Introduction

The story of Werner von Siemens (1816–92) is an important part of the history of industrialization in Germany. Siemens played a key role in German industrialization as an inventor and, especially, as an entrepreneur with a broad and international business vision. He worked successfully to take German technology to other countries. The result was the founding of a profitable business enterprise that bore his name, that continued his approach of combining entrepreneurial and international vision with technological innovation, and that stood at the end of the twentieth century as one of the largest industrial firms in the world.

Industrialization began in Germany in the middle of the 1830s, and the processes of industrial change accelerated around 1850. Before industrialization, the German economy was largely agricultural and less prosperous than other economies of western Europe, and certainly less vigorous than the economy of Britain, where industrialization first began to appear in the late eighteenth century. With industrialization, however, combined with political union after 1870, the German economy boomed, and Germany became one of the world’s economic powers.

Werner von Siemens’s prominence in German industrialization resulted from his participation as an inventor and entrepreneur in electrical technology. During his lifetime,
industrialization in Germany went through two phases. The first phase saw the construction of railway lines, the growth of new technologies in mechanical engineering, and the appearance of heavy industry, especially iron and steel. The second phase took place at the end of the nineteenth century. Sometimes called the “second industrialization,” it took a rather dynamic course in Germany as compared with other nations. The increasing utilization of electricity and of newly developed inorganic and organic chemical products were the predominant characteristics of the “second industrialization” in Germany. Both the electrical and the chemical industries were fundamental innovations, as defined by the Austrian economist Josef Schumpeter, fostered by technical progress in science and engineering. Although by 1914 the production value of these “new” industrial branches and their share of the total number of employees were still minor in comparison with “traditional” industries, electrical and chemical goods were enjoying above average growth rates and had obvious potential for substantial expansion.

Siemens was an electrical engineer who developed several inventions that proved highly profitable. He was first acclaimed in the field of telegraphy, and founded a firm, Siemens & Halske, that built Germany’s first important telegraph line and that went on to build telegraph lines elsewhere in Europe and in Asia. Siemens learned how to insulate wires with gutta-percha, a natural latex from the Palaquium gutta tree in Malaysia, and this invention allowed his firm to be a pioneer in laying underground and submarine telegraph cables. The most dramatic among Werner von Siemens’s many inventions was the modern electric dynamo, which made possible the inexpensive generation of electricity.

The Development of Electrical Engineering

The electrical engineering projects and the business of supplying electrical goods in which Siemens participated had their origins in breakthroughs in scientific knowledge about elec-
tricity. The theory of electricity developed as a science at the end of the eighteenth century from the observation and interpretation of physical phenomena. The study of electricity represented an entirely new field of physics, thencefore dominated by the study of mechanics and the initial investigations of thermodynamics. Within two centuries the basic laws concerning electricity were discovered and investigated. Engineers learned how to apply electricity as a practical form of energy. The new product technology associated with electricity escalated rapidly, and the financial benefits of using electricity led investors to adopt its technology. Just as the overall process of economic growth since the middle of the nineteenth century was self-supporting owing to the primary and secondary effects of income and capacity, so too was the development of the electrical industry driven by multiplying opportunities in its product technology. Siemens and others invented, improved, and manufactured machines and instruments for the production, storage, transmission, and transformation of electrical energy into other forms of useful energy.

Once the basic principles of electrical energy were understood, Siemens and others discovered and explored new possibilities of and applications for electricity. Consequently, by the end of the twentieth century electrical engineering came to be, directly or indirectly, intimately connected with all spheres of daily life. Growth in the world market for electrical and electronic products and services has been positive throughout this period. With a value of $1,712 billion in 1993, the world market in electrical and electronic equipment is one of the largest, and with a 12% share of manufacturing, the electrical industry is the second largest industrial branch.

Before 1780, observers knew electricity merely as a curiosity, as something generated by rubbing glass rods or sulphur spheres with silk or wool, what was later called "static electricity." Observation of the electricity generated by this rubbing, and of lightning and magnetism, increasingly aroused the curiosity of many philosophers and physicists in the second half of the eighteenth century, the Age of Enlightenment. Electrotech-
nical experiments resulted in the discovery of new phenomena, some of which could soon be put to practical use. A major breakthrough occurred in 1780 when Luigi Galvani (1737–98) discovered contact electricity. Further contributions soon appeared: Charles-Augustin de Coulomb (1736–1806) discovered a law, named after him, describing the forces of attraction and repulsion of electrical charges. The lightning rod invented by Benjamin Franklin (1706–90) is still in use today. Georg Simon Ohm (1789–1854) was the first to express the relations between electrical current, voltage, and resistance in a law, which was to bear his name. André-Marie Ampère (1775–1836) established a law on the interaction between two parallel conductors carrying electrical currents. Hans Christian Ørsted (1777–1851), while analyzing the effects associated with continuous (direct) current, observed the declination of a magnetic needle by an electrical current. His discovery of the mutual interaction between electric and magnetic fields made him the founder of the science of electromagnetism.

In the following decades the Englishmen Michael Faraday (1791–1867) and James Clerk Maxwell (1831–79) systematically developed the experimental foundations of electrical engineering. Faraday found out that a voltage was generated when a conductor or a coil was moved in a magnetic field (induction). This discovery enabled the use of electricity as a practical form of energy. Maxwell confirmed the mutual relations between an electrical current and a magnetic field discovered by Ørsted and Faraday. In addition, he devised equations, named after him, which provided the theoretical-mathematical tools for subsequent practitioners.

Although the principle of electromagnetic induction made the transformation of mechanical into electrical energy feasible, its practical use was still limited. Galvanic elements could not be produced in any size, and the magnetic-electrical machines using induction to generate electrical power needed large permanent magnets, which proved difficult to produce and which, in addition, reduced the efficiency of the machines.

For these reasons the beginnings of the electrical industry were identical with the development of low-current technol-
ogy, as signal transmission technology was called at that time to distinguish it from electrical power technology. The first products of the low-current technology “industry,” which during the early stages was still based on a centralized workshop type of production, were the electrical telegraph, the overhead lines, and the cable for long distance telecommunication. The development of the first electrical industry was made possible by the improvements to the telegraph made in 1837 by the American Samuel Morse. Morse constructed the first electrical telegraph producing a line in zigzag writing at the receiving station. His system soon replaced the existing optical systems, based on stations on hills using semaphore, and proved superior to the pointer type electrical telegraph invented by Charles Wheatstone. The system developed by Morse was able to meet
the rapidly increasing demand for information and communication systems as the world economy developed. In his system direct current, provided by galvanic elements and switched on in short and longer intervals in the rhythm of Morse code, served as the medium of communication.

Werner von Siemens: Inventor and Businessman

Werner von Siemens was among the leading personalities who created the conditions for the development of electrical technology from the initial experimental stage into the modern electrical industry. From 1888 on, after he had been granted hereditary nobility, he bore the name Werner von Siemens, a name virtually synonymous with the early stages of German electrical technology. Siemens’s prominence—and the importance of the enterprise Siemens & Halske, founded by him in 1847 and the nucleus of the present Siemens Corporation—has attracted the attention of biographers and of historians of industrial economy and of technology. A short time after Werner’s death, and under the supervision of his younger brother Carl, Richard Ehrenberg began a study entitled “The Enterprises of the Siemens Brothers” (“Die Unternehmungen der Brüder Siemens”). This work was never completed; the first volume alone was published in 1906. On the occasion of Werner’s 100th birthday, Conrad Matschoß published a short description of his “life and accomplishments” (“Leben und Werk”) in conjunction with a partial edition of his letters. In 1966, as part of the activities for the 150th birthday of the founder of German electrical technology, Sigfrid von Weiher published a synopsis of the publications mentioned above, and of numerous specialized studies that had been prepared in the meantime.

The scholarly exploration of Werner von Siemens’s life and accomplishments has emphasized primarily his importance in the technological development of electrical engineering. This
emphasis is appropriate, considering Siemens's pioneering inventions and developments, such as the pointer telegraph and the discovery of the dynamo-electric principle—to mention only the most important. The impact of his achievements in the nineteenth century might well be compared to the rapid advancements in microelectronics in the twentieth century. Because of Siemens's outstanding contributions to technology, his importance as a businessman has received less attention, despite the fact that his activities as a businessman promoted the development of the electrical industry in a decisive way. Notwithstanding his strong interest in technology, Werner von Siemens until the last years of his life expended much effort on the acquisition of profitable enterprises that would enhance the prestige of his firm. Many of these enterprises were engaged not only in production but also in the installation and operation of industrial plants.9

Werner von Siemens left his mark as a businessman and as an inventor. In that respect he differed from Wheatstone and Morse, whose contributions were limited to science and invention. Unlike those two important contemporaries, Siemens provided a synthesis between science and business, establishing the business philosophy of the Siemens company that persists to the present day. Siemens's approach, and the approach of the company that bears his name more than a century after his death, may be summed up as the use of the technical and economic possibilities of electricity in a general and universal sense, concentrating almost exclusively on electrical engineering and electronics. Siemens the man and Siemens the company were involved in almost the entire spectrum of electrical technology, including activities and representation in all the world's markets.10

As a businessman, Siemens combined the qualities of the entrepreneur and the manager. Recent research on the concept of entrepreneurship considers an entrepreneur as distinct from a manager in that an entrepreneur makes decisions of strategic importance that transcend the mere managerial level of a firm. In addition, an entrepreneur differs from a capitalist in that his own stake in the capital of the enterprise is of secondary
importance to his position. For a long time Werner von Siemens engaged personally in managerial tasks in his firm and, after the first consolidation, became the most important contributor of its capital. Entrepreneurial activities, however, were always of primary concern to him.

The established scholarship on Siemens stressing his role as an inventor reflects his own wishes. He wanted to be seen as a scientist and inventor. Siemens never showed great interest in or particular esteem for the profession of a businessman. In spite of his predilections, however, Siemens's own writings, both published and unpublished, reveal a man with a business vision and the ability to carry out that vision. For instance, the treatise "On the Transformation of Mechanical Power into Electrical Current without the Application of Permanent Magnets," which Siemens submitted to the Academy of Sciences of Berlin on January 17, 1867, reveals him to be not only a scientist trying to get to the bottom of the observed phenomena but also an engineer and farsighted businessman deducing, from his experiences with his experimental machine, the following prediction: "At present, technology has acquired the means to generate electric currents of unlimited strength in an inexpensive and convenient way at any place where mechanical power is available. This fact will be of utmost importance in several of its branches."12

Werner von Siemens outlined his expectations for his invention in even greater detail in a letter to his brother Wilhelm in England, dated December 4, 1866: "Provided the design is correct, the effects should turn out to be enormous. This concept can well be expanded and may initiate a new era in electromagnetism. Thus magnetic electricity will become available very inexpensively, and lighting, galvanometallurgy, etc., even small electromagnetic machines obtaining their energy from larger ones may become feasible and useful."13 At this early stage, Werner von Siemens already envisioned the principal applications for electric power that were in general use by the time of his death. This vision, combined with Siemens's business acumen, led to the creation of a significant industry. When Siemens died in 1892, Siemens & Halske alone pro-
duced 1,000 electric generators annually, had sales of almost 20 million marks, and employed 6,500 persons worldwide, 4,775 of whom worked in Germany.

The Enterprise Siemens & Halske

For the most part, historians of the many firms of the Siemens Corporation have focused on the history of the firm Siemens & Halske in Berlin. But such an approach overlooks the fact that the business strategy of Werner von Siemens was internationally oriented. This strong international orientation was apparent even before the foundation of the Telegraph System Construction Enterprise in 1847, and it continued as the existence of the Berlin business came to be based almost exclusively upon its foreign relationships. Indeed, the growth of the foreign branches occasionally outpaced the parent enterprise in Berlin. The international orientation and the corporate identity of the present Siemens Corporation dates back to the spirit of the founder. Ever since its founding, the firm has been a European enterprise while retaining characteristic German features. At the end of the 1870s this international orientation was emphasized by the establishment of a production plant in Austria, and since 1890 by the creation of Siemens Technical Offices at home and abroad. During Siemens’s lifetime, only a few other German businessmen showed a determination comparable to that of Werner and his brothers in regard to the establishment of branches in other European countries.

Against this background, the present study, which was initiated on the occasion of the 100th anniversary of Werner von Siemens’s death on December 6, 1892, focuses on the most important strategic decisions for the development of the multinational Siemens enterprise, on the specific reasons for the engagement abroad, and on the international marketing strategies pursued. This emphasis on business activities is not intended to detract from Siemens’s achievements as a scientist, technician, and inventor, particularly since they formed the
basis for his social and economic rise. The obvious economic success of the enterprises of Werner von Siemens and his brothers at home and abroad, however, justifies an approach investigating the reasons for this success grounded both in the circumstances of the time and in the personalities of the founder of the business and his brothers.

In recent years multinational corporations, operating on a worldwide scale, have attracted both scholarly and public attention. Anglo-American scholars in particular have asked why such enterprises developed and what influences they have had on the international economic web. Case studies have shown that enterprises on their way to becoming international concerns pass through various stages of development: During the first stage of export orientation, independent agents sell the products of the firm abroad. During the second stage, the firm acquires an export agency or hires an export manager. In the course of the expansion of this agency, the enterprise establishes a sales branch or a subsidiary abroad before finally, in the third stage, starting production abroad.

The forerunner firms of the present Siemens Corporation did not follow this three-stage pattern. However, the idea that the expansion of the international network of the Siemens firms in Berlin, London, and St. Petersburg was more similar to the model of the ties of the preindustrial French Huguenot families of bankers and merchants than to the concept of a multinational enterprise is also not correct. With their first inventions and economic enterprises, Werner von Siemens and his brothers strove for success outside of Germany. By starting subsidiaries and manufacturing establishments of their own almost without delay after the founding of the parent firm in Berlin, Siemens met an important criterion of the multinational enterprise.

Part of the explanation for the international orientation of the firm from its beginning most likely involves the special conditions facing the still young electrical "industry" around the middle of the nineteenth century. The electrical industry, and also the chemical industry, were eager to have a presence abroad for the sake of securing patent rights. Furthermore, the
special nature of the first electrotechnical products, such as telegraph systems, made an early engagement abroad necessary. These systems, after proving to be of great use, faced a rapidly increasing demand that was neither directly market oriented nor dependent on general economic development but dominated by a few, mostly large governmental or semigovernmental, customers. Another main reason for the engagement abroad is rooted in the personalities of the Siemens brothers—their views, their political convictions, and their strong family ties.

The plans, conflicts, and views of the founder of the firm and his brothers, who also had a share in the business, can be readily traced thanks to the rich treasure of sources available. After his withdrawal from active business, Werner von Siemens wrote his memoirs, a prime source of information. The publication first appeared in 1892, shortly before his death, and is currently available in its eighteenth edition, with an expert introduction. Even allowing for the possibility that a retrospective view on a successful life might describe conflicts in a more favorable light, this autobiography gives important insights into Werner von Siemens’s motives and guiding principles.

After the untimely death of Werner’s younger brother Wilhelm (1823–83), who had spent almost all of his professional life in England, Wilhelm’s widow, Anna, had William Pole write an “official” biography. For this assignment the author had at his disposal Wilhelm’s official papers and his notes and letters, as well as oral statements from his wife and friends. Thus this contemporary biography represents an important source of information, although the author largely omitted problems or conflicts among the brothers.

The correspondence between Werner and his brothers undoubtedly offers much insight into their subjective assessments of different situations, plans, and feelings. For decades, the “senior” Werner, who had his residence mostly in Berlin, conducted an exceedingly active correspondence, which lasted almost continuously for over forty years and includes more than five thousand letters. These letters cover everything that
occupied the brothers with respect to scientific, business, and personal matters; most of them are accessible in transcribed form in the Siemens Archives in Munich, Germany.\textsuperscript{17} This wealth of information offers a valuable supplement to the business documents, which have already been analyzed in several studies of the enterprises in Berlin and abroad.\textsuperscript{18} The letters reveal a multifaceted picture of Werner von Siemens as a businessman, complementing the prevailing impression of him as a brilliant technician and inventor.

After a short summary of the general economic conditions in Germany at the time (chap. 1), I have structured the following presentation mostly chronologically. A short outline of Werner’s family background, his childhood and youth (as far as they can be reconstructed from the sparse source material), and his fifteen years of military service (chap. 2) is followed by

Genealogy of the Siemens family. From Weiher, Überseegeschäft.
a description of his entrepreneurial activities, divided into two periods (chaps. 3 and 4).

The initial period of growth of the enterprise Siemens & Halske lasted up to the mid-1860s. During this time Werner was active mostly as an inventor and devoted to the precise details of mechanical design. Manufacturing was for the most part based upon manual work. Division of labor or the use of machines occupied only a minor role. The start of the process of the separation from his partner, Johann Georg Halske (1814–90); Werner's changed political engagement (in 1866 his political creed shifted within a few months from a liberal-oppositional view to a national-liberal one in support of Bismarck); and finally the new business possibilities created by electrical power technology, which soon surpassed low-current technology owing to its much wider range of applications, opened up a new period in the firm's history. Manufacturing methods changed; the use of machines, and soon of specialized machines, gained ground rapidly; and problems concerning business had to be solved, in addition to those of technology.

From its beginnings the electrical industry showed an inherent tendency toward large establishments. During the period of development and expansion of telegraph systems this was due to the complicated technology involved, the small number of customers, and their interest in securing a long-term continuous and dependable supply. The tendency toward expansion was enhanced by the high capital requirements of the electric power industry and by the economic recession that Germany experienced at the turn of the century. The economic crisis hit the electric power industry particularly hard, since some parts of that industry operated on a highly speculative basis.

The history of the electric power industry, of course, did not stop with Siemens's death in 1892. The dynamics of the industry eventually produced two large firms that dominated the German market. After the Siemens-Schuckert Corporation gained control of the Bergmann Electrical Corporation in Germany in 1912, two conglomerates of approximately equal
weight, Siemens and AEG, faced each other. Together they controlled about 75% of the German market. In some fields of business strong competition prevailed between the two giants, whereas in others they joined forces and occasionally even founded joint subsidiaries, among which Telefunken Corporation was the most important.

Subsequently, in chapter 5, in the form of a short survey, I discuss the most important parameters for the success of the enterprise and the personal style of the founder of the firm. An outline of the development of the Siemens concern up to World War I concludes this book (chap. 6).