

This is the first of three articles to mark the 50th anniversary of women being initiated in the Association. The second will be in the Spring Bent.

No Bent! All Women Were Given Was A Badge

by Jill S. Tietjen, P.E., Virginia Alpha '76

IT MIGHT SURPRISE our current collegiate members to find out that the major engineering professional societies, including Tau Beta Pi, did not admit women for many years. When they finally decided to do so, women were often not admitted as full members but instead as “associates” or, in the case of TBPI, with a “Women’s Badge.” Indeed, it wasn’t until

decades after the institution of the Women’s Badge that women were finally able to join as full members.

This article provides context for how and when women were admitted to membership and fellowship in the professional societies, with a perspective on the number and percentages of women receiving engineering education throughout this period of history.

The Founder Societies, the five

original engineering societies that founded the United Engineering Society in 1904, include the American Society of Civil Engineers (ASCE), the American Institute of Mining Engineers (AIME) (now called the American Institute of Mining, Metallurgical and Petroleum Engineers), 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). The years of founding are ASCE—1852, AIME—1871, ASME—1880, AIEE—1884, and AIChE—1908. None of these societies admitted women at the time of their founding.

Cultural Norms of the Time

They were reflecting the cultural norms of the time. When the United States Military Academy (USMA) was established in 1802 to educate engineers, it did not admit women. Rensselaer Polytechnic Institute (RPI), established in 1824 in Troy, NY, is the oldest surviving non-military engineering school in the U.S. and it did not admit them. In fact, prior to the Civil War, only six engineering schools existed in the U.S. and none did. Both the USMA and RPI are Eastern colleges.

The situation was different, however, in Western states where most colleges were state-supported (versus private) and co-educational from the time of their founding. Why? Because there weren’t enough male students in the less-populated West at the time to enroll and because taxpayers wouldn’t support these institutions unless their daughters could attend.

The Morrill Act of 1862 was responsible for the establishment of many of these institutions (the so-called land grant colleges). This has



Emily Warren Roebling, the first woman to address ASCE, in 1883, painted in Paris circa 1896 by French society artist Carolus Duran.



Ellen Richards, the first woman to attend, and graduate from, MIT. Photo: Library of Congress.

HISTORY OF FEMALE RECOGNITION

WHEN TAU BETA PI was founded in 1885, its original Constitution made no mention of gender, yet it took eighty-three years until the first female member was initiated.

"The document had been written at a time when there were no women in the profession, and it had been assumed that only men would join."—Nancy Hill, *The Bent*, Fall 1985.

As far as we know today, the first female student eligible for membership was an architectural student at the University of Illinois, Ethel Ricker. In 1903, she was the top student of her senior class. Illinois Alpha was more than willing to initiate her, but her election was rejected by the Executive Council. In response, the chapter appealed the decision to the 1903 Convention. The minutes from that meeting give only a brief mention: "Moved that [the Secretary-Treasurer] be instructed to issue a bent and certificate to Miss Ethel Ricker. Motion lost. Adjourned for lunch."

Not satisfied with merely rejecting this one student, the Convention decided to explicitly interpret the Constitution as banning women from membership: "Resolved that the Tau Beta Pi Association in Convention assembled interpret the Constitution as prohibiting the admission of women into Tau Beta Pi Association." Backlash continued at the following Convention where delegates passed an amendment to the Constitution to specify that only men could be initiated.

The backlash was felt in other areas as well. Delegates at Convention began referencing each other as "Brother." In the early 1900s, the topic of merging with Sigma Xi, the scientific research honor society, was debated. Several delegates listed "no further election of women" as a required concession for merging into Sigma Xi which had been initiating women since 1888. Ultimately, the 1905 Convention resolved against the merger, stating "That it is the sense of this Convention that the purpose, scope, usages and field of work, of Tau Beta Pi and Sigma Xi, are so distinctly different that we do not believe there need be conflict or competition between the two Societies."

Twenty years later, a woman's eligibility was again presented at Convention. Katharine Cleveland, a civil engineering student at the University of Kentucky, was the top student in the class of 1924 but could not be elected because of the previous changes.

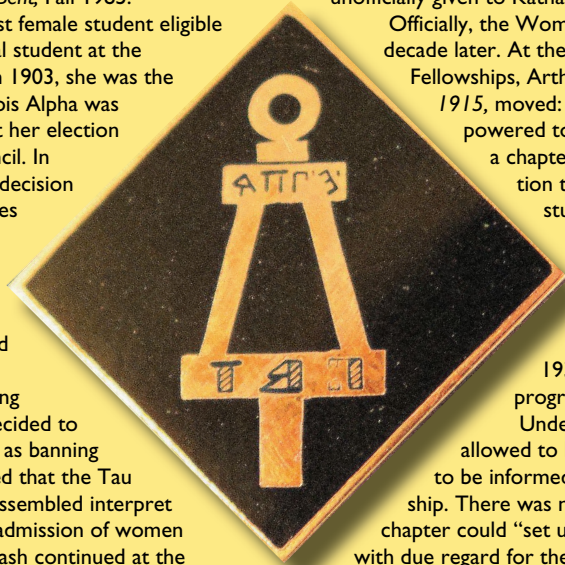
Ernest Bureau, *Indiana Alpha 1915*, an alternate delegate from Kentucky Alpha, presented her situation at the 1923 Convention. Instead of asking for full membership for her, he suggested she "be permitted to wear a silver bent" as partial recognition. The Convention approved, and the first Women's Badge was unofficially given to Katharine.

Officially, the Women's Badge program began over a decade later. At the 1936 Convention, the Director of Fellowships, Arthur D. Moore, *Pennsylvania Gamma 1915*, moved: "That the Executive Council be empowered to put into operation a plan whereby a chapter may give some suitable recognition to a promising woman engineering student." According to the minutes, two specific cases of candidates were discussed, and "several delegates spoke of a need for such action." The motion passed, but the Executive Council took until 1938 to work out the details of the program.

Under that program, women were not allowed to be elected to membership and had to be informed of their ineligibility for membership. There was no fee for receiving the badge. Each chapter could "set up special pledge duties for a woman, with due regard for the amenities." Recipients could not be "initiated," only "presented." Instead of an official certificate, they received the Badge—"a small gold, black-enamelled square with a gold border, bearing a half-inch-high Tau Beta Pi Bent."

Chapters began awarding Women's Badges in 1939, the first under this new program to Carmen de la Vega, a chemical engineering student at Tulane University. In total, 619 Badges were awarded over the program's thirty-year lifespan. The last Badge was awarded on January 26, 1969, to Mary Baker, an engineering mechanics student at the University of Wisconsin. That month, the Executive Council announced the successful ratification of amendments to the Constitution to admit women to full membership in Tau Beta Pi, including previous Women's Badge recipients. On April 18, 1969, the first Women's Badge recipient, Katharine (Cleveland) Harelson, *Kentucky Alpha 1924*, became one of the first women initiated into Tau Beta Pi.

—Allen D. Erickson, *New Mexico Gamma '14*



been credited with democratizing higher education in the U.S. and providing colleges for the industrial classes.

The first woman to earn an undergraduate degree in engineering, Elizabeth Bragg, achieved that feat in civil engineering back in 1876 at the University of California, Berkeley. By 1880, 85 engineering colleges had been established in the U.S.

In 1893, when the Society for the Promotion of Engineering Education (later named the American Society for Engineering Education) was established, only three women were recorded as ever having received engineering degrees across the entire U.S. In addition to Elizabeth Bragg, these women were Elmina Wilson (who graduated in 1892 from Iowa State College in civil engineering) and Bertha Lamme (who graduated in 1893 from The Ohio State University in mechanical engineering with an emphasis on electricity). It is worth noting

that many women—and men—who sought employment as engineers in the late 1800s and early 1900s did not receive formal engineering education.

Women and the Professional Engineering Societies

Emily Warren Roebling was the first woman to address ASCE in 1883, defending her husband's role as the formal director of construction of the Brooklyn Bridge. Nora Blatch de Forest became a junior member of ASCE in 1905, after graduating in the top five of her Cornell University class, but was not able to advance in the membership ranks of ASCE in spite of the lawsuit she filed. Elsie Eaves became an associate member of ASCE in 1927—achieving full membership in 1957—three decades later. She was honored as the first female ASCE Fellow.

Ellen Henrietta Swallow Richards became a full member of AIME in 1879. Although she was technically

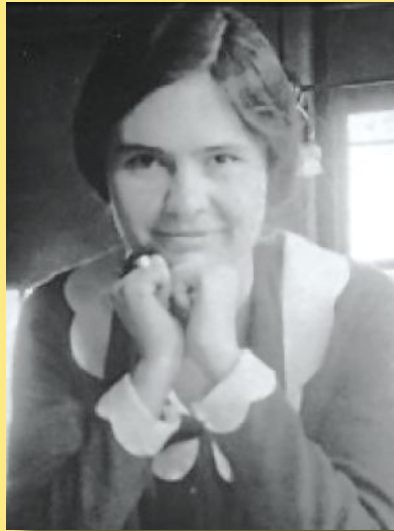
TAU BETA PI'S "FIRST LADY"

KATHARINE CLEVELAND HARELSON (1902-70), badge holder #1 and later Kentucky Alpha '24, was a 1924 University of Kentucky graduate in civil engineering. She is considered Tau Beta Pi's "First Lady" because she received Women's Badge #1. Katharine was among the first group of 155 women initiated in 1969 (shortly before her death in 1970), after the prohibition on women members was lifted.

Katharine Cleveland, born March 16, 1902, in Kenton County, KY, was a student at the University of Kentucky in the early 1920s. She likely studied under Kentucky's founding dean of engineering, F. Paul Anderson, and knew his dog, Jerry, who all but lived on campus and even accompanied his owner to classes. Like many of our engineering majors today, Katharine worked "after school" and during the summers while an undergraduate at the University of Kentucky. Her employer was the architectural firm Frankel & Curtis in Lexington, KY, where she identified her job title as "draftsman."

Katharine had a remarkable, although short, career for a female engineer in the mid-1920s. Upon graduation in 1924, she moved to San Francisco, CA, where she took a draftsman position with renowned female architect Julia Morgan from 1924 to 1926. Morgan is perhaps best known for her work on the Hearst Castle (and other Hearst buildings), in addition to the Los Angeles Examiner Building and YMCA in Chinatown. Morgan was a trendsetter, much like Katharine, being the first woman to obtain an architecture license in the state of California, in 1904. While the Julia Morgan Architectural Drawings collection at the Bancroft Library, UC Berkeley, contains drawings from Morgan's firm for the years that Katharine was employed there, inspection of several pieces did not reveal any indication of the draftsman. Therefore, we do not know which projects Katharine worked on during her time there. She did note in her 1953 TBPI Association Women's Badge Questionnaire that she took several classes in architecture at the University of California, Berkeley, while she worked for Morgan. The Berkeley's Cal Alumni Association verified that her coursework was at the graduate level.

In 1926, Katharine returned to Lexington. One wonders what prompted her to return home from what would appear to have been an excellent position for a young female engineer in the 1920s. Carol Street, Special Collections Librarian at the University of Kentucky, observed that Kentuckians "tend to love their state above any other. Particularly here in the Bluegrass, I think." Perhaps love of her home state is what drew Katharine back. In any case, Katharine took a position as a draftsman at her college employer, Frankel & Curtis, where she worked until 1927. Frankel & Curtis have a number of buildings listed on the National Register of Historic Places, including the Russell Theatre, Lexington Herald Building, and Second Presbyterian Church. As with the Julia Morgan collection at UC Berkeley,



the University of Kentucky Margaret I. King Library houses the Frankel & Curtis collection, but inspection of drawings from the time that Katharine worked there do not reveal any identifying information about the draftsman.

In 1927, Katharine left Frankel & Curtis for a draftsman position at H.A. Churchill and John P. Gillig, Architects, in Lexington, where she worked until 1929. Again, one wonders what prompted her move. While there is no way to be sure, it is interesting to note that Churchill and Gillig designed the Lexington Post Office and Federal Building (completed in 1934). The construction of this and similar buildings around the nation were spurred by the passage of the federal Public Buildings Act of 1926, which created a backlog of construction projects that necessitated reaching beyond the typical Washington, DC, architectural firms that designed post offices and federal buildings to local architectural firms in order to meet demand. Katharine's move to the firm in 1927 could have been related to Churchill and Gillig's having been awarded the contract

for the massive federal building and their associated need for additional draftsmen. Given that Churchill and Gillig had, at one time, designed post offices around the country for the federal government, it is not surprising they were picked as the architect for the Lexington building (which still exists and is considered an excellent example of Classical Revival architecture).

Katharine married civil engineer and classmate **Henry Lloyd Harelson, KY A '24**, in 1929, the same year she left Churchill and Gillig. It would have been expected back then for a woman to quit her job upon marriage, so it is not surprising this ended her career.

On her 1953 Women's Badge Questionnaire, Katharine noted "my connection with engineering for the past 24 years has been through marriage." According to the 1940 U.S. Census, Katharine had at least three children, the oldest being William Henry "Hank" Harelson born in 1930, and his sisters Katie, born around 1936, and Elizabeth, born around 1938. Hank followed in his parents' footsteps, graduating from the University of Kentucky with a B.S. in mining engineering, was a registered professional engineer and worked in underground production, had a consulting firm, and was an inspector for the Colorado Tramway Board, which inspects ski lifts.

When asked about receiving the Women's Badge, Katharine answered "Yes" to the question about whether the honor bestowed upon her by the award of the Badge was a sufficient distinction, but added that "perhaps, at the time" she would have preferred full membership. She added: "My feelings about the question shouldn't be given as much weight as the opinions of the younger women who are actually in the profession."

TBPI's First Lady, Katharine Cleveland Harelson died June 27, 1970, and is buried at Bluegrass Memorial Gardens in Lexington.

—Jenna P. Carpenter, Ph.D., *Indiana Alpha '83*

INVENTOR, TEACHER, AND PIONEER

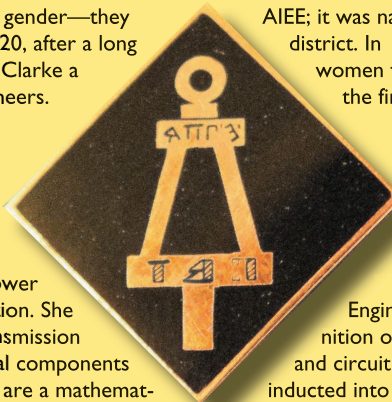
EDITH CLARKE (1883-1959), badge holder #95, wanted to be an engineer. But, when she graduated from Vassar with an A.B. in mathematics and astronomy in 1908, engineering was not offered or encouraged as a career for women. Instead, she did the same as many women of her era, she worked for three years as a teacher. After a year studying civil engineering at the University of Wisconsin, she went to work for American Telephone & Telegraph Company (AT&T) as a computing assistant. Clarke is an example of an early “computer”—women with advanced training in mathematics who performed calculations for engineers (men).

During World War I, she supervised women at AT&T who did computations for research engineers and studied radio at Hunter College, and electrical engineering at Columbia University at night. Eventually, she enrolled at MIT and received her master’s in electrical engineering in 1919, the first woman awarded that degree from MIT. On graduation, she wanted to work for General Electric (GE) or Westinghouse.

Even with her stellar credentials, no one would hire her as an engineer because of her gender—they had no openings for a woman engineer! In 1920, after a long employment search, General Electric offered Clarke a computing job, directing calculations for engineers.

But, Clarke wanted to be an electrical engineer! Since that was not the job she was offered, she left GE in 1921 to teach physics at the Constantinople Women’s College in Turkey. A year later, GE did offer her a job as an electrical engineer.

Clarke’s area of specialty was electric power systems and problems related to their operation. She made innovations in long-distance power transmission and development of the theory of symmetrical components and circuit analysis. Symmetrical components are a mathematical means by which engineers solve problems of power system losses and performance of electrical equipment.



Clarke literally wrote the textbook: *Circuit Analysis of AC Power Systems, Symmetrical and Related Components* (1943) and a second volume in 1950. This textbook, in its two volumes, was used to educate all power system engineers for many years. She published 18 technical papers during her employment at GE reflecting her status as an authority on hyperbolic functions, equivalent circuits, and graphical analysis within electric power systems. She was involved in the design of hydroelectric dams.

Clarke received a patent in 1925 for her “graphical calculator”—a method of considering the impacts of capacity and inductance on long electrical transmission lines. It greatly simplified the calculations that needed to be done. In 1926, she was the first woman to address what is now the Institute of Electrical and Electronics Engineers (IEEE)—it was then the American Institute of Electrical Engineers (AIEE). Her topic was “Steady-State Stability in Transmission Systems.”

In 1932, Clarke became the first woman to present a paper before the AIEE; it was named best paper of the year in the northern district. In 1948, Clarke was made one of the first three women fellows of IEEE. She had previously become the first female full voting member of IEEE.

After her retirement from GE in 1945, Clarke became an associate professor of electrical engineering at the University of Texas. In 1947, she rose to full professorship becoming the first woman professor of electrical engineering in the U.S.

Clarke received the Society of Women Engineer’s Achievement Award in 1954 “in recognition of her many contributions to stability theory and circuit analysis.” In 2015, she was posthumously inducted into the National Inventors Hall of Fame for inventing the graphical calculator.

—Jill Tietjen

qualified, her ascension was no doubt facilitated by the role of her husband, a vice president of the organization. Richards was the first woman to attend and graduate from MIT, although as a “special student” without tuition so that the students, faculty, and administration, could say “no” when asked if females were enrolled. Although she completed the work for a doctoral degree at MIT, the degree itself was not awarded. In 1917, the Women’s Auxiliary of AIME was formed.

ASME admitted Kate Gleason to full membership in 1914. Kate was the exception. Lydia Weld was granted associate membership in 1915 and full membership two decades later when, in 1935, ASME granted full membership status to women.

Edith Clarke was the first woman to address AIEE

in 1926. By 1942, AIEE counted three women members and over 17,000 male members. The AIEE Fellow grade was established in 1912. Not until 1948, however, were the first three women elected Fellows—Edith Clarke, Vivien Kellems, and Mabel Rockwell.

AIChE welcomed its first female member in 1945. Other engineering societies admitted their first women members in 1920 (American Society of Automotive Engineers), 1946 (American Society of Safety Engineers; Society of Naval Architects and Marine Engineers), 1947 (Institution of Structural Engineers), and 1954 (Illuminating Engineering Society).

Representation of women in the Founder Societies in 1946 is shown in the following table:

A LIFE OF SHATTERED GENDER BARRIERS

ELSIE EAVES (1898-1983), badge holder #241 and later Colorado Beta 1920, shattered gender barriers throughout her life. After graduating in 1920 from the University of Colorado at Boulder (CU-B) with a B.S. in civil engineering (with honors), Eaves held a variety of jobs in Colorado before heading to New York City and going to work for McGraw-Hill Publishing Company. Legend has it that the editor of another organization had told her that “a woman’s place, if not in the home, is in the department store.”

She began as an assistant on market surveys for *Engineering News-Record* (ENR) in 1926. Subsequent positions included director of market surveys for ENR, director of market surveys for *Construction Methods and Equipment*, and manager of the *Business News* department. In this last position, she directed 100 staffers across the U.S. and Canada.

Her career at McGraw-Hill was a series of “firsts.” In 1929, Eaves originated and compiled the first national inventory of municipal and industrial sewage disposal facilities—which she replicated at periodic intervals.

A few years later, she compiled statistics on needed construction, which aided the passage of the Federal Loan-Grant legislation which was used to revitalize the construction industry during the 1931-35 depression. In 1945, she organized and directed the *Engineering News-Record’s* measurement of Post War Planning by the Construction Industry. This was used by the Committee for Economic Development and the American Society of Civil Engineers (ASCE) as the official progress report of the industry. It was an unprecedented index and she converted it into a continuous inventory of planned construction that has become ENR’s “Backlog of Proposed Construction.”

The index documents more than \$100 billion of construction activity. Her indexes were cited in contract escalation clauses, court testimony, and Congressional debates. She defined the limits for and edited the pilot issues of *Construction Daily*, a nationwide service.

A founding member and Life Member of the Society of Women Engineers (SWE) who served on its Board of Trustees, Eaves “always encouraged women by her active example and

participation.” She was often contacted by young women, high school counselors, and university professors looking for advice and information on careers for women in engineering.

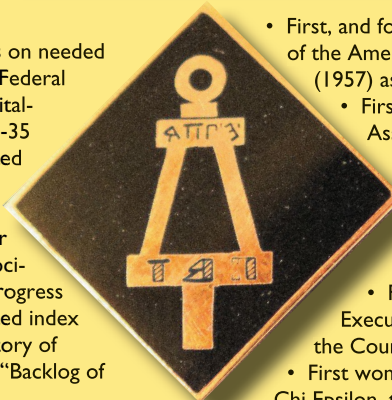
After her retirement from ENR, Eaves advised the International Executive Service Corps about construction costs in Iran and served as an advisor to the National Commission on Urban Affairs regarding housing costs.

Her extensive list of firsts includes:

- First woman to be licensed as a professional engineer in New York State
- First woman member of ASCE (as a corporate member in 1927)
- First woman to be a life member of ASCE (1962, at which time there were 54 women among 48,000 members)
- First woman elected to honorary membership of the ASCE (1979); first woman to be elected Associate Member, Fellow of ASCE



Society of Women Engineers Photograph Collection, Walter P. Reuther Library.



- First, and for a long time, the only woman member of the American Association of Cost Engineers (1957) as well as the first civil engineer
 - First woman to receive the American Association of Cost Engineer’s Award of Merit (1967)
 - First woman to receive the Honorary Life Membership Award from the American Association of Cost Engineers (1973)
 - First woman to receive the International Executive Service Corporation “Service to the Country” Award
 - First woman elected Chapter Honor Member of Chi Epsilon, the civil engineering honorary
 - First woman to receive CU-B’s Engineering Alumna Award
 - First woman to deliver the Arthur Boase Lecture for CU-B’s Department of Civil and Environmental Engineering
 - Elected a Fellow of the Society of Women Engineers in 1980, the first year that SWE elected Fellows.
- Jill Tietjen

Membership in the Founder Societies, 1946

Organization	Total Membership	Number of Women
AIEE	24,526	14
ASCE	21,100	23
ASME	20,060	33
AIME	12,600	26
AICHE	5,788	5

Lillian Gilbreth, the co-founder of the field of industrial engineering and so-called “first lady of engineering,” was made an honorary member of the Society of Industrial Engineers in 1921 as a favor to her husband, Frank Gilbreth, but not admitted to regular membership. She was the first woman elected to the National Academy of Engineering (NAE) in 1965, only one year after the 1964 establishment of the NAE.

The 1921 edition of American Men of Science lists zero women employed in engineering. The 1920 census,

however, reports that 130,000 engineers were counted and 41 of them were women, up from 21 in the 1890 census. Prior to 1920, at least 45 women were known to have graduated from college having received engineering degrees. By 1929, a total of 158 women were believed to have graduated with degrees in engineering and 53 engineering colleges (up from 35 in 1920) now admitted women. The 1940 census reports 730 women employed as engineers representing 0.3% of the total work force. No women were on the faculty of the 20 largest doctoral universities in the U.S. in 1938. In that same year, no women were employed in the federal classified civil service out of 20,000 engineers.



Lillian Gilbreth—"first lady of engineering."

Sigma Tau, the other engineering honor society (which was merged into TBPI in 1973), voted at its 1954 Conclave to admit women. The first woman initiate was an aeronautical engineering student from the University of Kansas. The honor society for liberal arts and sciences, Phi Beta Kappa, was established at the College of William and Mary, in Williamsburg, VA, in 1776. It first welcomed women as members in 1875 (the University of Vermont) and 1876 (Connecticut's Wesleyan University).

To Recognize Achievements

In 1936, Tau Beta Pi began offering a Women's Badge to recognize engineering achievements by women. The Badge did not, however, include membership in the Association. TBPI was one of the last honor societies to refuse to admit women as full members. When chapter delegates told the 1968 Convention that they would lose their charters at their schools if membership was not opened to women, the language in the Constitution was amended enabling women to become members.

The first women were initiated in 1969. The Women's Badge holders were not automatically enrolled as members, but could opt to do so. Of the 155 women initiated in 1969, 97 held the Women's Badge. Also in 1969, the first women delegates were seated at the

Convention. All sexist language in the Constitution and Bylaws was finally removed in 1978.

A major milestone in engineering education was reached in 1972 when the percentage of women receiving undergraduate engineering degrees in the U.S. reached one percent. In 1968, five women across the entire U.S. received engineering doctorates. Today, the percentages and numbers are higher but nowhere near parity.

Summary

Since the engineering profession as a whole wasn't very welcoming to women in general for many years, it isn't much of a surprise that Tau Beta Pi didn't have full women members until the middle of the twentieth century.

The lack of acceptance didn't deter many of the early women engineers who certainly demonstrated determination and persistence to make it through the education process and establish themselves in a career.

As an engineer who graduated in the third class in which women were admitted as undergraduates at my university, I am grateful that attitudes towards women's aptitudes and abilities to be successful engineers have changed at the educational institutions, within the engineering societies and within Tau Beta Pi.

Jill Tietjen is a senior member of IEEE and the president, and



CEO of Technically Speaking, Inc. An author, speaker, and electrical engineer, she spent 40 years in the electric utility industry providing planning and consulting services to utilities and organizations in that industry, and served as an expert witness before public commissions. Tietjen's books include *Her Story: A Timeline of the Women Who Changed America*, and an introduction to engineering textbook, *Keys to Engineering Success*. Tietjen has received numerous awards and honors including TBPI's Distinguished Alumna Award.

\$\$ Benefit for Members

Members may be eligible for an additional discount off their automobile insurance.

Did you know that GEICO provides a discount to Tau Beta Pi members on their auto insurance, which benefits Tau Beta Pi whenever a member gets a quote? Members could save up to an additional 8% on car insurance. Also, GEICO can help you find great insurance rates on motorcycle,

homeowners, renters, boat, and much more. Get a free quote today to see how much you could save with GEICO. It will be a very wise decision! Visit www.geico.com/greek/tbpi or call 1-800-368-2734 for your free quote.

