*Nippon Telegraph and Telephone Public Corporation (NTTPC) established*
	Aug	*Japan joins IMF*
	Nov	Receives Deming Application Prize (first time for company in communications industry)
1953	Feb	*NHK's Tokyo Broadcasting Station provides first regular television broadcasting services*
	Mar	Delivers microwave PTM (pulse time modulation) multiplexing equipment to Tohoku Electric (Japan's first wholly automated repeater line)

	Mar	*Kokusai Denshin Denwa Co., Ltd. (KDD), established*
	Apr	*NTTPC implements First Five-Year Telegraph and Telephone Expansion Plan*
	June	Splits off Radio Receivers Division and transfers operations to newly established New Nippon Electric Company, Ltd.
	July	Reopens research laboratory
	Aug	*Nippon Television provides first regular television broadcasting by private broadcasting station*
	—	Produces prototype germanium point contact diodes and alloy transistors
1954	July	Imports crossbar (XB) switching system made by Kellogg Switchboard and Supply Company of U.S. and delivers to NTTPC's Takasaki Telephone Office
	—	Begins research into computers
1955	Sep	*Japan joins General Agreement on Tariffs and Trade (GATT)*
	—	Develops 7 GHz PAM-FM system (high-sensitivity receiver system)
1956	Apr	Establishes Nippon Electric Technical School
	June	Exports 2 GHz microwave communications testing equipment to India; company's first such exports
	July	Installs first domestic-made XB switching system in Sanwa Telephone Office (Tochigi Prefecture)
	July	*Economic Planning Agency publishes Economic White Paper; states "Postwar period is over"*
	Aug	Introduces industry division system
	Nov	Delivers first domestic-made television broadcasting equipment to Osaka Television and Chubu-Nippon Broadcasting
	Dec	Produces prototype electronic switching system using parametrons
	Dec	*Japan joins U.N.*
1957	Oct	*Soviet Union launches Sputnik I, world's first artificial satellite*
1958	Mar	Establishes Taiwan Telecommunications Company (first postwar overseas joint venture)
	Mar	Develops parametron computers NEAC-1101 and NEAC-1102
	Apr	Builds factory inside Tamagawa Plant for exclusive production of transistors; begins mass production of transistors
	Sep	Develops fully transistorized NEAC-2201 computer
	Sep	*Texas Instruments develops IC*
	—	Develops over-the-horizon microwave communications system
1959	June	Exhibits NEAC-2201 computer at UNESCO AUTOMATH Show in Paris as first fully transistorized computer operated in public venue

1960	Feb	Begins development of ICs
	Mar	Installs NEAC-2203 in Kinki Nippon Railway Co. for operating Japan's first online, real-time seat reservation system
	Mar	Develops time division electronic switching system; delivers first system to Mitsukoshi Department Store
	Aug	***U.S. launches first communications satellite, Echo I***
	Sep	***NHK and four private broadcasting stations begin first regular color television broadcasts***
1961	Apr	Opens first postwar overseas office in Taipei
	Apr	***Soviet Union launches Vostok I manned satellite***
	Apr	Introduces business division system
	Oct	Participates in communications network expansion project in Philippines, accompanied with large orders for telephone equipment and facilities
1962	Feb	Exports technology for over-the-horizon microwave communications equipment and carrier equipment to ITT in U.S. (first exports of technology to advanced industrial nation)
	July	Signs technical assistance agreement with Honeywell related to electronic data processing equipment
	Nov	Sagamihara Plant begins operations
1963	Jan	Establishes Nippon Electric New York, Inc. (later, NEC America, Inc.)
	Jan	***Bell Telephone Laboratories announces No. 1 ESS electronic switching system***
	Feb	Issues American Depositary Receipts (ADRs)
	Mar	Registers new NEC trademark
	Sep	Signs patent licensing agreement with Fairchild concerning planar process for producing semiconductor devices and ICs
	Nov	***First experimental satellite-relayed television broadcast between Japan and U.S. reports assassination of President John F. Kennedy***
	—	Installs over-the-horizon microwave circuits for U.S. Forces in Japan (total length 3,134 kilometers)
1964	Apr	***Japan joins OECD and accedes to Article 8 status in IMF***
	Apr	***IBM introduces IBM System/360***
	May	Introduces NEAC-2200 computer (later, NEAC-Series 2200 Model 200)
	May	Delivers special 16-channel bank system for terminal equipment to KDD for Trans-Pacific submarine cable
	May	Fuchu Plant begins operations
	Aug	***International Telecommunications Satellite Organization (Intelsat) established***
	Oct	***Portions of 1964 Tokyo Olympics successfully televised via satellite***
	Nov	Toshihide Watanabe appointed chairman, and Koji Kobayashi appointed president

	—	Provides all equipment needed for Kashima Satellite Communications Earth Station of Ministry of Posts and Telecommunications
1965	Mar	Installs experimental system for postal automation in Omiya Post Office outside Tokyo
	Apr	***World's first commercial communications satellite, Early Bird (later renamed Intelsat 1), successfully launched***
	May	Implements new business division system
	May	Introduces ZD movement
	May	Introduces NEAC-Series 2200 computers
	Aug	Delivers PCM-24 digital transmission system to NTTPC
1966	Mar	Exports experimental-use satellite communications earth station to India (first export of satellite communications earth station)
	May	Public testing of STAR satellite communications system at Hot Springs, Arkansas, experimental station
	July	Delivers first commercial-use C400 XB switching system to NTTPC Ginza Central Office in Tokyo
1967	Feb	Markets very small-size NEAC-1240, world's first computer to use ICs throughout
	July	Receives order from Thailand for XB switching systems for four central telephone offices
	July	Receives order from Brazil for first stage of southern microwave communications system project
	Dec	Receives order from Mexico for commercial satellite communications earth station, used later to televise Mexico City Olympics
1968	Jan	Installs NEAC-2200/500 at Osaka University; enables Japan's first computer time-sharing service
	Mar	Develops 144-bit high-speed N-channel MOS IC memory
	Mar	Establishes NEC de Mexico, first wholly owned manufacturing subsidiary operated overseas
	Nov	Establishes NEC do Brasil
	Nov	Delivers automatic program control systems to NHK broadcasting center and to its rural broadcasting stations throughout Japan
1969	July	Receives large-scale order from Taiwan for XB switching systems
	July	***U.S. Apollo 11 spacecraft lands on lunar surface; live television coverage of man's first step on Moon***
	Aug	Yokohama Plant begins operations
	Sep	Establishes NEC Kagoshima for producing fluorescent indicator panels (FIP), and establishes NEC Kyushu for producing semiconductor devices (afterward, establishes number of other local production subsidiaries)

	Dec	Establishes NEC Australia
1970	Jan	Participates in international consortium that successfully wins order to build Integrated National Telecommunications System in Iran (Iran INTS)
	Feb	Delivers Osumi experimental satellite to Institute of Space and Aeronautical Science of University of Tokyo
	Mar	***EXPO '70 held in Osaka***
	Apr	Develops SPADE (Single Channel Per Carrier PCM Multiple Access Demand Assignment Equipment) system; receives first order for such system from COMSAT in U.S. for use at Etam Station in West Virginia
	June	***IBM announces IBM System/370***
	Sep	***Honeywell buys GE's computer division, establishes Honeywell Information Systems Inc. (HIS)***
1971	June	Installs first D10 electronic switching system in Ginza Central Office in Tokyo
	Aug	***U.S. halts dollar-gold convertibility***
	Nov	***Intel Corporation markets world's first microprocessor, 4-bit i4004***
	Dec	***Smithsonian Agreement takes effect ($1.00 = 308 yen)***
1972	Jan	Implements company-wide quality management program (Operation Q)
	Apr	Develops first domestic-made microprocessor, μPD700 Series
	Sep	Builds transportable satellite communications earth station in Beijing to televise visit of Prime Minister Kakuei Tanaka to China
	Sep	***Sino-Japanese relations normalized***
1973	Feb	***Restrictions removed from system of fluctuating exchange rates (starts at $1.00 = 264 yen)***
	June	Relocates Head Office to Morinaga Plaza Building near Mita Plant (until 1990)
	Aug	Markets office computer NEAC-System 100
	Sep	Lists shares on Amsterdam Stock Exchange
	Oct	***First Oil Crisis due to outbreak of fourth Middle East War***
	Nov	Markets 4-bit single-chip general-purpose microprocessor μCOM-4
1974	Mar	NEC-Toshiba Information Systems established
	Mar	Lists shares on Frankfurt Stock Exchange
	May	Introduces new computer series, ACOS Series 77
	July	Establishes NEC Malaysia and NEC Ireland (first steps in moving semiconductor production overseas)
	Nov	Develops 4Kb DRAM
	Dec	***Full liberalization of IC capital and imports***

1975	May	Completes construction of new Central Research Laboratories in Kawasaki near Tokyo
	June	FS-10 Frame Synchronizer receives Emmy Award
	Sep	Establishes NEC Software
	Dec	*Full liberalization of computer capital and hardware imports*
1976	Mar	*VLSI Technology Research Association established*
	June	Koji Kobayashi appointed chairman, and Tadao Tanaka appointed president
	Aug	Markets TK-80, microcomputer training kit
	Dec	Announces Distributed Information Processing Network Architecture (DINA)
1977	Apr	Markets 16Kb DRAM
	Apr	Establishes NEC Information Systems, Inc., in U.S.
	July	*Japan's first geostationary meteorological satellite Himawari successfully launched*
	Oct	Participates in INTELCOM 77 held in Atlanta, Georgia; Chairman Kobayashi speaks about integration of computers and communications in keynote address (C&C declaration)
	Oct	Announces NEAX61 digital switching system in New York
1978	Mar	Markets DP-100 speaker-dependent continuous speech recognizer
	Mar	ISE sells all shareholdings of Nippon Electric
	Mar	*Backlog of telephone applications eliminated; telephones installed without delay*
	June	Establishes C&C Committee
	June	Delivers fiber optic cable system to Vista Florida Telephone Co. (world's first commercial-use fiber optic cable system)
	Aug	Receives order for 100 small-size earth stations for satellite communications from Satellite Business Systems Co. (SBS) of U.S.
	Oct	NEC America, Inc., completes construction of Dallas Plant for producing electronic PBXs and key telephones
	Dec	Purchases Electronic Arrays, Inc., semiconductor manufacturer (merged later with other companies and renamed NEC Electronics U.S.A., Inc.)
1979	Jan	*World's first satellite-relayed live television broadcast from Antarctica*
	Jan	*Second Oil Crisis*
	Mar	Markets office computer ASTRA Series in U.S.
	Mar	*Nationwide direct dialing network completed*
	Sep	Markets PC-8001 personal computer
	Dec	*NTTPC begins car telephone service in Tokyo's 23 wards*
	—	Develops 64Kb DRAM

1980	Mar	Receives order from Argentina for digital communications network for use in Buenos Aires
	May	Becomes three-year sponsor of NEC Federation Cup
	June	Tadahiro Sekimoto appointed president
	Sep	Markets ultra-large general-purpose ACOS System 1000 (NEC System 1000) computer
1981	Jan	Establishes NEC Semiconductors (UK)
	Jan	***NTTPC opens procurements of materials and equipment to overseas companies***
	Mar	Establishes NEC Electronics U.S.A. Inc. (today's NEC Electronics Inc.)
	Apr	Implements Software Quality Control (SWQC) Campaign
	Sep	Lists shares on London Stock Exchange
1982	Jan	***U.S. Department of Justice antitrust suit settled after AT&T accepts government's divestiture proposal***
	June	Convenes first NEC International ZD Convention
	June	Markets world's first 16-bit personal terminal (later renamed "personal computer") N5200/05
	July	Installs first commercial-use D70 digital switching system for toll calls in Aomori Telephone Office
	Aug	***IBM announces its first personal computer IBM PC***
	Oct	Abiko Plant begins operations
	Oct	Markets 16-bit PC-9801 personal computer
	Dec	Receives order for automated fingerprint identification system (AFIS) from San Francisco Police Department and puts it into operation in March 1984 (first exports of AFIS)
1983	Apr	Lists shares on Switzerland's three stock exchanges
	Apr	Completes development of SX-1 and SX-2 supercomputers
	Apr	Changes company's English name to NEC Corporation
	July	Her Majesty Queen Elizabeth II guest of honor at ceremony marking start of operations of NEC Semiconductors (UK)
	Oct	Demonstrates research model of automatic interpretation system at TELECOM 83 in Geneva
	—	Announces V20 and V30 16-bit original microcomputers
	—	Markets 256Kb DRAM
1984	Mar	Begins shipping ACOS System 1000 (NEC System 1000) to HIS on OEM basis
	June	***After Daini Denden Incorporated (today's DDI Corporation), other new common carriers established***
	Aug	***IBM markets IBM PC/AT***
	Dec	Receives order for AFIS from California Department of Justice, one of the biggest customers of NEC's AFIS; in August 1985, system helps arrest Night Stalker in L.A.
1985	Feb	***NTTPC completes laying fiber optic cables across Japanese archipelago***
	Mar	Establishes C&C Foundation

	Apr	*NTTPC privatized as Nippon Telegraph & Telephone Corporation (NTT)*
	Sep	*Plaza Accord (cooperative economic measures to offset appreciated U.S. dollar)*
	Oct	Begins C&C-VAN service
	Nov	*Microsoft Corporation ships Windows 1.0*
	Dec	SX-2 supercomputer demonstrates world's fastest performance
1986	Feb	Markets ACOS System 2000 (NEC System 2000) series of ultra-large general-purpose computers
	Feb	Develops 4Mb DRAM
1987	Mar	Assumes equity position in Honeywell Bull Inc. in U.S.
	Mar	Starts delivery of nationwide integrated postal service communications network (P-NET) to Ministry of Posts and Telecommunications
	Apr	*Cellular phone service begins*
	Sep	Certified as first international VAN operator in Japan
1988	May	Confers title "Chairman Emeritus" on Koji Kobayashi; Atsuyoshi Ouchi appointed chairman
	June	Establishes NEC Research Institute, Inc., in Princeton, New Jersey
1989	June	Opens Tsukuba Research Center
	Nov	NEC Information Systems and NEC Home Electronics USA merged to form NEC Technologies, Inc.
	Nov	Markets 98NOTE, notebook version of PC-9801
	Nov	*Berlin Wall removed*
	—	All-out entry into color liquid crystal display (LCD) market
1990	Jan	Moves head office operations to newly completed Head Office, NEC Super Tower
	Apr	Enters secondary battery business
	May	Markets laptop computer with TFT color LCD (TFT-LCD) panel
	June	Kenzo Nakamura appointed chairman
	July	Implements NEC Super 21 Campaign, and introduces Corporate Philosophy and Management Commitment
1991	Jan	*Gulf War erupts; international coalition forces begin bombing Iraq*
	Mar	Establishes NEC Foundation of America in U.S.
	Apr	Delivers Mova N folding-type cell phone with volume of only 150cc to NTT
	July	Assumes equity position in Compagnie des Machines Bull of France
	July	Implements C&C Business Structure in company-wide reorganization
	Oct	Markets world's first color LCD notebook computer
	Nov	Establishes NEC Environmental Principles

	Nov	Carbon nanotube discovered at NEC Central Research Laboratories; prediction of new substance
	Dec	Establishes joint venture Shougang NEC Electronics Co., Ltd., in China
1992	July	Announces NEC 21st Century Vision, new NEC mark, and single "communications" name—"NEC"
1993	Mar	Markets parallel computer Cenju-3
	Mar	Hosts First Meeting of Council of International Advisors
1994	Jan	***North American Free Trade Agreement (NAFTA) takes effect, and European Union launched***
	May	Markets AX7300, small model in Parallel ACOS Series
	June	Tadahiro Sekimoto appointed chairman, and Hisashi Kaneko appointed president
	July	C&C Research Laboratories opened in outskirts of Bonn, Germany
	Nov	Markets Express5800 Series of high-performance servers
1995	Jan	***Great Hanshin-Awaji Earthquake: over 6,000 killed, 280,000 telephone lines lose service***
	Feb	Develops 1Gb DRAM
	June	Domestic shipments of PC-9800 Series reach 10 million units
	Aug	***Microsoft markets Windows95***
1996	July	Begins providing BIGLOBE multimedia service, fusing Internet and PC communications
1997	Feb	Presented first Japan Quality Award, established by Japan Productivity Center for Socio-Economic Development
	Feb	Markets 42-inch color plasma display panel (PDP)
	July	***Hong Kong reverts to China***
	Oct	Markets PC98-NX Series of personal computers with advanced specifications
1998	June	Markets world's fastest supercomputer, SX-5 Series
1999	Feb	***NTT DoCoMo, Inc., begins i-Mode Internet access service for cell phones***
	Mar	Introduces Digital Mova N501i HYPER for NTT DoCoMo's i-Mode service
	Mar	Hajime Sasaki appointed chairman, and Koji Nishigaki appointed president
	Apr	Establishes NEC Code of Conduct
	July	Celebrates 100th Anniversary (July 17)
2000	Apr	Divides all business operations among three in-house companies; introduces Corporate Officer System to conduct daily business operations

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