Chapter 10
William Siemens: An Engineer and Industrialist in Germany and England

Wolfgang König

Physical, Cultural, and Technological Spaces in Germany and England

Space and time are foundations of technological development. Technology advances over time as the result of innovative work by engineers and scientists, the accumulation of knowledge and material devices, and as humans make choices between alternatives. Technology differs in physical and cultural spaces. In this article, I will be discussing three types of space: physical, cultural, and technological (cf. Löw, Steets, & Stoetzer, 2008; Schlögel, 2006; Soja, 1989).

There is no strict separation between cultural and physical space because human beings have considerably transformed the physical conditions on this earth today. Nevertheless, under physical space one can subsume natural conditions like the place of states on the earth, resources, the climate, and landscape's surface. Cultural space covers a broad range of phenomena like society and politics, the economy, values, research and development, and education and training, which I emphasize in this article. Technological space could be interpreted as a part of cultural space, but it is also influenced by nature. It consists of the structure and function of artifacts and their contexts, which are their cultural and social origins and impacts (König, 2009; Ropohl, 1999).

First, I would like to briefly mention that physical spaces play an important role in technological development. Sometimes distance alone influences technology. After the Second World War, the Japanese consumer electronic industry went abroad. Its goal was to place its products on the American and Western European markets, which were the largest markets in the world. To reduce transportation costs, Japanese companies concentrated on small, lightweight products like portable radios, the Walkman, and the Discman (cf. Ouchi, 1984).

W. König (✉)
Berlin Center for Knowledge Research, Technical University Berlin, Berlin, Germany

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The natural resources found in specific spaces are also important for technological development. English industrialization was based on coal and iron ore; the Nordic countries built a significant paper industry because of their forests; and Saudi Arabia has profited from its rich oil deposits. With respect to the Federal Republic of Germany, you will often read that its lack of natural resources has been offset by skills and knowledge. Climate, too, influences technology. Textile industries and papermaking are at their best in warm and humid environments. Today, companies in these industries can generate this kind of favorable climate artificially.

The central thesis of my article is that England and Germany were two different physical, cultural, and technological spaces (cf. König, 1999, 2003). To give some examples: England's island status proved favorable for laying submarine telegraph cables, which was the Siemens companies' main business (physical space). Laying cables from Germany was much more expensive. England was also the first industrialized country, whereas Germany was a latecomer to industrialization (cultural space). German technology was more theoretical than the English. English engineers received a broad empirical training on the job, whereas German engineers often were educated at least parttime in schools (technological space). In my article, I deal with Germany and England as cultural spaces with respect to the Siemens brother William (1823–1883) and the German Siemens company and its English branch (Feldenkirchen, 2003). William Siemens received his engineering education in both countries, where he also worked. Therefore, the company and William are good examples for researching what different physical, cultural, and technological spaces could mean in history.

Document Analysis

I have based this article on numerous sources from a wide variety of collections (König, 2020). Two of these, however, are of particular importance. The first key group is William's letters to family members, held in the Corporate Archives of the Siemens Historical Institute. Among others, these include 2236 letters between William and Werner Siemens (cf. Bähr, 2016), and 580 between William and his younger brother Friedrich, who worked with William for a number of years and logged his own achievement in the energy-saving fabrication of glass (Bähr, 2016, p. 154). As a general rule, William's letters are terser than his brothers'. And in many cases, they deal with details of technical innovations. A bundle of letters the English Electric Company acquired in 1953 from a cousin of William's wife Anne and then edited (Nelson, 1953) is a valuable supplement to this collection of sources. This collection of letters is in no particular order; it appears to have come about more or less by chance. Various English, German, and Swiss archives and libraries possess a limited number of other letters from William.

The second important resource is William's own publications. By far the majority of his English-language publications is available in an exemplary edition prepared by his private secretary, Bamber (1889). A number of works were translated into German; some articles appeared in German only. I should also mention that I investigated William's work with technical and scientific associations in part through those associations' historical descriptions and in part from their journals. In William's letters, in his technical and scientific publications, and in the association journals, his innovations occupy much space. By contrast, the portrayal of William as a businessman and private person is afforded less attention.

The Siemens Company in Germany and England

The Telegraphen-Bauanstalt Siemens & Halske was founded in 1847 in Berlin by Werner Siemens (1816–1892) and Johann Georg Halske (1814–1890). In the beginning, it built telegraph lines for the Prussian state. When state orders declined, it looked for new opportunities in other countries. In 1850, the company initiated entrepreneurial activities in England (von Weiher, 1990) and in 1853 in Russia. Werner Siemens conceived his company as a family firm and tried to position his brothers in important roles. Brother Wilhelm, who changed his name to William, was responsible for the English business and brother Carl (Lutz, 2013) for the Russian enterprise. In 1857, the English company Siemens & Halske was founded, and in 1865 it was renamed Siemens Brothers (Scott, 1958). William Siemens was the head of both companies until his death in 1883.

The German and the English Siemens companies and Werner and William worked in different cultural spaces. In England, industrialization was at its peak. In several important industries like textile, iron, and coal mining, Great Britain produced more goods than the rest of the world. Germany, on the other hand, was just at the beginning of its industrialization and was hard at work imitating its British counterpart. These differences resulted in tension and conflict between the Siemens companies and brothers.

The English company was established to market the telegraph products that were being manufactured in Berlin. This arrangement, however, turned out to be problematic. William believed that the German equipment was too expensive and that it could be manufactured more cheaply in England. Werner insisted that the English company should contribute to returning the German investment in research and development.

One of the brothers' successful innovations was a water meter. Water companies wanted to be able to measure the exact volume of water delivered to their various clients, but the challenge was designing meters with a long lifespan. William designed his meters in England and sent the drawings and descriptions to Berlin, where the workshop manufactured them. The distance between England and Germany alone and the deficient postal services were sources of ongoing misunderstandings. William also complained that Halske's workshop needed too much time to manufacture the prototypes: In Germany it would take months, whereas in England he could get the meters in weeks. We can assume that these differences were the result of the unequal state of industrialization in the two countries. Some English companies had begun mass production, whereas Siemens & Halske still built its products in the German craft tradition. Ultimately, the German and the English companies each manufactured different meters that were marketed separately.

An important discussion among the brothers was how Siemens should approach global telegraphy (Müller, 2016). Siemens & Halske had started by building continental telegraph lines, and now other entrepreneurs were planning to link the continents. Most of these initiatives came from Great Britain, which sported the necessary concentration of capital and which wanted to improve communication with its colonies. The investment, however, was huge, as were the risks. Indeed, several of the first intercontinental cables were lost or did not work. William wanted to fight for market leadership: Siemens should manufacture, lay, and operate cables for the big projects that crossed the Atlantic and ran under the Red Sea to India. Werner and Carl hesitated because of the attendant risks. Siemens ended up concentrating on manufacturing and laying specific cables, and the company also controlled cables electrically that were laid by other companies. Siemens made a substantial profit, but was far from being a market leader.

In Werner's conception of the family firm, William should run the English company. William, on the other hand, wanted to also work as an independent engineer and industrialist. He was fascinated by the technological developments in England and wanted to contribute. Eventually, Werner had no alternative but to comply with William's wishes.

These were the most significant conflicts between the Siemens brothers, and they were sparked primarily by the different cultural, economic, and technological spaces where they worked, not by personal differences. Werner and William collaborated in a very fruitful way in much of their joint innovative work, and they were always able to find a compromise when they disagreed.

William Siemens' Career in Germany and England

William Siemens (pictured in Fig. 10.1) was born in Mecklenburg-Strelitz, one of the small German states. He attended secondary schools ("Realschulen") in Lübeck and Magdeburg until 1841. In hindsight, he said that his early education was very poor. Nevertheless, in 1841 and 1842 his brother-in-law's chemistry teaching post enabled him to sit in on science lectures at Göttingen University. This brief sojourn at Göttingen did not make William a physicist or chemist, but it did provide him with an introduction to scientific methods and thinking. William later profited from this education when he published articles on the thermodynamics of the sun (Siemens, 1885). After leaving Göttingen, William trained as a mechanical engineer in a respected machine-building company that designed and manufactured steam engines and other products. In other words, he was trained on the job at a company and not at a technical school. Until the 1870s, this was how most industrial

Fig. 10.1 William Siemens. Source: Picture by Siemens Historical Institute. Reprinted with permission

engineers in Germany were trained (König, 1998): Only a minority attended trade schools (“Gewerbeschulen” or “Polytechnische Schulen”).

William went to England in 1844 and decided to stay and become an Englishman. In the early years, he worked in very different industrial fields such as textile manufacturing, railway engineering, and iron and steel. This gave him the broad technological exposure that later made him a successful mechanical and civil engineer. His first biographer, William Pole, a brother engineer and member of the Royal Society, wrote: “He was probably one of the best and most accomplished mechanics that ever lived” (Pole, 1888, p. 393).

After moving to England, William made great strides towards becoming a professional engineer. Starting in 1851, he joined many scholarly and professional societies. In 1859, he married a woman from a respected Scottish family and became an English subject. We can assume that he benefited from his wife in terms of learning British customs and the English language, and he became proficient at lecturing and publishing in English. After his death, an obituary described his achievements thus (Institution of Mechanical Engineers, 1884, p. 71): “His linguistic attainments were very remarkable; accent apart, he spoke purer and more correct English, and with far greater facility of expression, than most Englishmen by birth.” And in another journal (British Association for the Advancement of Science, 1885, p. 4): He was a master “of the art of lucid statement in his adopted tongue.”

William did not reveal much about why he decided to spend his life in England. There was probably a combination of motives: In England, the opportunities for an engineer and industrialist were much greater than in Germany. He received a friendly welcome in British scholarly associations and was accepted by his brother engineers. And finally, he by far preferred the English political system to the German. William was a liberal and a republican who attacked the Prussian kings and Prussian politics in particular with harsh words.

William knew that in English society, science and engineering societies (Fig. 10.2) and clubs played an important role. In these learned professional societies, engineers, industrialists, and scientists met to discuss technological problems, inventions, and innovations (Buchanan, 1989). Societies and clubs were also social institutions where the elite exchanged their views and met new people, and William succeeded in making influential friends. We can assume that the Siemens company also profited from William's professional contacts. Some societies focused on hashing out opinions on scientific and technological problems like patenting, standardizing, and representing British technology internationally, which were then conferred to the English government or Parliament.

Becoming a member of scholarly and professional societies meant that one was a highly esteemed scientist or engineer. William's technological interests were very broad, so he acquired memberships in numerous associations. He became a member of the Institution of Mechanical Engineers, the Institution of Civil Engineers, the Institution of Naval Architects, the Royal Society, the Chemical Society, and the Society of Telegraph Engineers. He also joined associations aimed at promoting

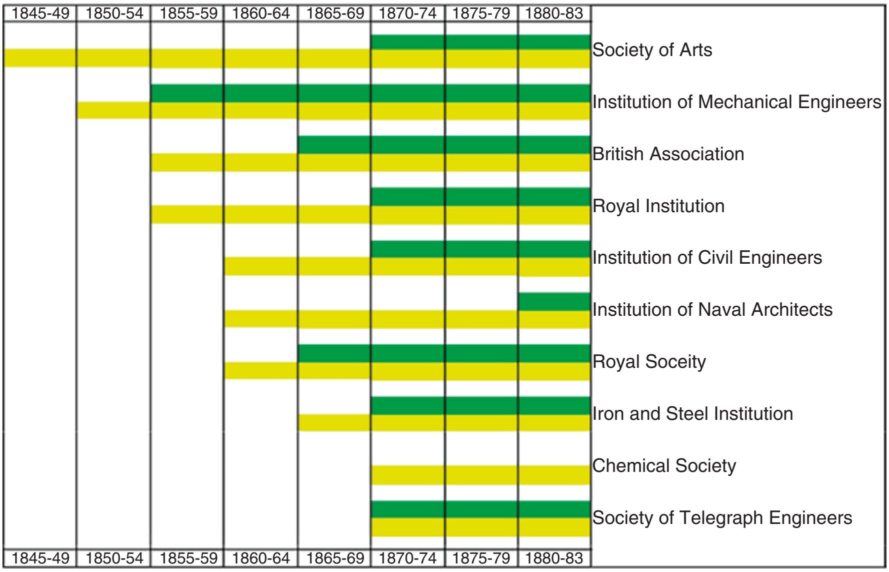

Fig. 10.2 William Siemens' engagement in learned and professional societies. Membership (yellow) and positions of responsibility (green) in decades. Source: Design by author

science, like the Society of Arts, the British Association for the Advancement of Science, and the Royal Institute. He became a member of industrial associations like the Iron and Steel Institute and was elected as member of clubs like the Whitehall Club and the Athenaeum Club (Cowell, 1975), whose members included prime ministers, industrialists, artists, and scientists.

William joined these societies in the 1850s and early 1860s or at their founding in later years. In the 1860s and 1870s, he held responsible positions like president, member of the board, and chairman of a section. After his death, he was honored with a window in the Westminster Abbey, which was and is the Pantheon of British society.

William was also active in the societies' scholarly work (Fig. 10.3). He published articles in their journals (Siemens, 1889), participated in their meetings, and contributed to the discussions. He published in very different fields, including mechanical engineering, metallurgy, power technology, electrical engineering, and telegraphy. He published articles about telegraphy, the Siemens company's business area, throughout his life. Mechanical engineering articles appeared in his early publishing career, and later in life he shifted his focus to metallurgy, in particular steelmaking.

William worked diligently as an inventor and innovator (Fig. 10.4). He received at least 133 patents and was responsible for several product and process innovations. In the 1840s and early 1850s, when he began his career as an independent engineer in England, he developed several technologies that worked but were not successful on the market. These included anastatic printing, a process for copying old prints.

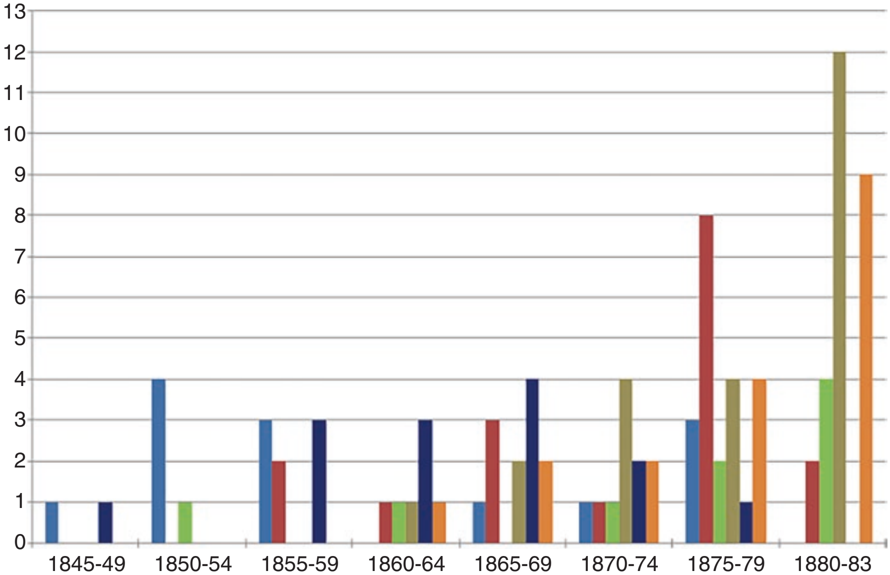

Fig. 10.3 William Siemens' articles in engineering science journals, presented by topic (light blue mechanical engineering, dark blue telegraphy, light green power technology, dark green electrical engineering, dark brown metallurgy, light brown others. Source: Design by author

Failed Innovations

- Anastatic printing
- Steam engine regulators
- Regenerative steam engine
- Regenerative hot-air engine
- Direct process of steelmaking
- Telegraph cables

Successful Innovations

- Watermeters
- Regenerative Furnaces
- Siemens-Martin process of steelmaking

Fig. 10.4 William Siemens' innovations (selection). Source: Design by author

Unfortunately, lithography rendered anastatic printing obsolete. William improved James Watt's regulator for steam engines, and his was more precise but was too expensive. He invented a regenerative steam engine that utilized the engine's waste heat. The engine, however, did not work well. In his early years in England, William had a hard time earning a living.

William and his brother Werner developed several of these innovations together. The failures caused Werner to withdraw from this broader field of invention and to concentrate on telegraphy. William, however, continued working on inventions. Success came in the 1850s with his water meters and regenerative furnaces that used waste energy. What had failed with steam engines worked in furnaces. The furnaces were employed in a variety of fields, including glass and steelmaking. William also received earnings from the Siemens companies that were finding success in the telegraph business. By 1860, he was a millionaire.

When one considers the complete list of William's innovations, one sees that the number of failures is greater than those of the successes. This should not be a surprise: In technological development, failures always outnumber successes (Bauer, 2006; König, 2018). In fact, technological success cannot be achieved without many failures. William's greatest success—and failure—was in steelmaking. His regenerative furnace laid the foundation for a new process that made steel of a higher quality. William was very close to inventing this process himself, but he decided to focus on a different process. Instead, the new process was perfected by the French iron dynasty of the Martins (Laurant, 2013). It was named after the two innovators, the Siemens-Martin process, and the steel was called Siemens-Martin steel. Over a period of one century, the Siemens-Martin process became the world's most important steelmaking process (Riedel, 1994).

Instead of working further on the Siemens-Martin process, William became engaged in another innovation, the direct process of steelmaking. Steelmaking is a two-step process: First, pig iron is produced from iron ores in a blast furnace. Next, steel is produced from the pig iron. "Direct process" means making steel directly from the iron ores, and William was convinced that he had solved this problem. In 1870, he founded an iron works in southern Wales, the Landore Siemens Steel Company, that was to produce steel using the direct process. The company hired between 1000 and 2000 workers. In the 1880s, the Landore company and the direct process had proved to be a failure, and William and his investors lost several 100,000 pounds. Nevertheless, William remained a rich man. It should be noted that the direct process has yet to be realized.

William Siemens' Education and Training

William Siemens was born and educated in Germany. He completed secondary school in 1841, then moved to the University of Göttingen. He registered for a diverse potpourri of subjects, emphasizing sciences but enriched through mathematics, physical geography, and technology. During this short time in Göttingen, William probably acquired a broad, though superficial, understanding of the fundamentals of science. The next step on William's path to becoming an engineer was an apprenticeship at a machine factory. He found a place at the Stollberg'sche Maschinenfabrik in Magdeburg, which was a well-known company making products such as steam engines—what might be called the supreme specialty in mechanical engineering in those days. After two years at Stollberg, one could say that William had completed his training as a mechanical engineer.

In Germany, William's training sufficed for a beginner in mechanical engineering—in England, this was not the case. When William moved to England in the mid-1840s, he was not successful with his inventions made in Germany. He had to learn to invent for the British competitive market. Products had to be not only good, but also cheap and in demand.

In England, William could call himself a mechanic, but not an engineer. He lacked, firstly, some years of practical work and, secondly, the recognition of professional societies. During the next years, William worked for railway companies, in printing, textile, and machine factories, and at a telegraph construction company. He initiated connections with a couple of machine-building industrialists.

One may view these activities of William in various English industries and at various English companies—some of the well-known—as the journeyman's stage in the education of a mechanical engineer. Developing and refining entirely different machines for entirely different purposes gave him a broad knowledge of mechanical engineering and a highly evolved capacity for solving problems. By around 1850, he was rightfully entitled to call himself a professional engineer—even by rigorous British criteria.

From the beginning of his career in England, William tried to become a member in engineering societies, as membership would certify his belonging to the group of professional engineers (Buchanan, 1989). In 1851, he became elected as a member of the Institution of Mechanical Engineers (Parsons, 1947; Pullin, 1997; Rolt, 1967). He was a member of the Institution of Civil Engineers (Watson, 1989) from 1854 onwards, and of the Royal Society from 1862 onwards. From that point, one could rightfully call him a highly distinguished professional engineer.

For a long time, the ingrained belief in England was that practical activity was the best way to become an engineer. There were two ways to do this: (1) An aspiring engineer either went into training ("pupilage") with an experienced civil engineer, or (2) he would train at an industrial company ("apprenticeship"). He could additionally acquire a better theoretical knowledge by attending brief courses at a school. Finally, to become a true engineer, he had to serve for several years in positions of responsibility. This training system had proved its worth in the past and had helped England move into a role of industrial leadership in the world. But as the nineteenth century progressed, criticism mounted that the system was outmoded or inadequate. Critics pointed to the industrial rise of countries on the European continent, and the relative decline of English industry. Among other factors, they especially credited the rising countries' technical schools for those nations' success.

William Siemens was among the fundamental advocates of a system of technical schools, and also one of the critics of the practical system of training engineers in England (Scott, 1958, pp. 257–258). The German Polytechnic Schools, however, had less credit with him. He gave preference to the universities—on the grounds that he preferred a strict separation of theory and practice. Schools, he felt, should provide a training in mathematics and science, whereas engineers should gain their practical knowledge in the workshop, the office, or out in the field. Schools should provide no lessons at all in actual workshop activities. The problem in Germany, he said, was that the polytechnic schools and their professors claimed to teach practical knowledge—about which they understood nothing. They lacked the "commercial element, that is of due regard to cost of production, of which the teacher himself must be comparatively ignorant, as otherwise we should probably find him employed at the factory or the engineer's office, instead of in the schoolroom" (Siemens, 1889, p. 274). School instructors, he claimed, should preferably teach long-established information. That might be useful for work in government administration, but it was inimical to innovation.

For England, William did allow that practitioners had sparked industrialization. But he felt their time was past (Divall, 1990; Guagnini, 1993). He concurred with the industrialists and engineers who demanded and supported the foundation of technical schools in England as well. In contrast to the continent—said William—English technical schools had arisen from private initiatives; the government had not played much of a role. He found that schools of this type had developed quite well in past years.

Concluding Remarks

In this article, I have dealt particularly with the differences between the English and the German cultural space that influenced technological development in the two countries in the nineteenth century. England was the first industrialized country, whereas Germany followed about half a century later. The British Empire comprised much better conditions for laying submarine telegraph cables, which was the main Siemens business from 1850s onwards. Engineers in England possessed much more know-how in empirical electrical engineering than in Germany. German engineers tried to compensate this by more theoretical knowledge. One can discover these differences by considering the technical education and training of William Siemens.

William's career reflected some of the cultural, economic, and technological differences between the two countries. There were several elements in his skill set that contributed to his success. (1) William possessed wide-ranging engineering expertise. This originated in his training in Germany and his engineering practice in several technological fields in England. (2) William combined this expertise with the fundamentals of the natural sciences. He had no scientific education, but he had a solid understanding of science that enabled him to use *ad hoc* scientific methods and get results. (3) German by birth, William became an Englishman. He was at home in two cultures that provided him with strong intercultural skills. (4) When one considers his engagement in many scholarly and professional societies, one gains the impression that he had highly developed social and communication skills.

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Wolfgang König is Professor Emeritus of the History of Technology at the Berlin Institute of Technology (Technische Universität Berlin) and ordinary member of acatech, the German Academy of Science and Technology. He earned distinctions of the Verein Deutscher Ingenieure (VDI), the Verband der Elektrotechnik, Elektronik, Informationstechnik (VDE), and the *Braunschweigische Wissenschaftliche Gesellschaft*. From 2000 until 2006 he was president of the German Society for the History of Technology (Gesellschaft für Technikgeschichte). His interests include the history of technology in the nineteenth and twentieth century, in particular the history of engineering sciences and consumer society. Recently, he published a book on the history of throwaways.