Chapter 2
Women Can Be Engineers, Too!

Abstract Prior to the late 1800s, engineering education was available only to male students. For most women whose aspirations were inclined toward science or engineering, the educational system and associated opportunities would not be available until late in the twentieth century. Thus, many of the early women "engineers" were not educated as engineers in the sense one would expect today. In 1893, the official records only documented three women as having received engineering degrees in the U.S. As women did endeavor to be educated and practice as engineers, a backlash developed. Once educated, women wanted to participate as men did in the engineering societies established for camaraderie, professional development, and networking opportunities. Those societies did not welcome women. It would take many years for the engineering societies as well as the engineering honor society to admit women. Profiles of engineering and scientific women from the late nineteenth and early twentieth century are provided.

Engineering Education in the Nineteenth Century

Prior to the late 1800s, engineering education was available only to male students. While the U.S. population was centered in the East, the colleges in the West and mid-West formally admitted women earlier than East Coast institutions, primarily because many state-supported institutions were established as a result of the 1862 Morrill Act. But even then, the number of women formally studying engineering in the late 1800s were very few. For most women whose aspirations were inclined toward science or engineering, the educational system and associated opportunities would not be widely available until late in the twentieth century.

Some women were able to slip in through the cracks that were starting to show in the male-dominated bastions of engineering educational institutions, either as students enrolled in engineering curriculum or in related science curriculum. Many of the early women "engineers" were not educated as engineers in the sense one would expect today.

Ellen Henrietta Swallow Richards was one of these non-traditional engineers. Although she was not an engineer by training, she contributed much to the establishment of the forerunners of environmental and sanitary engineering and is

J.S. Tietjen, *Engineering Women: Re-visioning Women's Scientific Achievements and Impacts*, Women in Engineering and Science,
DOI 10.1007/978-3-319-40800-2_2

credited as the woman who founded ecology and home economics. When she applied to the chemistry department at the Massachusetts Institute of Technology for a graduate degree in chemistry in 1870, she was not accepted because the department did not want its first graduate degree to go to a woman. She was not rejected, however, (as she was at all the other universities where she had applied), but instead was allowed to enroll as a candidate for a second bachelor's degree. She was classified as a special student who did not have to pay tuition (she had already received a bachelor's degree from Vassar College). Richards did not know that MIT had admitted her without tuition so that they could deny she was officially enrolled, if anyone complained. She completed her work for a doctoral degree, but MIT refused to grant it to her. MIT formally admitted women in 1878 [1, 2].

Elizabeth Bragg became the first woman to obtain an engineering degree. She graduated in civil engineering from the University of California at Berkeley in 1876 [1]. Kate Gleason was the first woman to enter Cornell's Sibley College of Engineering in 1884, but did not stay to complete her studies, as she was called back to help the family business [4]. Perhaps the second female engineer by education, Elmina Wilson graduated in 1892 from Iowa State College with a civil engineering degree and was the first female instructor at that school [3]. In 1893, Bertha Lamme graduated from The Ohio State University with a degree in mechanical engineering with an option in electricity. She was the first woman to graduate with a degree in a field other than civil or architectural engineering [1].

When the Society for the Promotion of Engineering Education (later named the American Society for Engineering Education) was formed in 1893, only the three women noted above were recorded as having received engineering degrees in the U.S. However, as women began to enter the educational system, graduate, and then try to find work as engineers, a backlash developed [3].

Professionalization

Professionalization of engineering began in the late nineteenth and early twentieth centuries. As women were finally able, at least in small numbers, to gain an engineering education and engineering employment, they also endeavored to join the engineering societies. These organizations, however, did not welcome women and developed a strict hierarchy of requirements for each of several levels of membership. They were already in the midst of upgrading themselves and the entrance of women into the profession was not seen as a positive development by most of the men involved in the leadership positions of these organizations [2].

Professionalization, in this case, meant upgrading the membership or image of a profession by excluding or diminishing the influence of persons who could be perceived to be "amateurs." Professionalization in engineering included deliberately creating barriers between engineers with college degrees and relevant professional experience and those other "engineers" who had learned their jobs by experience and lacked the "professional" credentials. In professional societies,

professionalization often meant raising the standards of membership and led to great concerns about the perceived prestige of the organization. As most engineering schools did not admit women (and thus women could not get the desired "professional" credentials), the most significant impact of professionalization was to exclude women [2].

Professionalism was probably also a by-product of the state of engineering education. Engineering educational standards in the late 1800s and early 1900s were not yet at a level necessary to earn a college education. As a consequence, engineers were not invited to serve on national scientific advisory boards, nor were engineers recognized as part of the established scientific community until 1916. And not until 1932 was the Engineering Council for Professional Development (ECPD), now known as ABET, created to provide accreditation of engineering degree programs, in partial response to reports sponsored by the engineering societies [4].

Professional Societies

By the end of the nineteenth century, civil and mechanical engineering were firmly established as engineering disciplines, with electrical and chemical engineering following closely behind [1]. Engineering societies were forming. Organizations, such as these engineering societies, are deemed the hallmark of a profession. These societies define intellectual style and norms of conduct and generally act to promote the interests of their members. The early engineering societies placed a high value on free enterprise, individualism, hard work, ambition, and success—characteristics of a rugged male culture, with concepts of prestige, status, and professionalism closely intertwined with masculinity [4].

The "Founder" societies, the five original engineering societies that founded the United Engineering Society in 1904 (which later became the United Engineering Foundation) included the American Society of Civil Engineers (ASCE), the American Institute of Mining Engineers (AIME) (now called the Society for Mining, Metallurgy and Exploration), the American Society of Mechanical Engineers (ASME), the American Institute of Electrical Engineers (AIEE—a predecessor organization to the Institute of Electrical and Electronics Engineers—IEEE), and the American Institute of Chemical Engineers (AIChE) [5–7]. A brief look at their history and their admittance (or more accurately, their lack of admittance) of women shows the impact that professionalization and the associated membership requirements had on the recognition for and advancement of women in the engineering profession.

ASCE, America's oldest national engineering society, was founded in 1852. Twelve founders met at the Croton Aqueduct in New York City on November 5, 1852, and agreed to incorporate as the American Society of Civil Engineers and Architects (later the ASCE) [8, 9]. Emily Warren Roebling, probably the first woman field engineer, became the first woman to address the ASCE in 1892, when she argued that her husband should not be replaced as the formal director for the construction of the Brooklyn Bridge [1]. In 1909, Nora Blatch de Forest, a graduate

of Cornell University in the top five of her class, was admitted as a "junior member" of the ASCE but was unable to advance any higher. When her junior membership expired in 1916, ASCE refused to promote her to full membership, in spite of her meeting the stated requirements, and instead, dropped her from the rolls. She brought a lawsuit against the Society, but did not prevail [2]. Elsie Eaves became an associate member of ASCE in 1927 and later the first female member (1957), first female life member, first female Fellow, and the first woman elected to honorary membership (1979) [1, 10].

AIME was founded in 1871 by 22 mining engineers in Wilkes-Barre, Pennsylvania [7, 11]. The first woman member was Ellen Henrietta Swallow Richards, who became the first woman member of any engineering society when she was elected a full member of AIME in 1879. Richards was aided by her MIT degree, her publications in mineral chemistry, and the fact that her husband was a vice president of the organization [2]. In 1917, the Woman's Auxiliary to the AIME was established and is still active today as the WAAIME [11, 12].

By 1880, 85 engineering colleges had been established in the U.S. and most offered a full mechanical engineering curriculum. Thirty engineers met in New York City in February 1880 and decided to form the ASME. In April, a formal organizational meeting was held with 80 engineers at the Stevens Institute of Technology in Hoboken, New Jersey. The first annual meeting of the organization was held in November 1880 [13]. The first woman member, Kate Gleason, was admitted to full membership of the ASME in 1914 [14]. Lydia Weld, a 1903 naval architecture graduate of MIT, became an associate member of ASME in 1915. She was allowed to become a full member in 1935, when the ASME finally granted full membership status to women [3].

By 1884, twenty-five prominent figures in electrical technology signed a "call" to establish an American electrical national society, mindful that civil, mining, and mechanical engineers had already established their own national societies. Twenty-five electrical engineering practitioners met in the headquarters of the ASCE on April 15 to devise an organizational structure for what became at first the AIEE. The first general meeting was held on May 13, also at ASCE headquarters [15]. In 1926, Edith Clarke, who would later become one of the first AIEE female fellows, was the first woman to address the AIEE [16]. As late as 1942, there were only three women in the AIEE and over 17,000 men [16]. The Fellow grade was established in 1912 for engineers who had demonstrated outstanding proficiency and had achieved distinction in their profession. It was not until 1948, however, that the first women were elected AIEE Fellows [17]. These three distinguished women were Edith Clarke, who significantly contributed to knowledge about and modeling for electric utility systems; Vivien Kellems, the founder of Kellems Company, a manufacturer of cable grips and shell lifters; and Mabel Rockwell, who significantly contributed to electrical control systems [18–20].

AIChE was founded in 1908 at the Engineers' Club in Philadelphia by 19 men. Chemical engineering was just coming into its own and was somewhere between chemistry and mechanical engineering. The founding of AIChE helped to establish chemical engineering as a separate discipline. At the time, the founding members of

AIChE believed that about 500 people were practicing chemical engineering across the country [21]. The first female member of AIChE, Margaret Hutchinson Rousseau, the first woman to receive a Sc.D. in chemical engineering from MIT and who made significant contributions to the field, was not admitted until 1945 [17].

In addition to the Founder Societies, an engineering honor society, Tau Beta Pi, was established. The engineering equivalent of Phi Beta Kappa (which had been founded at the College of William and Mary in 1776), Tau Beta Pi, was established at Lehigh University in 1885. It was founded to:

> *. . . mark in a fitting manner those who have conferred honor upon their alma mater by distinguished scholarship and exemplary character as undergraduates in engineering, or by their attainments as alumni in the field of engineering, and to foster a spirit of liberal culture in engineering colleges.*

Membership in Tau Beta Pi was limited to men until 1969. Women's badges had been authorized in 1936 as an alternative to membership for women. Only 619 Women's Badges had been awarded by 98 chapters until women were admitted to full membership in 1969, 84 years after the founding of the organization [22–24].

Other engineering societies, in addition to the Founder societies, came into existence in the early to mid 1900s. However, these organizations also excluded women from membership or often relegated them to lower membership status. Marie Luhring was elected as an associate member of the American Society of Automotive Engineers in 1920 [14]. That same year, Ethel H. Bailey became the first full female member of the organization [14]. The American Society of Safety Engineers, founded in 1911 in New York City with 62 members as the United Society of Casualty Inspectors, admitted its first female member, Vera Burford, in 1946 [17, 25]. The first time a woman was elected as a junior member of the Society of Naval Architects and Marine Engineers was 1946 [26]. The first female fellow of the Illuminating Engineering Society, Gertrude Rand, a researcher on the way color perception is affected by illumination and on color blindness, was elected in 1954 [16, 17].

Lillian Gilbreth, "the first lady of engineering" and the co-founder of the field of industrial engineering, was made an honorary member of the Society of Industrial Engineers in 1921 (as a personal favor to her husband, Frank Gilbreth), but not admitted to regular membership [2, 27]. She was, however, the first woman elected to the National Academy of Engineering (NAE), an event that occurred in 1965, only one year after the founding of the NAE in 1964 [28, 29].

Early Twentieth Century

The struggle for women to enter the engineering profession made some little progress in the early twentieth century. Women are known to have graduated in engineering from some universities, even if only in ones or twos. Finding a job was the next problem. Attaining the credentials necessary for recognition as even a junior or associate member of one of the professional engineering societies was a further obstacle faced by most women. And then, if a woman married, she was expected, except in

very rare cases, to become a wife and mother and abandon all thoughts of a career. The situation was so dire that *American Men of Science*, 1921 edition, lists zero women as employed in engineering [2]. The 1920 Census, however, reports that of 130,000 engineers counted, 41 were women, up from 21 in the 1890 Census [30].

Key Women of This Period

The key women in engineering whose most significant contributions occurred after the Civil War and prior to World War I, were generally not educated in "engineering." With admission to engineering programs prohibited for women in almost every instance, most of the women who impacted the engineering profession either were educated in other scientific fields or gleaned their "engineering" knowledge through on-the-job training.

Ellen Henrietta Swallow Richards (1842–1911)

Ellen Swallow was admitted to MIT as a "special student" and earned a bachelor's degree there in chemistry in 1873 (the first woman graduate of MIT) after having graduated from Vassar (as one of its first graduates) in 1870. She was denied an earned doctoral degree from MIT, as the school did not want a woman to be the first person awarded a doctorate in chemistry. While a graduate student, she executed a complete survey of Massachusetts drinking water and sewage for the Massachusetts Board of Health (1872), taking more than 40,000 samples. Through this work, she warned of early inland water pollution. She also contributed the first Water Purity Tables and the first state water quality standards in the U.S. From 1873 to 1878, she taught in the MIT chemistry department without a title or salary as the first women teacher. She also did extensive research in mineral analysis.

After her marriage in 1875 to Professor Robert H. Richards, head of the department of mining engineering at MIT, she persuaded the Women's Education Association of Boston to contribute the funds needed for the opening of a Woman's Laboratory at MIT. As assistant director to Professor John M. Ordway, an industrial chemist, Richards began her work in the laboratory by encouraging women to enter the sciences and to provide scientific training to women. In 1879, she became the first woman member of the American Institute of Mining Engineers. She was certainly technically qualified for this membership classification; however, her husband's status of vice president of the organization contributed significantly to her selection.

By 1883, the laboratory had proved so successful that MIT allowed women to enroll in regular classes and closed the laboratory. Richards' work in the laboratory had resulted in several books and pamphlets including the seminal *Food Materials and Their Adulterations* (1885). This publication influenced the passage of the first Pure Food and Drug Act in Massachusetts. Her work included analysis of air, water,

and food and led to national public health standards and the new disciplines of sanitary engineering and nutrition. The interaction between people and their environment, her areas of study, have led to Richards being called the founder of ecology.

In 1884, she was instrumental in setting up the world's first laboratory for studying sanitary chemistry. She served as assistant to Professor William R. Nichols in the new laboratory and held the post of instructor on the MIT faculty for the rest of her life. From 1887 to 1889 she supervised a highly influential survey of Massachusetts inland waters.

Since 1876, Richards had been on the forefront of promoting education for women, especially in science. In 1881, Richards helped found the Association of Collegiate Alumnae (later renamed the American Association of University Women). In 1882, she helped to organize the science section of the Society to Encourage Studies at Home.

After 1890, she concentrated most of her efforts on founding and promoting the home economics movement (at first it was called domestic science)—an achievement for which she is primarily noted (and frequently criticized for its detrimental effect on women's equality). Home economics was given definition by a series of conferences held in Lake Placid, New York, organized and chaired by Richards starting in 1899. She was involved in the formation of the American Home Economics Association (1908) and was appointed in 1910 to the National Education Association [1, 2, 16, 31–34]. Richards has been inducted into the National Women's Hall of Fame.

Emily Warren Roebling (1844–1903)

Emily Warren Roebling, generally considered the first U.S. female field civil engineer and construction manager, is remembered for her significant accomplishments in the construction of the Brooklyn Bridge. The inscription on the East Tower of the bridge reads (placed there in 1953):

> The Builders of the Bridge
> Dedicated to the Memory of
> Emily Warren Roebling
> 1843–1903
> whose faith and courage helped her stricken husband
> Col. Washington A. Roebling, C.E.
> 1837–1926
> complete the construction of this bridge
> from the plans of his father
> John A. Roebling, C.E.
> 1806–1869 who gave his life to the bridge
> BACK OF EVERY GREAT WORK WE CAN FIND
> THE SELF-SACRIFICING DEVOTION OF A
> WOMAN.

Without Emily Warren Roebling, the Brooklyn Bridge—one of the greatest engineering projects of the nineteenth century—might not have been completed on May 24, 1883. With the assistance of her brother and husband, Roebling learned

engineering through the study of higher mathematics, strength of materials, stress analysis, the calculation of catenary curves, bridge specifications, and the intricacies of cable construction. Her engineering skills allowed her to become the principal assistant and inspector of the bridge as her husband, Washington Roebling, could no longer visit the site because he had "Bends" disease. She was able to discuss structural steel requirements with representatives from steel mills and assisted them with designs and shapes never before fabricated.

She said, ". . . I have more brains, common sense, and know-how generally than any two engineers civil or uncivil that I have ever met . . ." The bridge, with a span of 1,595 feet, was the largest suspension bridge in the world when it was completed and remains functional today [1, 35, 36].

Edith Judith Griswold (1863–Unknown)

Renowned as a lawyer and patent expert (this is how she is listed in the *Who's Who in Engineering* in 1925), Edith Grisworld spent four years at New York Normal College where she graduated with a license to teach in the New York Schools. However, she took a special course in electricity at the time (with her father's permission). She felt that she gained a great deal in the course and that her best work was always along electrical lines.

Her career as a mechanical draftsman began in 1884. In 1885 and 1886, she worked in D.J. Miller's office, one of the first cable railroad men, where she made drawings for and estimated costs associated with cable railroads. All of her subsequent work was in patent-office drawing. During this time, she also taught geometry and mathematics in a private school.

By 1887, she was very interested in patent law and gave up her work as a mechanical draftsman to work as a managing clerk in a patent law office and learn the profession. She attended lectures at New York University Law School. In 1897, Griswold opened her own law offices as a patent attorney. She took the bar in 1898. After 1905, her health forced her to give up regular office work.

Her engineering work was primarily in mechanics, including electrical apparatus, instruments of precision, and other intricate devices. Her legal work, which came from other patent lawyers, was always (with but one exception) patents related to articles used or worn by women [14, 37].

Kate Gleason (1865–1933)

Kate Gleason began her career in the family's Gleason Works at age 11 when her brother, Tom, died. Hearing her father lament the loss of his assistant, Kate simply showed up and took his place. And, her father did not send her back home to do "women's" things; he taught her the family business. By age 14, she was the Gleason

Works bookkeeper. She became her father's indispensable assistant. In addition to keeping the books, she traveled around the country and the world selling the company's products, and serving as the public face of Gleason Works.

In 1884, she entered Cornell University's engineering program, the first woman to so enroll. However, before her freshman year was over, she needed to return to the family business, as her father could not afford the salary of the man that had been hired to take her place. Although she significantly lamented the loss of education, she was on the road by 1888, selling machines on her first road trip. By 1890, she was the Secretary-Treasurer of The Gleason Works, and its chief sales representative, a position she held until 1913. In 1893, on doctor's orders for rest, she went to England, Scotland, France, and Germany, and came back with machine orders. This was one of the earliest efforts at international marketing for any company in the U.S. Gleason learned how to turn being a female in business into an asset. She had also learned from Susan B. Anthony, one of the leaders of the suffrage movement, that any advertising is good. In 1913, family tensions, caused in large part by her being a woman in a man's world and to a widely circulated story that credited her with being the inventor of the Gleason gear planer (the inventor was her father), led to her resigning from the company.

Kate Gleason became the first woman member of the ASME in 1914. Also in 1914, she was the first woman to be appointed receiver by a bankruptcy court. She successfully undertook the reorganization of the Ingel Machine Company of East Rochester, New York. In 1916, she was one of the first women to be elected to the Rochester Chamber of Commerce and the first woman elected to the Rochester Engineering Society. She also served as president of the First National Bank, Rochester, New York, from 1917 to 1919, while its president went off to fight in World War I.

Later, Gleason became very interested in low-cost housing and built concrete houses in the Rochester area that are still inhabited today. She was the first female member of the American Concrete Institute. Gleason served as the ASME's representative to the World Power Conference in Germany in 1930. Her estate was used to establish the Kate Gleason fund, one of whose beneficiaries was the Rochester Institute of Technology (RIT). In 1998, RIT named its College of Engineering after her. Gleason attributed her success to "a bold front, a willingness to risk more than the crowd, determination, some common sense, and plenty of hard work." [1, 3, 16, 33, 38]

Bertha Lamme (1869–1954)

Bertha Lamme went to work for Westinghouse after graduating from The Ohio State University with a degree in mechanical engineering and an emphasis in electricity. She had studied electrical engineering with her brother at Ohio State "for the fun of it" and had no plans to pursue a career after earning her degree in 1893. However, she received a surprise job offer from Westinghouse where her brother Benjamin was by then employed and worked there until she married in 1905.

Bertha Lamme worked in the East Pittsburgh plant for 12 years, where she designed motors and generators. A 1907 *Pittsburgh Dispatch* article reports on her tenure at Westinghouse saying that Lamme's work in designing dynamos and motors won her a reputation "even in that hothouse of gifted electricians and inventors. She is accounted a master of the slide rule and can untangle the most intricate problems in ohms and amperes as easily and quickly as any expert man in the shop."

In 1905, she married her supervisor and retired, as required by company policy, to become a wife and mother. Her husband, Russell S. Feicht, also an Ohio State graduate, designed the 2,000-horsepower induction motors displayed at the St. Louis World's Fair in 1904, and later retired from Westinghouse as its director of engineering. The Feicht's daughter, Florence, had well-developed mathematical abilities and went on to become a physicist for the U.S. Bureau of Mines.

The Westinghouse/Bertha Lamme Scholarships were established by the Society of Women Engineers (SWE) in 1973 in honor of Westinghouse's first woman engineer [1, 3, 14].

Nora Stanton Blatch de Forest Barney (1883–1971)

Nora Stanton de Forest Barney, granddaughter of Elizabeth Cady Stanton (one of the leaders of the suffrage movement), first distinguished herself by graduating from Cornell University with a bachelor's of civil engineering in 1905. The American Bridge Company employed her, as she was in the top five of her class and a member of Sigma Pi. She became a "squad boss" after 3 weeks of employment. In 1906, she became an assistant to Lee de Forest, inventor of the radio vacuum tube and pioneer in television. They were married in 1908 and divorced in 1912. In 1909, she joined the staff of Radley Steel Construction Company as an assistant engineer and chief drafter. From 1909 to 1917, she was also active in the New York State women's suffrage movement. Then, beginning in 1912, she was an assistant engineer for the New York Public Service Commission. She married Morgan Barney, a marine architect in 1919. Barney also served as an architect and engineering inspector for the Public Works Administration in Connecticut and Rhode Island.

Besides her broad work experiences, Barney was a prolific, and widely read, writer in her field. She was actively involved in the world peace movement and the women's rights movement. Despite her many achievements, she was granted only a junior membership status in the ASCE in 1909. Nearly 14 years after being allowed to join, she filed to have her membership status elevated to "associate member," but her application was denied. She filed an appeal, but her appeal was denied. And when she attempted to regain her junior membership status, it too was denied. In her later life she became a real estate developer. In 1944, she wrote *World Peace Through a Peoples Parliament* [14, 16].

References

1. Kass-Simon G, Farnes P (eds) (1990) Women of science: righting the record. Indiana University Press, Bloomington, IN
2. Rossiter M (1992) Women scientists in America: struggles and strategies to 1940. The Johns Hopkins University Press, Baltimore, MD
3. LeBold WK, LeBold DJ (1998) Women engineers: a historical perspective. ASEE Prism 7(7):30–32
4. Barker AM (1994) Women in engineering during World War II: a taste of victory. Rochester Inst Technol unpublished
5. An overview of the United Engineering Foundation: History. www.uefoundation.org/overview.html. Accessed 15 Dec 2000
6. Founder societies of the United Engineering Foundation. www.uefoundation.org/fndsoc.html. Accessed 15 Dec 2000
7. Historical highlights. www.idis.com/aime/history.htm. Accessed 15 Dec 2000
8. ASCE profile. www.asce.org/aboutasce/profile.html. Accessed 15 Dec 2000
9. 150 Years of civil engineering. www.asce.org/150/1506years.html. Accessed 15 Dec 2000
10. Elsie Eaves—pioneer from the west. SWE Newsletter, May 1959, p. 3
11. WAAIME. www.idis.com/aime/WAAIME.HTM. Accessed 19 Dec 2000
12. The woman's auxiliary to the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. A Division of the Society for Mining, Metallurgy and Exploration (SME). http://www.smenet.org/waaime/. Accessed 5 Apr 2015
13. The history of ASME international. www.asme.org/history/asmehist.html. Accessed 15 Dec 2000
14. Ingels M. Petticoats and slide rules. Western Soc Eng. Accessed 4 Sept 1952, and later published in Midwest Engineer
15. The origins of IEEE. www.ieee.org/organizations/.ical_articles/history_of_ieee.html. Accessed 15 Dec 2000
16. Read PJ, Witlieb BL (1992) The book of women's firsts. Random House, New York
17. Rossiter MW (1995) Women scientists in America: before affirmative action 1940-1972. The Johns Hopkins University Press, Baltimore, MD
18. Welcome to the IEEE fellow program: our history. www.ieee.org/about/awards/fellows/fellows.htm. Accessed 19 Dec 2000
19. Goff AC (1946) Women can be engineers. Edwards Brothers, Inc., Ann Arbor, MI
20. www.swe.org/SWE/Awards/achieve3.htm. Accessed 1 Sept 1999
21. A brief history of AIChE. www.aiche.org/welcome/history.htm. Accessed 20 Aug 1999
22. www.tbp.org/TBP/INFORMATION/Info_book/membership. Accessed 20 Aug 1999
23. Tau Beta Pi: integrity and excellence in engineering. www.tbp.org. Accessed 20 Aug 1999
24. The Phi Beta Kappa Society: a short history of Phi Beta Kappa. www.pbk.org/history.htm. Accessed 19 Dec 2000
25. Society history. www.asse.org/hsoci.htm. Accessed 19 Dec 2000
26. (1948) The outlook for women in architecture and engineering. U.S. Government Printing Office, Washington, DC, p. 5–33. Bulletin of the Women's Bureau No. 223-5
27. www.iienet.org/Aboutg.htm. Accessed 20 Aug 1999, p. 1
28. About the NAE. www.nae.edu/nae/naehome.nsf/weblinks/NAEW-4NHMQM?opendocument. Accessed 19 Dec 2000
29. www.iienet.org/historg.htm. Accessed 20 Aug 1999
30. Schneider D, Schneider CF (1993) The ABC-CLIO companion to women in the workplace. ABC-CLIO, Santa Barbara, CA
31. Shearer BH, Shearer BS (eds) (1997) Notable women in the physical sciences: a biographical dictionary. Greenwood Press, Westport, CT
32. Oglivie MB (1993) Women in science: antiquity through the nineteenth century, a biographical dictionary with annotated bibliography. MIT Press, Cambridge, MA

33. (1996) Webster's Dictionary of American Women. SMITHMARK Publishers, New York
34. Richards E. www.greatwomen.org/rchrdse.htm. Accessed 26 May 1999
35. Weigold M (1984) Silent builder: Emily Warren Roebling and the Brooklyn Bridge. Associated Faculty Press, Inc., Port Washington, NY
36. (1959) Landmarks of the world: Brooklyn Bridge. Holiday, The Curtis Publishing Company, pp 125–129
37. Lee EC (ed) (1925) The biographical Cyclopaedia of American Women, vol II. The Franklin W. Lee Publishing Company, New York
38. Bartels N. The first lady of gearing. www.geartechnology.com/mag/gt-kg.htm. Accessed 2 Sept 1999

http://www.springer.com/978-3-319-40798-2

Engineering Women: Re-visioning Women's Scientific Achievements and Impacts

Tietjen, J.S.

2017, XIII, 85 p. 1 illus., Hardcover
ISBN: 978-3-319-40798-2