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Women Pioneers in Science and Math: An Overview

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Women Pioneers in Science and Math at Berkeley: An Overview

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Introduction

The history of women students at the University of California at Berkeley is almost as long as the history of the university itself. Just two years after its founding in 1868, the University of California opened its doors to eight women students, after the Regents voted unanimously in 1870 to admit women “on equal basis with men” with permission to “pursue the same curriculum of instruction as the other sex.” Four years later, President Daniel Coit Gilman remarked that “the proportion of women who ranked high in scholarship was greater than that of men.”¹ After ten years, women students represented about one-quarter of the student body, 62 out of 244 students. By 1900, women comprised 43 percent of the student body. (In 2024, women make up more than fifty-four percent of the undergraduates at UC Berkeley.) In contrast to growing numbers of women students, the Berkeley faculty was almost devoid of women. Qualified female scientists were often hired as lecturers in non tenure track faculty positions.

When UC Berkeley recognized the 150th anniversary of the admission of women in 2020, Chancellor Carol Christ launched the 150W History Project to chronicle both the struggles and the achievements of women students, faculty, staff and alumnae. This essay complements three other essays written for the 150W History Project (150w.berkeley.edu) which track doctoral alumnae who earned degrees in astronomy, botany and zoology.² Berkeley women chemists and chemical engineers have been thoroughly chronicled by the College of Chemistry in a detailed history written by Marge d’Wylde.³ My intention in this essay is to offer an overview of selected Berkeley women graduates in fields not covered by the specific 150W essays mentioned above: medicine and physiology, mathematics, physics, and engineering.

Many of these determined women who studied, taught, and conducted research in science and engineering deferred enrollment in the university until in their thirties

¹ John Aubrey Douglas, *The Conditions for Admission: Access, Equity, and the Social Contract of Public Universities* (Stanford, CA: Stanford University Press, 2007), 21–24.

² Sheila Humpheys. Early Women Botanists at Berkeley; Celestial Observers: The First Sixteen Berkeley Women Doctoral Graduates in Astronomy; Early Women PhDs in Zoology at UC (1902-1928). 150w.berkeley.edu

³ Marge d’Wylde. *150 Years and Counting: Co-education and the College of Chemistry*. Catalyst Magazine, College of Chemistry, UC Berkeley. May 2020

after spending years teaching in secondary schools to earn money to pay for graduate education. They married later or not at all. As a group, those women who obtained faculty positions in coeducational schools advanced more slowly than their male colleagues and earned less. Exceptions were faculty at women's colleges, who had robust careers. By making sacrifices and overcoming obstacles, they succeeded in creating new knowledge and made scientific discoveries. Through their research and activism, they were engaged in addressing pressing societal issues of their times, such as suffrage, public health, and pacificism.

Women, the University, and a Growing State of California

In the latter part of the nineteenth century, the young state of California looked to its new university for science training to meet the needs of a rapidly growing population and economy. The Morrill Land Grant College Act of 1862, signed by President Lincoln, and the Organic Act of 1868 specified that land grant universities would provide practical instruction in agriculture, engineering, and the mechanical arts, spurring the formation of the Colleges of Agriculture, Civil Engineering, and the Mechanical Arts and Mining in the new university. Mining included geology, which attracted students from all over the world. The College of Civil Engineering encompassed the study of irrigation, critical to California agriculture. Instruction in engineering mattered to the State, but few women enrolled as engineers. California urgently needed to train teachers to staff the secondary schools scattered all over the state. The preparation of young women who sought high school teaching jobs was a practical and compelling reason for the university to welcome coeducation, and the majority of women attracted to the university early on sought to prepare themselves to be secondary school educators.⁴

“Preparation of Marriage and Motherhood”

During the early decades women students at Berkeley received a mixed message about the purpose of their education. Certain faculty perceived the purpose of women's education as different from that of men. In 1899, Professor Edward Bull

⁴ Geraldine Clifford. "Equally in View: The University of California, Its Women, and the Schools." *Chapters in the History of the University of California*, vol. 4, 1995, Center for the Studies in Higher Education and Institute of Governmental Studies. https://cshe.berkeley.edu/sites/default/files/4equally_in_view.pdf.

Clapp argued that “coeducation of the sexes is an integral part of the University’s history.” In contrast President Benjamin Ide Wheeler, whose term extended from 1899 to 1919, declared that women were “not here to be like men.” Instead, women were receiving an education to “grow more true, more womanly.” Wheeler emphasized moral leadership. He declared to representatives of the Association of Women Students of Berkeley in 1904: “You are not here with the ambition to be schoolteachers or old maids, but you are here for the preparation of marriage and motherhood. This education should tend to make you more serviceable as wives and mothers. We want women for purifying, refining, and upbuilding of life.”⁵ Other voices, however, countered Wheeler’s low expectations of educated women. President of Mills College Aurelia Reinhardt, class of 1898, wrote an article, “University Women,” for the 1918 semi centenary anniversary of the university, in which she praised the accomplishments of alumnae of Berkeley’s first fifty years. Reinhardt named such prominent women in charitable agencies and professional life, such as Anna Head (education), Katherine Felton (public welfare), and Dr. Romilda Paroni Meade (medicine).⁶



Women undergraduate students. Credit: UC Berkeley Library

⁵ Maresi Nerad. *The Academic Kitchen* (New York: SUNY Press, 1999), 29, quoting the *Daily Californian*, September 1, 1904, 1.

⁶ Aurelia Reinhardt. “University Women” *California Fortnightly*, Vol IX, No 16, 1918, 41-45. Reinhardt was President of Mills College.

In her history of “Women at Berkeley: 1870-1970”⁷ Catherine Gallagher has documented the lesser status of women on campus, from insufficient spaces to gather, poor housing conditions, and fewer extracurricular opportunities. Women had no official space on campus in which to meet, eat lunch, or organize student activities, except for the “Ladies Room,” a single room in the basement of North Hall. Certain sacrosanct spaces were reserved for men, like Senior Men’s Hall and the Senior Bench. Student housing was not provided on campus. The regents of the university explicitly decided against university-owned student dormitories for campus; none existed until 1929. Not until 1942 was Stern Hall built, the first campus dorm for women, thanks to a private donation. Women either commuted long distances from their homes or lived in local boarding houses. Only a small fraction of women students lived in houses owned by sororities. Commuting from San Francisco involved a ferry trip across San Francisco Bay to Oakland, and from there a horse-drawn car to the Berkeley campus. Access to physical education was contentious for women because participation in “physical culture” required a physical examination. There was no female physician on campus available to give exams until Dr. Mary Ritter agreed to provide examinations without pay. Dr. Mary Ritter became the first physician to women students and her salary was paid by Regent Phoebe Hearst. Women were not permitted to use the Harmon gymnasium until the late 1890s and then only after 5 pm.⁸

As historian Karen Merritt points out in “Academic Ambitions: The First Fifteen Women Who Earned Ph.D.’s at the University of California.”⁹ over half of the first fifteen earned degrees in the sciences, rather than in the humanities or social studies.

⁷ Catherine Gallagher. “Women at Berkeley, The First Hundred Years”. UC Berkeley: The 150 Women Project. Retrieved from <https://escholarship.org/uc/item/3cm210vt?>

⁸ Historian Anne MaLachlan discusses the development of doctoral education in the US and for graduate women at Berkeley in her essay: "Writing a History of Graduate Women at the University of California, Berkeley" Anne J. MacLachlan, Center for Studies in Higher Education, UC Berkeley, unpublished manuscript, 2024.

⁹ Karen Merritt. “Academic Ambitions: The First Fifteen Women Who Earned Ph.D.s from the University of California.” UC Berkeley, 2023: The 150 Women Project. Retrieved from <https://escholarship.org/uc/item/24w262bg?>

First PhDs Granted to Women at Berkeley ¹⁰

Year of PhD Years of other Berkeley degrees	Name	Fields of PhD Fields of other Berkeley degrees
1898 1880	Millicent Washburn Shinn BA	Pedagogy
1900 1894	Jessica Blanche Peixotto PhB	Economics and Political Science
1902 1898, 1899	Alice Robertson BS, MS	Zoology
1910 1906, 1907	Edna Earl Wilson BS, MS	Zoology
1911 1908	Annie Dale Biddle Andrews BA	Mathematics
1912 1908, 1909	Myrtle Elizabeth Johnson BS, MS	Zoology Zoology/Teaching, Zoology/Math
1912	Lillian Ruth Matthews	Economics
1913	Anna Estelle Glancy	Astronomy
1913	Emma Phoebe Waterman	Astronomy
1914	Frances Lytle Gillespy	English (Philology)
1914 1909, 1910	Rosalind Wulzen BS, MS	Physiology
1915	Olga Louise Bridgman	Physiology
1915 1907	Helen Margaret Gilkey BS	Botany

¹⁰ This table is derived from data developed by Anne MacLachlan tracing doctoral recipients at UC Berkeley. Source: to 1916: California Alumni Association (1916), *Directory of Graduates of the University of California 1864-1916*. University of California (1918), *Annual Report of the President of the University, 1918-1919*.

1915 1913, 1914	Olive Swezy BS, MS	Zoology
1916	Irene Agnes McCulloch	Zoology
1918	Annie May Hurd Karrer	Botany
1918	Mary Helen Sznyter	Mathematics
1919	Ruth Lovella Stone	Bacteriology
1919	Marjorie Green Foster	Research Medicine
1923	Dolly Cora Hagan	Botany

Women Students and Faculty in Science and Mathematics at Berkeley

In the following sections, women in specific disciplines who studied STEM fields at Berkeley and or taught during Berkeley’s first five decades are profiled.¹¹ Despite the lack of consistent encouragement, women studied the whole range of scientific and mathematical subjects from the university’s very first course offerings. Astronomy, mathematics, botany, zoology, geology, and chemistry attracted many women students. Mathematics was required of all students and was a necessary qualification for the high school teaching jobs to which most female undergraduates aspired. Almost as many women as men studied mathematics at the turn of the century.

Women in Medicine, Physiology and Anatomy

Two medical schools were founded in San Francisco prior to the merger creating the Medical Department of the University. Dr. Elias Samuel Cooper created the Medical Department of the University of the Pacific in 1859 and Cooper Medical College, which lasted until 1864. Dr. Hugh Toland established the Toland Medical College in San Francisco in 1864 with eight faculty. After Dr. Cooper’s death, his faculty joined Toland.

¹¹ An exception to this timeframe is a section on women in electrical engineering and computer science, a department which was created in 1973.

Students were offered two four-month courses which conferred the degree of doctor of medicine.¹² The curriculum emphasized clinical instruction and dissection. Toland Medical College in San Francisco¹³ merged with the University of California in 1873, becoming “The Medical Department of the University of California.”¹⁴ On September 15, 1874, the regents of UC opened the door to women with a resolution stating “young women offering themselves for admission and passing the required examination must be received to all the privileges of the medical department.”¹⁵

Few Berkeley undergraduate women chose to study medicine in the 1870s and 1880s despite having graduated in science fields. Women medical students focused on maternal and child health, and addressed public health challenges like family and child welfare, sanitation, and housing and epidemics. The women physicians who established medical practices in the East Bay in the 1880s and 1890s knew and supported each other. Doctors Sarah Shuey, Mary Bennett Ritter, Edith Brownsill, and Romilda Paroni, profiled below, were affiliated with the university as clinicians and held part-time faculty appointments at Berkeley as lecturers in hygiene. Both Shuey and Brownsill were outspoken advocates for women’s suffrage.



Lucy Maria Wanzer MD, the first graduate of the Medical Department.

Credit: UCSF Alumni Archives

¹² A History of UCSF. 1868-1898 “The Origins of the University of California and Affiliated Colleges” <https://history.library.ucsf.edu/story.html>

¹³ Eventually Cooper split from UC and became Stanford Medical School. *ibid.*

¹⁴ *idem.*

¹⁵ *ibid.*

Lucy Maria Field Wanzer (1850–1930) was the first woman to graduate from the Medical Department of the University of California in 1876 and first female graduate of a medical school West of the Mississippi. Born in Milwaukee, Wanzer moved with her family to California. To raise money for her medical studies, Wanzer taught elementary school in Oakland for seven years. At first her medical school application was rejected, but she appealed to the regents and gained admission at the age of thirty-three. For a time Wanzer was hazed by several faculty and fellow students. Fortunately a senior faculty member and future dean Dr. Beverly Cole, adopted Wanzer as his mentee and steadily promoted her career. Wanzer set up a practice in San Francisco above a plumbing shop, where she specialized in obstetrics and pediatrics and served on many boards of health. Wanzer was an early staff member at The Pacific Dispensary for Women and Children, later called Children’s Hospital, in San Francisco for the care of women and children.¹⁶



Sarah Isabel Shuey MD, the first woman physician in Berkeley. Credit: Ancestry.com

Sarah Isabel Shuey (1851–1921) graduated from Berkeley in the class of 1876 and attended Toland Medical College before its merger with the University of California. Dr. Shuey established practice as the first woman physician in Berkeley. Public health was her passion. After she discovered the filthy conditions in the Berkeley barns where cows were milked, she joined the Berkeley Milk Committee

¹⁶ Accessed December 2023.

http://www.ucsfalumni.org/s/1420/images/editor_documents/medicine/library/lucy_wanzer_md_76_bio_by_r_sh_erins_final.pdf

to raise standards of cleanliness in local dairies and to ensure a sanitary milk supply for babies and children. A leader in the medical community, Shuey was elected President of the Oakland Board of Health and was the President of the Alameda County Medical Association. In 1911 Dr. Shuey wrote an article “Public Health Movement on the Pacific Coast,”¹⁷ in which she analyzed the most serious diseases affecting the West and the responses by health organizations and legislators in the Western states. From typhoid and tuberculosis to syphilis and Bubonic plague, Shuey summarized some of the progressive programs to improve public health and efforts to educate the public about treatment and prevention. For example, she pointed out the benefits of fresh air in outdoor schools for tubercular children and playgrounds in public schools.

Sarah Shuey was also an active Suffragist in the Berkeley Political Equality League and was an active member of the Equal Suffrage League of San Francisco. She is famously quoted, “Why do I believe in suffrage for women? Because I am a human being as well as a woman, and I believe in true democracy, and wish to get into the company of rational human beings before the law, and not to be classed with the idiots, imbeciles, the insane and criminals—because the city, State or nation is only a larger family, therefore it is inevitable that women should share in the responsibility for the normal development of the race.”¹⁸ Dr. Shuey was a crucial mentor to and medical partner of Dr. Mary Bennett Ritter, whom she invited to join her practice.

¹⁷ Shuey, Sarah I. “Public Health Movement on the Pacific Coast.” *The Annals of the American Academy of Political and Social Science*, vol. 37, no. 2, 1911, pp. 87–94.

¹⁸ Steven Finacom. “Centennial of Women's Vote in California is 2011: Berkeley Celebrations Planned.” *Berkeley Daily Planet*, 1 Mar. 2011, www.berkeleydailyplanet.com/issue/2011-03-02/article/37399.



Mary Elizabeth Bennett Ritter MD, in 1908.
Credit: Special Collections & Archives, UC San Diego.

Mary Elizabeth Bennett (Ritter) (1860–1949) was closely involved with the university her entire life although not an alumna. After spending her youth in Fresno, Bennett set her heart on medical school. To save money for her training she taught in rural secondary schools in and near Fresno. Mary Bennett entered Cooper Medical College of San Francisco in 1884, one of two women students. She graduated in 1886 and spent a year in San Jose as an intern under Dr. Charlotte Blake Brown. In 1887 Bennett moved to Berkeley to enter into medical practice with Dr. Sarah Shuey and later inherited Shuey’s successful practice. As the first university physician for women, Dr. Ritter lectured students in the required course on home sanitation and hygiene. She was appointed to her position at the University as a result of student activism. She agreed to serve as physician to women students *gratis* in 1891, after being asked by the students to provide the physical examinations required of them in order to use the gymnasium.

Ritter’s autobiography describes in vivid detail what it was like to practice medicine as she traveled by horse and buggy to make house calls and to deliver babies at night.¹⁹ Ritter’s influence extended far beyond her medical role; she was a sympathetic adviser to and advocate for women students in the years before the

¹⁹ Mary Bennett Ritter. *More than Gold in California*. 1933, reprinted, ed. Gesa Kirsch, Rowman and Littlefield, 2017.

appointment of the first dean of women at Berkeley, Lucy Sprague. Ritter was an enthusiastic sponsor of the *Prytanean Honor Society*, the first such organization for women in the country, founded by a group of student leaders in 1900. The students met at Ritter's home for the first few years.²⁰ Ill health forced Dr. Ritter's retirement in 1904. She moved to La Jolla in 1909 with her husband, Professor William Ritter, who established Berkeley's Marine Biology Station there. In that close community of oceanographers, Mary Ritter was an important friend and mentor to women doctoral students in zoology from Berkeley who lived and conducted their research in La Jolla.²¹



Edith Brownsill MD, for Alpha Gamma Delta Sorority. Credit: Fran Becque, Ph.D.

Edith Sara Brownsill (1873–1926) was born in Wisconsin and graduated from Santa Barbara High School. She earned her bachelor's degree in 1899 from Berkeley. As captain of the women's basketball team, she played in the first intercollegiate game against Stanford. Brownsill was President of the Young Women's Christian Association (YWCA). All during her life she maintained a robust connection with the YWCA. One of just four women in her class at the medical school of the University, Brownsill earned a degree in 1904. She then interned at the Children's Hospital in San Francisco from 1904-1905. After the 1906 earthquake, many San Franciscans rushed to Berkeley for medical treatment. In response, Dr. Brownsill co-founded the Berkeley Settlement Clinic, where she treated the women patients. From 1906-1922 she was affiliated with the Berkeley Dispensary General Medicine. In 1917, she interned for three months at Johns

²⁰ Janet Ruhl. "The Early Prytanean", Ladies Blue and Gold, 1998, 50.

²¹ Sheila Humphreys. "Early Women PhDs in Zoology at UC, 1902-1927." UC Berkeley: The 150 Women Project. Retrieved from <https://escholarship.org/uc/item/28b9t9h>

Hopkins and for a month at the Lying-in Hospital in New York City.

Like Shuey and Ritter, Brownsill resolved to strengthen standards of local public health. She joined the effort to improve the sewage systems and monitor the milk supply in Berkeley. The forward-looking Brownsill was a proponent of birth control and an outspoken suffragist. Brownsill did not marry, but left a crowd of appreciative colleagues and patients. A tribute was paid to Edith Brownsill after her death by the Alameda County Medical Association:

*She was, in the fullest sense, a beloved physician. For her the practice of medicine was a constant search for more abundant life who came to her for counsel and care. She never asked what her work would bring her; never sought to build up a moneyed clientele; made no plans on anticipated returns. For her the art of healing was an end in itself; the patient was the means, regardless of wealth, class or culture. Her work was never a task imposed, but rather a cherished privilege. To a real degree she possessed that depth of spirit which always inspires confidence; her very presence in the sickroom meant that 'hearts were brave again and arms were strong.'*²²



Romilda Paroni MD. Credit: *The Blue and Gold Yearbook*, 1903, Bancroft Library, UC Berkeley

Romilda Paroni (Meads) (1880–1957) grew up in Berkeley across from the campus and graduated from both Berkeley High School and UC Berkeley.

²² Fran Becque. Edith Brownsill, M.D., Alpha Gamma Delta, #NotableSororityWomen, #WHM2023 Posted on March 29, 2023.
<https://www.franbecque.com/edith-brownsill-m-d-alpha-gamma-delta-notablesororitywomen-whm2023/>

Emigrants from the Lago Maggiore area of Switzerland, Paroni's parents emphasized the importance of higher education for their seven children. The second child, Romilda, graduated from Berkeley with the class of 1903, and was elected to the Prytanean Honor Society. She proceeded directly to medical school in San Francisco. Paroni was one of four women graduates in her medical class of thirty in 1907. In 1908 she studied at Harvard for one year. Paroni set up a private practice in obstetrics in Berkeley. Dr. Paroni (known as Dr. Meads after her marriage) accepted part-time employment in 1911 as university physician for women and lecturer in hygiene for \$2,000 a year. She taught human reproductive biology, a course required of all freshmen women. Like her predecessor, Dr. Mary Bennett Ritter, Paroni was a trusted maternal presence for students in her role as the physician for women on campus before Lucy Spague assumed the position of dean of women in 1906. During the influenza epidemic, Paroni cared for women students: *"the women students were inadequately provided for, as but a limited section of the Infirmary could be reserved for their use. A service department was instituted by Drs. Lillian Moore, Romilda Paroni Meads, and Ruby Cunningham of the Infirmary and these, with the cooperation of the Dean of Women, and student helpers, ministered to the women who were ill in sororities and club houses...and without their help it would have been impossible to have provided adequate medical and nursing service to our college women."*²³

It is reported that Dr. Paroni Meads advised students to shed their corsets because they were too constricting and to avoid pointy-toed shoes. She was a member of the Alameda County Tuberculosis and Health Association, YWCA, Town and Gown Club and served as Trustee of the Tuberculosis Association.²⁴

²³ Robert T. Legge. "University Infirmary", Report to the President of the University of California, July 1919.

²⁴ "Dr. Romilda Paroni Meads, 88, Obituary, Oakland Tribune Oakland, California, 5 Jan 1969.



Rosalind Wulzen (Physiology BS 1904, MS '10, PhD '14).

Credit: *The Blue and Gold Yearbook*, 1904, Bancroft Library, UC Berkeley

Rosalind Wulzen (1886–1980) earned bachelor's, master's, and PhD degrees in Physiology at UC Berkeley. As an undergraduate, Wulzen was president of Phi Beta Kappa. She taught science at two local California high schools before enrolling in graduate school, as was typical of many women graduate students. She was the first woman to earn a doctorate from the Department of Physiology. For her MS, she wrote "On the mechanism of cytolysis in paramecium." Her doctoral thesis was entitled, "The pituitary gland in its relationship to the early period of growth in birds." During graduate school, Wulzen taught biology, physiology and anatomy with the title of Assistant Professor of Biology at nearby Mills College for women, where she led their department for four years. Wulzen was the first woman faculty member hired in the department of physiology at Berkeley. She retained the non-ladder title of instructor, a rank she retained for fourteen years.

In 1927, Wulzen was named instructor in the Department of Animal Biology at the University of Oregon in Eugene. There, she continued her research on the pituitary gland and also began a notable academic career. Wulzen took a full-time position as an assistant professor at Oregon State University in Corvallis in 1933 where she remained for the rest of her career. In 1941, Wulzen rose to associate professor and in 1946 she attained the rank of full professor. She retired in 1948 but continued to teach as an Emerita until 1954. Wulzen is best remembered for making the discovery of a compound that could reverse joint calcification in osteoarthritis, known as the "Wulzen factor" or anti-stiffness factor. She conducted experiments

on guinea pigs by feeding them unpasteurized dairy products. Notably, Wulzen's discovery came to light in the popular press in 2023 in a book entitled "The Wulzen Anti-Stiffness Factor: How Stigmasterol Can Help You Stay Young, Active And Pain-Free."²⁵



Professor Rosalind Wulzen. Credit: Smithsonian Institution Archives, Acc. 90-105 Science Service, Records, 1920s-1970s

Wulzen advised the theses of two graduate students in the Departments of Zoology and Chemistry: Mary Lorene Wickert (MS 1944) and Virginia Lee Wiemar (MS 1947). She was Professor Emerita from 1947 to 1954. Oregon State College awarded her an honorary doctor of science degree in 1943, and the Oregon Academy of Science recognized Wulzen as an outstanding Oregon scientist in 1954.²⁶

²⁵ Patsy Hynum, *The Wulzen Anti-Stiffness Factor: How Stigmasterol Can Help You Stay Young, Active And Pain-Free Paperback* – May 26, 2023

²⁶ Merritt. I am indebted to Karen Merritt for references on both Rosalind Wulzen and Olive Swezy.



Lillian Moore (Physiology PhD 1918). Credit: Smithsonian Institution Archives, Acc. 90-105 - Science Service, Records, 1920s-1970s

Wulzen's contemporary **Lillian Mary Moore** (1887–1929) was born in New Mexico in 1887 and first attended Wellesley College. She transferred to the University of California where she received her bachelor's degree and her doctorate from the department of physiology in 1918. With the title of instructor of physiology she taught at Berkeley from 1916 to 1920. In addition to research and teaching, she fulfilled the dual role of Assistant to the Dean of Women, with responsibility for attending to the needs of individual women students. Her heroic role in tending to women students during the influenza epidemic, along with Romilda Paroni, was cited by the University Physician.²⁷

Both Moore and her contemporary Rosalind Wulzen continued to conduct productive research while carrying heavy teaching loads.²⁸ In 1923 Moore was appointed Assistant Professor and Lecturer in Physiology at Berkeley. From that time until her early death on August 2, 1929 at the age of forty-two, colleagues recall her steady devotion to the University of California. Her most important research focused on the regulation of body temperature. At the time of her death, she left unfinished manuscripts and promising research yet to be completed. According to her colleagues she had already pushed on to new ideas. Moore pointed the way for subsequent advances in her field.²⁹

²⁷ Legge, *ibid.*

²⁸ Nello Pace. "Tides of Physiology at Berkeley," Vol.29, No 5, 1986, 12.

²⁹ Authors Lillian Mary Moore: Physiology University of California, In Memoriam, 1931.

First Women Appointed as Ladder-rank Faculty in STEM by Department

Year	Department	Name
1915	Nutrition	Prof. Agnes Fay Morgan
1915	Plant Pathology	Prof. Elizabeth Hight Smith
1923	Mathematics	Prof. Pauline Sperry
1956	Statistics	Prof. Elizabeth Scott
1958	Physiology / Anatomy	Prof. Paola Timras
1970	Zoology	Prof. Mary Lou Pressick*
1971	Computer Science	Prof. Susan Graham
1971	Paleontology	Prof. Carole Hickman
1973	Botany	Prof. Nancy Vivrette*
1973	Mechanical Engineering	Prof. Constance Miller*
1973	Zoology	Prof. Marvalee Wake
1978	Chemistry	Prof. Judith Klinman
1970s	Civil Engineering	Prof. Catharine Van Ingen*
1981	Industrial Engineering & Operations Research	Prof. Dorit Hochbaum
1991	Physics	Prof. Mary K. Gaillard
1982	Mechanical Engineering	Prof. Alice Agogino
1983	Materials Science & Engineering	Prof. Fiona Doyle
1984	Astronomy	Prof. Imke DePater
1987	Electrical Engineering	Prof. Avidah Zakhor
1991	Bioengineering	Prof. Lisa Pruitt (.33 FTE)

1991	Chemical Engineering	Prof. Susan J. Miller
1991	Geophysics	Prof. Barbara Romanowicz
1992	Nuclear Engineering	Prof. Jasmine Vujic
2001	Bioengineering	Prof. Kimmen Sjolander

*Left without tenure

Women in the Mathematics Department

The closely associated Departments of Mathematics and Astronomy at Berkeley granted some of the earliest doctoral degrees to women in the country. Three women were hired as instructors in the Mathematics Department in the 1920s: Annie Dale Biddle, Pauline Sperry, and Sophia Levy. Both Biddle and Levy earned doctorates at Berkeley. Although she joined the Mathematics Department, Sophia Levy actually received her PhD in astronomy. Eventually Biddle, Sperry, and Levy moved to tenure-track positions in math after years spent at the level of instructor. Emeritus Mathematics Chair Calvin Moore reports in his comprehensive history of the Mathematics Department at Berkeley that women's appointments were initially treated just as men were. All faculty appointments were made at the instructor level until 1933 and all were given to Berkeley graduates.³⁰ However, the rate of advancement of these three women dragged behind that of their male counterparts.

³⁰ Calvin Moore. *Mathematics at Berkeley: a history*. Wellesley, MA: A K Peters Ltd, 2007.



Annie Dale Biddle (Math PhD 1911).

Credit: *The Blue and Gold Yearbook*, 1909, Bancroft Library, UC Berkeley

Annie Dale Biddle (Andrews) (1885–1940) was born in Hanford, California. She became the first woman to receive a PhD in mathematics from Berkeley in 1911 and the third student to earn a PhD in mathematics at Berkeley. The first Berkeley math PhD was only granted two years prior. A vivacious redhead, Annie Biddle was active as an undergraduate in pushing for women’s rights through the Association of Women Students. Biddle’s dissertation, written under the joint supervision of Derrick Lehmer and Mellen Haskell, focussed on the “constructive theory of the unicursal plane quartic by synthetic methods.” Biddle taught mathematics for one year at the University of Washington after graduation.

In 1912 she married Mr. Wilhelm Samuel Andrews, an Irish lawyer, and they raised two children. Her academic possibilities narrowed because of existing bias against married women in the academy. Calvin Moore related that Biddle was dismissed in 1930 when the Math Department was reorganizing, partially because she was married. Colleagues perceived that she did not need the income. The department was beginning to focus on graduate education. Biddle was an instructor in mathematics at UC Berkeley off and on between 1915 and 1932. For example, during 1922–1923 she taught Mathematical Theory of Investment, Plane Analytic Geometry and Differential Calculus, Solid Analytic Geometry, Integral Calculus, and Infinite Series, College Algebra, and Introduction to Projective Geometry. She published a research paper in March 1933: "The space quartic of the second kind

by synthetic methods" at a meeting of the American Mathematical Society in Palo Alto. The abstract for the talk was published in the AMS Bulletin (vol. 39 (1933), 205-206).³¹ Biddle died at the early age of 54 in 1940, leaving her husband and two children.



Pauline Sperry. Credit: Department of Mathematics, UC Berkeley

Pauline Sperry (1885–1967) was born in Peabody, Massachusetts, the daughter of a Congregational minister. As an adult she joined the Quakers. She studied for two years at Olivet College and transferred to Smith College, where she graduated in 1906 with a BA in mathematics. Devoted to music, she sang in the Smith choir and earned an MS in music from Smith in 1908. With the title of instructor, Sperry taught math at Smith from 1908 to 1912. She then moved to Chicago and earned a PhD in mathematics from the University of Chicago in 1916 with a thesis entitled “Properties of a certain projectively defined two-parameter family of curves on a general surface” under former Berkeley Professor Ernest Wilczynski, considered the father of differential geometry.

Sperry returned to Smith as an assistant professor of mathematics but left after one year in 1917 and moved to California to accept a lower rank as instructor of math at Berkeley. In 1923 she was the first woman to be promoted to the tenure track as assistant professor in the Mathematics Department and advanced to the level of associate professor in 1931. Sperry's specialty was geometry, and she taught many

³¹ Agnes Scott College, “Biographies of Women Mathematicians,” 2019
<https://www.agnesscott.edu/lriddle/women/andrews.htm>

of the geometry courses at Berkeley during her long career. University President Robert G. Sproul praised her “exceptional ability as a teacher in a subject in which the quality of teaching can be responsible in large measure for the difference between brilliance and mediocrity in a student's work.” Sperry was acknowledged as an influential mentor to junior women faculty. For example, she befriended Elizabeth Scott when Scott was a graduate student and often took her to lunch at the Women’s Faculty Club. Sperry and her partner, Professor of German Alice Tabor, created a community of women faculty who met at a Friday Dinner Club, where the guests shared their wide-ranging research. After writing her own dissertation, Sperry didn’t continue to publish. However, she successfully directed five doctoral students at Berkeley between 1931 and 1949, all of whom went on to academic careers. She compiled a *Bibliography of Projective Differential Geometry* in 1931, which was important at the time because of its relationship to Einstein’s new Theory of Relativity.

Women mathematics students at Berkeley formed Mu Theta Epsilon, a mathematics honor society to which faculty were invited as honorary members. Pauline Sperry was exceptionally selected by students to join as the sole active faculty member. During the 1920s she wrote two textbooks for undergraduate freshman math courses, *Short Course in Spherical Trigonometry* and *Plane Trigonometry*.³² During WWII, Sperry was drafted to instruct Navy ROTC students in navigation. With other mathematicians she worked in the Berkeley Statistics Lab, which was devoted to the war effort.

Sperry was one of thirty-one faculty who refused to sign the infamous loyalty oath required of faculty by the Regents of UC in 1950 during the era of Senator Joseph McCarthy’s investigations. The oath required University of California faculty and staff to deny membership in the Communist Party and intent to overthrow the government. Her defiance resulted in her dismissal. Colleagues wrote after her death that Sperry “felt The Regents encroached on the political freedom of the University.” Following protracted litigation she and the other non-signers were reinstated, just before her retirement. Sperry was given the title of Associate Professor Emerita, and received two years of back pay. During this trying

³² Pauline Sperry. *Short Course in Spherical Trigonometry*. Johnson Publishing Company, 1928.

experience she felt that she was “fighting for, not against, the university she loved.”³³

After retiring Sperry moved to Carmel, California, where she spent her last years working for human rights. She was appointed to the Friends Service Committee, to promote peace and reconciliation through social service, to the American Civil Liberties Union (ACLU) and the Committee for a Sane Nuclear Policy. Sperry wrote with pride in the *Smith College Alumnae Quarterly* that she had “always burned for causes.” Reflecting at age eighty, she advised Smith alumnae to be “*bold enough to ask the right questions, and brave enough to face the answers about the untouchable subject, money...Give 'till it hurts!*”³⁴ She was a generous donor to human rights and supported a school for orphaned children in Port-au-Prince, Haiti. “In the end, she knew that her efforts had been instrumental in saving from starvation and ignorance some 50 impoverished children and this satisfaction embellished her last years.”³⁵ Although her story is not well remembered today, the Berkeley Department of Mathematics honors her memory with an annual Pauline Sperry lecture for undergraduates.



Sophia Hazel Levy (Astronomy BS 1910, PhD '20).
Credit: UC Berkeley Mathematics Department

Sophia Hazel Levy (1888–1963), the daughter of California pioneers, developed

³³ D. H. Lehmer, Hans Lewy, and R. M. Robinson, “In Memoriam: Pauline Sperry,” UC Berkeley Mathematics Department, 1968.

³⁴ P Sperry, “Formula for happiness at eighty,” *Smith Alumnae Quarterly* (Spring, 1965), 154-155.

³⁵ *idem*.

an interest in astronomy as a Berkeley undergraduate. She earned a BS in 1910 and PhD in 1920 in astronomy. For most of her career, however, Levy belonged to the mathematics faculty at Berkeley. While pursuing graduate study she was hired as an astronomy assistant from 1910 to 1914. After that she was employed in two administrative posts, assistant to the dean of the Graduate Division and Secretary to the California State Board of Education for the Commission of Credentials. She was appointed as astronomy instructor in 1921 for two years. Levy contributed many papers to theoretical astronomy. Because of her ability in mathematical analysis, she was hired as an instructor in mathematics at Berkeley in 1923. Eventually Levy rose to full professor of mathematics in 1949, *twenty-six years later*. During World War II, Levy directed the mathematics instruction for the Army Specialized Training Program at Berkeley.³⁶ She taught courses on anti aircraft gunnery and even published a text, *Introductory Artillery Mathematics and Antiaircraft Mathematics*.³⁷

Like her colleague Pauline Sperry, Levy cared deeply about improving the quality of mathematics instruction at the secondary school level. So she assumed leadership roles in the training of math teachers and prospective teachers. She advised the State of California on math curriculum for the California Committee for the Study of Education in California public schools. She served as chair and sectional governor of the recently organized Northern California Section of the Mathematical Association of America. In 1941, the Northern California and Southern California Sections established a Joint Committee on Mathematical Education under her chairmanship “to study means of strengthening the program of mathematics in schools and colleges.” Levy developed a summer session for math teachers to meet state requirements and published articles in *The Mathematics Teacher* on teaching mathematics in the schools. Her investment in pre-college teaching was valued by the Math Department according to Calvin Moore. Levy chose to defer her marriage to Professor John McDonald until he retired in 1944 because, under nepotism rules, one of the two would have had to resign from the faculty had they married. Anti-nepotism rules were not dropped until 1971 at Berkeley.

³⁶Louis E. Keefer, *The Army Specialized Training Program in World War II*, <http://www.pierce-evans.org/ASTP%20in%20WWII.htm>.

³⁷Sophia Hazel Levy, *Introductory Artillery Mathematics and Antiaircraft Mathematics* (Berkeley: University of California, 194



Emma Trotskaia Trotskaia (Math BS 1928).

Credit: University of St. Andrews, Scotland, School of Mathematics and Statistics

Emma Markovna Trotskaia (Lehmer) (1906–2006) was born in Samara, Russia, and moved to Harbin, China at the time of the Russian Revolution. She was homeschooled until age fourteen by parents who encouraged her. In high school she decided to come to America and worked to save money for her travel. As a sophomore at Cal she was hired by Professor Derrick Norman Lehmer to work in his lab on number theory, where she met his son, Derrick “Dick” Henry Lehmer, a physics undergraduate. She earned a BS in math summa cum laude from UC Berkeley in 1928. The pair married and attended graduate school together at Brown University. Emma Lehmer obtained a master’s degree in math from Brown in 1930, while her husband earned his PhD in math the same year. Emma Lehmer’s thesis, “A Numerical Function Applied to Cyclotomy,” was published in the April 1930 issue of *Bulletin of the American Mathematical Society* at the beginning of her productive research career. After the senior Professor Lehmer retired, Emma’s husband Dick Lehmer was hired at Berkeley in 1940. However, the University of California’s anti-nepotism policy forbade Emma Lehmer from teaching at UC Berkeley while her husband was a faculty member. During World War II she did teach briefly at Berkeley when wartime shortages of faculty forced exceptions to the rule. Writing tongue in cheek, Lehmer explained the benefits of her lack of a PhD in an unpublished essay, *On the Advantages of Not Having a PhD*: “First of

all there are lower expectations. If one happens to discover something new, one's peers are pleasantly surprised and generous in their praise. This is good for the morale.”³⁸

Emma Lehmer participated in war-related research in Berkeley's Statistics Lab in the 1940s, as did Pauline Sperry and Sophia Levy. As an independent scholar Lehmer pursued mathematics very productively. While raising two children, she wrote or co-authored about fifty-six mathematical papers in number theory, of which twenty-one were written jointly with her husband Dick Lehmer. Together they worked on computational number theory. They collaborated on a famous four century-old mathematical problem known as Fermat's Last Theorem. In his memorial essay colleague John Brillhart describes Emma as her husband's “helpmate, mother of their two children..., mathematical collaborator in their research, and hostess to vast numbers of visitors who came to Berkeley and stayed at the Lehmers' house as guests.”³⁹ As mathematical historian Kathy Kessel points out, Emma Lehmer enjoyed frequent contact with her husband's math colleagues and as a result was comfortably integrated into the mathematics research community.⁴⁰

In August 2000, UC Berkeley hosted “The Lehmers at Berkeley” a three-day conference to cover the contributions of Derrick Norman Lehmer, Derrick Henry Lehmer, and Emma Lehmer. Still working at the age of eighty, “ she discovered that certain units can be gotten from Gaussian periods by translation, a good example of the kind of basic number theory that she and her husband had done all their lives.”⁴¹ Lehmer remained in her Berkeley house until her death at the age of one hundred.⁴²

³⁸ “The Lehmers at Berkeley”

<https://wayback.archive-it.org/6111/20230426210948/https://bancroft.berkeley.edu/Exhibits/Math/>

³⁹ John Brillhart, “Emma Lehmer, 1906–2006,” *Notices of the American Mathematical Society* 54, no. 11 (December 2007): 1500. This article contains a bibliography of Emma Lehmer's mathematical publications.

⁴⁰ Kathy Kessel. “Tenured Women at Berkeley before 1980” *Notices of the American Mathematical Society*, March 2022, 430.

⁴¹ “The Lehmers at Berkeley” .Online exhibit, Bancroft Library, University of California, Berkeley, 2000.

<https://bancroft.berkeley.edu/Exhibits/Math/dhlc.html>

⁴² V.F. Lenzen, S. Einarsson and G. Evans. In Memoriam. Sophia Levy McDonald. University of California, April 1965.



Julia Bowman (Math BA 1940, PhD '48).
Credit: Neil D. Reid for The Open Logic Project

Julia Bowman (Robinson) (1919–1985) was born in St. Louis, Missouri. Bowman attended San Diego State College for three years and transferred to Berkeley for her senior year. She took five math classes that year including one from Professor Rafael Robinson, with whom she formed a friendship. She earned a BA in Mathematics from Berkeley in 1940 and married Raphael Robinson in 1941. Robinson joined the Mathematics Department as an assistant to Professor Jerzy Neyman in the Statistics Lab in 1941 to work on military problems, on which she based her first paper in 1948. She received her PhD in 1948, directed by Alfred Tarski, one of the most important logicians of his time. Tarski and Rafael Robinson were her two principal mentors. Campus anti-nepotism rules prevented Robinson from being appointed to a tenure-track position because of her marriage to Robinson.

Over her career Robinson wrote twenty-five papers. As told in her National Academy of Sciences In Memoriam, “Her first four papers dealt with probability theory, game theory, the subject of her dissertation, and the theory of recursive functions. Robinson's fifth paper was her first step along a road that led her to fame, and she followed it with eight other papers that brought her very far along the same road... These papers were successive efforts to solve ‘Hilbert's tenth

problem.”⁴³ In 1975 Julia Robinson was elected to the mathematical section of the National Academy of Sciences, in recognition of her various outstanding contributions and, in particular, of her central role in the work leading to the solution of Hilbert’s 10th Problem.

Statistics Professor Elizabeth Scott, who knew Robinson from their days as Berkeley grad students together, described Robinson’s difficulties in securing a faculty position at Berkeley despite her prominence in mathematics. At one point, wrote Scott, Robinson was required to submit a description of what she did each day to Berkeley’s personnel office. So she did: “Monday–tried to prove theorem, Tuesday–tried to prove theorem, Wednesday–tried to prove theorem, Thursday–tried to prove theorem; Friday–theorem false.” The personnel office then deferred to the graduate division to handle Robinson’s appointment. Scott appreciated the support she received from Julia Robinson and said that Robinson “...felt that women and minority mathematicians especially needed this support, which she provided with spirit yet in a quiet way...She encouraged us to work together so that all women who have the ability and the desire to do mathematical research can have the opportunity to do so.”⁴⁴

After Robinson achieved major national recognition as the first woman mathematician elected to the National Academy of Sciences, the Mathematics Department immediately offered her a full professorship. She was the first woman elected head of the American Mathematical Society and awarded a MacArthur Fellowship. Robinson’s brilliant career was cut short by leukemia in 1985.

Physics

Women entered graduate degree programs in physics at Berkeley twenty years later than women in mathematics and astronomy. The golden era of high-energy physics

⁴³ Solomon Feferman. “Julia Bowman Robinson: A Biographical Memoir.” Washington, D.C.:National Academy Press, 1994.

⁴⁴ Solomon Feferman. “Julia Bowman Robinson: A Biographical Memoir,” Volume 63, National Academy of Sciences. Washington, DC: National Academy Press, 1994. Professor Elizabeth Scott wrote: “Throughout her life Julia stood up for offering opportunities to all students...She also encouraged graduate students and young faculty to have more confidence in their real abilities.” Quoted from Notices of the American Mathematical Society (November 1985, pages 739-42)

at Berkeley followed WWI. Berkeley built a top physics department by hiring three future Nobel Laureates Ernest Lawrence, Emilio Segre, and Owen Chamberlain, who all worked on the Manhattan Project. Yet, not until 1982 did the Berkeley Physics Department appoint the first woman faculty member, Mary K. Gaillard.⁴⁵



Melba Phillips (Physics PhD 1933) at Berkeley in 1930.
Credit: Ellen and John Vinson, accessed Physics in Perspective 10 (2008).

The Physics Department granted one of their earliest doctorates to **Melba Newell Phillips** (1907–2004) in 1933. Melba Phillips was raised in rural Indiana in a family of schoolteachers and farmers. She attended a one-room school where her father was the teacher. Because it was inexpensive Phillips attended nearby Oakland College. She majored in math while taking the only two physics courses offered.

After graduation she taught at her former high school for a year. Thanks to a teaching fellowship she pursued a master's degree in physics at Battle Creek College in Michigan. Encouraged by physicist Edward Condon at a summer workshop on quantum mechanics that she attended at the University of Michigan in 1929, Phillips applied to Berkeley's physics graduate program. She entered in

⁴⁵ Professor Mary K. Gaillard was hired in 1981. <https://physics.berkeley.edu/people/faculty/mary-k-gaillard>

1930 with support from a teaching assistantship and joined the research group of newly arrived Assistant Professor J. Robert Oppenheimer. He later led the Manhattan Project team that built the first atomic bomb deployed to end World War II. Phillips was Oppenheimer's fourth doctoral graduate. "Oppie" became a lifelong friend, who called her "Melber." Phillips investigated two topics in experimental physics for her dissertation. "The first one was to try to understand some peculiarities of photoionization of potassium vapor, The second one was to try to understand the inversion of doublets in the alkali atomic spectra. Those two topics, those two papers, constituted my thesis."⁴⁶ Phillips maintained she was not the sole female in the graduate program. "There were at least four others [women] but not in theory" she reported in her oral history. She appreciated the collegiality of Oppenheimer's group and denied experiencing any gender discrimination.⁴⁷ In 1978 Phillips wrote personal recollections about studying physics at Berkeley in the 1930s. "I was often the only woman in class, but classes were never large and the competition was fun."⁴⁸



Melba Phillips. Credit: AIP Emilio Segrè Visual Archives, *Physics Today* Collection

Phillips continued to work very productively with Oppenheimer after finishing her

⁴⁶ Interview of Melba Phillips by Katherine Sopka on 1977 December 5, Niels Bohr Library & Archives, American Institute of Physics, College Park, MD USA, www.aip.org/history-programs/niels-bohr-library/oral-histories/48217

⁴⁷ It is not clear that Melba Phillips was the first female PhD in physics at Berkeley because in her oral history she refers to four other women in the graduate program, of whom one was the year ahead of her. Interview of Melba Phillips by Katherine Sopka on 1977 December 5, Niels Bohr Library & Archives, American Institute of Physics, College Park, MD USA, www.aip.org/history-programs/niels-bohr-library/oral-histories/4821

⁴⁸ Melba Phillips, "Studying Physics in the Thirties – A Personal Recollection," April 24, 1978, Folder 2: Correspondence, 1948-1999, Box 1, Niels Bohr Library & Archives, [American Institute of Physics](http://www.aip.org).

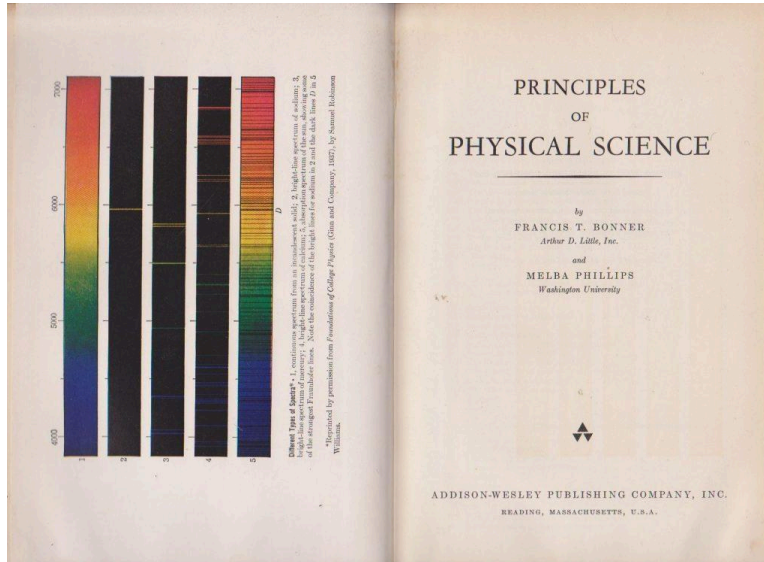
degree. In 1935, Phillips and Oppenheimer developed an explanation for what were then unexpected reactions of different kinds of subatomic particles. Called the “Oppenheimer-Phillips effect,” the process is considered a foundation of early nuclear physics.⁴⁹ Manhattan Project colleague Francis Bonner commented that normally such an accomplishment by Phillips, now considered “one of the classics of early nuclear physics, would have meant a faculty appointment. However, Phillips received no such appointment, perhaps due in part to the Great Depression, but also likely because of her gender.”⁵⁰

Phillips held a one-year fellowship at the Institute for Advanced Study at Princeton followed by temporary positions: a research fellowship at Bryn Mawr College for a year and teaching role at Connecticut College for Women. In 1938 she was appointed to the faculty at Brooklyn College while simultaneously conducting research part-time at the Columbia University Radiation Laboratory. During WWII Phillips taught for three years at University of Minnesota. In 1945 at a meeting in Washington, she helped to organize the founding of the Federation of Atomic Scientists (later called the Federation of American Scientists). Their mission was to educate the public to promote peaceful use of science and nuclear disarmament. Phillips was among the officers of the American Association of Scientific Workers who wrote to President Truman on August 16, 1945, offering “eight recommendations to help prevent the use of atomic bombs in future warfare and to facilitate the application of atomic energy to peacetime uses.”

In 1952 Phillips was fired from both her jobs after refusing to cooperate in testimony before a Senate House subcommittee investigating accusations of Communist activities. She was later reinstated at Brooklyn College and received a public apology in 1987.

⁴⁹Oppenheimer, J. R.; Phillips, M. (15 September 1935). "Note on the Transmutation Function for Deuterons". *Phys. Rev.* 48 (6): 500–2. [Bibcode:1935PhRv...48..500O](#). [doi:10.1103/PhysRev.48.500](#)

⁵⁰ Quoted in Jill Weiss Simins. “Physicist Melba N. Phillips: Indiana’s Oppenheimer Connection,” July 24, 2023



Phillips took a great interest in improving the teaching of physics at the pre-college level and made a significant impact on physics education. During her four and a half years of unemployment, she co-authored two influential texts for college students: *Principles of Physical Science* with Francis Bonner, a Manhattan Project scientist, and *Classical Electricity and Magnetism* with Wolfgang K. H. Panofsky.⁵¹ At a time when “there was much discrimination against people who had had any trouble of a ‘political’ kind, and it took a lot of courage...to hire any of the people in trouble during that time.” Phillips was appointed associate director of a program to train physics teachers at the Academic Year Institute of Washington University in St Louis. At the institute she developed programs to instruct high school teachers about how better to teach elementary science and physics.

"Probably no person has contributed to physics education over a broader range than Melba Newell Phillips," commented Francis Bonner, professor emeritus of chemistry at the State University of New York, Stony Brook. "She was a stellar teacher. She was very soft-spoken. You had to listen carefully to hear her. She had a way of getting her audience spellbound."⁵² In 1966, Phillips was the first woman named president of the American Association of Physics Teachers (AAPT).

⁵¹ Wolfgang Panofsky and Melba Phillips. *Classical Electricity and Magnetism*. Reading, MA: Addison Wesley:1962 (2nd Ed).

Francis T. Bonner and Melba Phillips. *Principles of Physical Science*. Addison Wesley, 1957.

⁵² Patricia Sullivan. "Physicist Melba Phillips, 97, Dies" Washington Post. Wednesday, November 17, 2004; p. B04

Phillips was the first recipient of the Melba Newell Phillips Award, created in her honor “*for exceptional contributions to physics education through leadership in the American Association of Physics Teachers.*”⁵³ The Physics Department of Brooklyn College of The City University of New York held a day-long symposium in her honor in 1997 and established a scholarship in her name.



Chien-Shiung Wu (Physics PhD 1940).

Credit: AIP Emilio Segrè Visual Archives, *Physics Today* Collection

Chien-Shiung Wu (1912–1997) was the second woman to receive a PhD in physics from Berkeley in 1940, after enrolling in 1936. The daughter of a progressive father who started a school for girls, Chien-Shiung grew up in China. She attended “normal school” to prepare for a career of teaching secondary school. A brilliant student, she was admitted to university in Nanjing, where she participated in student demonstrations against Japan. In 1936 she left for America with a friend and was never to see her parents again. As a physics grad student at Berkeley, she worked on atomic research under Ernest O. Lawrence in the Berkeley Radiation Lab. After earning her degree, Wu was initially distrusted because of her nationality and was not invited to help other scientists in the war effort. Instead, she taught first at Smith College and then became the first female physics instructor at Princeton University in 1942. Thereafter she was invited to work on the Manhattan Project at the Substitute Alloy Materials (SAM) Lab at

⁵³ The Melba Newell Phillips Medal is presented to AAPT leaders who, like Melba Newell Phillips after whom the medal is named, have provided creative leadership and dedicated service that resulted in exceptional contributions to AAPT.

Columbia University, where she focussed on radiation detectors from 1942 to 1945. Wu helped develop the process for separating uranium into uranium-235 and uranium-238 isotopes by gaseous diffusion. She designed and conducted the *Wu experiment*, which proved that parity is not conserved. Wu's experiments using cobalt-60, a radioactive form of the cobalt metal, disproved “the law of parity (the quantum mechanics law that held that two physical systems, such as atoms, are mirror images that behave in identical ways).”⁵⁴



Chien-Shiung Wu performing experiments. Credit: Acc. 90-105 - Science Service, Records, 1920s-1970s, Smithsonian Institution Archives

It is now widely recognized that Wu’s work made it possible for two of her male theoretical physicist colleagues, Tsung-Dao Lee and Chen Ning Yang, to win the Nobel Prize in Physics in 1957.⁵⁵ Wu’s contribution received no acknowledgment at the time. Wu took a post as professor of physics at Columbia after the war and remained there for the remainder of her career. She was recognized as the top experimentalist in beta decay and weak interaction physics. Her book *Beta Decay*, published in 1965, continues to be a standard reference for nuclear physicists. In 1957 she was elected to the National Academy of Science and awarded the

⁵⁴ Chien-Shiung Wu, *Biography Newsletter*: <https://www.biography.com/scientist/chien-shiung-wu>

⁵⁵ Heken Mankert “The Little Known Origin Story behind the 2022 Nobel Prize in Physics.” <https://amsayeed.wordpress.com/2023/03/25/the-little-known-origin-story-behind-the-2022-nobel-prize-in-physics-scientific-american/>

inaugural Wolf Prize in Physics in 1978. She was awarded the National Medal of Science, and the first honorary doctorate awarded to a woman at Princeton University. Wu has been called the First Lady of Physics and the “Chinese Marie Curie.” Berkeley professor emeritus of physics and senior faculty scientist at Lawrence Berkeley National Laboratory Herbert Steiner commented, “She was very influential. She was a pioneer and did a lot for women's rights.” In 2021 the US Postal Service issued a new stamp design honoring Wu’s significant contributions in the field of nuclear physics.



Vera Kistiakowsky (Chemistry PhD 1952).
Credit: Massachusetts Institute of Technology.

Vera Kistiakowsky (1928-2021) represents the next generation of women physicists following Phillips and Wu. Vera’s father was a prominent physical chemist, George Kistiakowsky, a Ukrainian born near Kiev. After fighting the Bolsheviks, he emigrated first to Germany and then to America after the Russian Revolution. During the second world war, he led the Manhattan Project’s Explosives Division at Los Alamos under Robert Oppenheimer. During summer vacations in 1943 and 1944, she visited her father at Los Alamos and spoke fondly of the freedom she enjoyed in New Mexico riding her horse.

Kistiakowsky enrolled at Mount Holyoke in 1944 where she majored in math and physics. After graduating in 1948, Kistiakowsky entered the PhD program at Berkeley. *“I went to Berkeley, and there—I think at the suggestion of my father—I*

got in contact with Glenn Seaborg, who father interacted with a lot during the war. He took me on as a graduate student, which is in the chemistry department but is nuclear chemistry, which is not that different from what nuclear physics was at that time...So that's what I did my Ph.D. work on.

I used chemistry to isolate isotopes of promethium, but I wasn't interested in the chemistry, unpleasant and difficult as it was. It was finding out what the isotopes were that was the point of it. From that, I moved on to doing nuclear scattering experiments, and then I moved on to do high-energy physics experiments. That is sort of how my career evolved.”⁵⁶

In 1951 she married a fellow Berkeley student, Gerhard Fischer. She earned a doctorate in physics at Berkeley in 1952 under the direction of chemist and Nobel prize winner Glenn Seaborg. In her dissertation she presented the first measurements which identified three new isotopes of promethium in the Radiation Laboratory. At the beginning of her career, she focused on nuclear chemistry, but her interests evolved to nuclear physics, and then particle physics, and finally astrophysics.

After graduating, she undertook a postdoctoral fellowship at the Radiation Lab in experimental nuclear physics with another future Nobelist, Luis Walter Alvarez. Kistiakowsky then was employed at Columbia University from 1954 to 1959 as a research fellow in chemistry. While at Columbia, Berkeley alumna Chien-Shiung Wu helped her transfer to a position as research associate in physics helping Wu.⁵⁷

Because her husband was hired at Cambridge Electronic Accelerator, the couple moved to Cambridge, Massachusetts. Kistiakowsky worked briefly at Brandeis University as assistant professor of physics before moving to MIT's Laboratory for Nuclear Science (1963-69) and Senior Research Scientist in the Department of Physics. In 1972 she was appointed as the first woman professor of physics at MIT, where she remained until retirement. She published more than 70 scientific papers on subjects ranging from experimental nuclear physics and experimental high

⁵⁶ Vera Kistiakowsky. "Vera Kistiakowsky's Interview". Voices of the Manhattan Project (Interview). Interviewed by Cindy Kelly. Atomic Heritage Foundation, 17 July 2014.

<https://ahf.nuclearmuseum.org/voices/oral-histories/vera-kistiakowskys-interview/>

⁵⁷ Kistiakowsky, *ibid.*

energy physics, to the effects of military funding on university research.

Kistiakowsky strongly advocated for women in science at MIT as a member and chair of numerous committees related to women. In 1969, she founded Boston Women in Science and Engineering (WISE), forerunner of the Association for Women in Science (AWIS). In 1971, she obtained a \$10,000 grant from the Sloan Foundation to create a new Committee on the Status of Women in Physics under the auspices of the prestigious American Physical Society (APS). The committee of fourteen women physicists, including Chien-Shiung Wu, undertook a national survey of women physicists, who reported on their difficulties in finding employment and challenging experiences in academia. The findings reflected the anti-nepotism rules in universities which prevented married couples being hired in the same department, the lower status appointments and lower pay of women received compared to their male counterparts, and lack of maternity leave policies.⁵⁸ The committee's detailed report convinced the APS to establish permanently the Committee on the Status of Women in Physics, which is still active today. In order to refute the usual argument given by faculty search committees that there were no women PhD physicists available to hire, Kistiakowsky compiled a list of 450 women physicists.

Kistiakowsky co-authored with Elizabeth Tidball, a fellow Mount Holyoke alumna, the influential article "Baccalaureate Origins of American Scientists and Scholars."⁵⁹ The paper asserts that the high ratio of women faculty teaching in women's colleges results in graduates who are more likely to pursue a doctorate in the sciences. They pointed out data on STEM doctoral graduates of Mount Holyoke, Smith, and Wellesley in particular, and the special contributions of Mount Holyoke alumnae to the physical and life sciences.

Like her Berkeley colleagues Robert Oppenheimer, Chien-Shiung Wu, Melba Phillips, and her own father, Vera Kistiakowsky was committed to nuclear disarmament. She explained "I must say, I have never gone to Japan and had opportunities to do so in the course of my own work, and to this day for some

⁵⁸ Anna Nowogrodzki. "A Binder Full Of Physicists". MIT Technology Review. (21 April 2015). <https://www.technologyreview.com/2015/04/21/168544/a-binder-full-of-physicists/>

⁵⁹ M. Elizabeth Tidball and Vera Kistiakowsky. "Baccalaureate Origins of American Scientists and Scholars, Science 193. 20 August 1976.

reason I still feel a great deal of guilt for both the initial bombing and then the denial of the fact that the radiation was killing the Japanese population. For quite a number of years, the line was, “Oh, nobody’s dying from radiation.”⁶⁰ At MIT she criticized a number of research projects sponsored by the Department of Defense. She served on the board of the Council for a Livable World and lectured against nuclear proliferation. Kistiakowsky remained an anti-war activist for the rest of her life.

Chemistry and Nutrition

By 1900 women students comprised 45% of the student body, and yet women were absent from the Berkeley faculty. Qualified female scientists were hired into non tenure-track faculty positions.



Agnes Fay Morgan. Credit: UC Berkeley Department of Nutritional Sciences and Toxicology

One of Berkeley’s first female faculty appointments went to **Agnes Fay Morgan** (1884–1968), who earned a bachelor’s degree, a master’s degree, and, finally, after seven years of college teaching, a PhD in organic chemistry in 1914 from the University of Chicago. Opportunities for women in chemistry were so limited that she compromised by accepting an appointment as assistant professor of nutrition in the College of Agriculture at Berkeley. When she came to interview, Morgan was scheduled to meet with the dean, but he sent his wife and teenage daughter in his

⁶⁰ Kistiakowsky, *idem*.

place. Morgan took the Berkeley job in 1915, for a salary of \$1,800 annually, while male faculty members at the university were paid \$2,400 if they had a doctorate and \$1,800 without one. The next year, 1916, she was named co-chair of the new Department of Household Science aimed at educating women. Morgan's career, gender stratification, and the role of home economics at UC Berkeley are thoroughly analyzed in historian Maresi Nerad's 1999 book *The Academic Kitchen*.⁶¹

Two years later Morgan was sole chair of the new department, which became the Department of Home Economics within UC Berkeley's College of Agriculture. She chose to conduct research on the science of nutrition and to distance herself from the domestic arts, the other academic half of household science. Morgan was already married when appointed, which was highly unusual for a female faculty member. She waited to have a son until 1923, the same year she attained the rank of full professor. For forty years Morgan encouraged women students and helped to found and sustain the chemistry honor society Iota Sigma Pi, founded in 1902, first known as the Chemistry Fiends.⁶²



Morgan in the lab. Credit: UC Berkeley Department of Nutritional Sciences and Toxicology

Morgan described the purpose of Iota Sigma Pi: “to promote interest and enthusiasm among women students in chemistry; to stimulate personal

⁶¹ Nerad, op. cit.

⁶² Kathryn M. Neal, *Honor Among Fiends: UC's Role in the Founding of Iota Sigma Pi*, newsletter of the Friends of Bancroft Library, Fall 2011, p. 13. The Chemistry Fiends later became a national honor society, Iota Sigma Pi.

accomplishment in chemical fields; to be, by our earnest endeavor, an example of practical efficiency among women workers.”⁶³ She also founded Alpha Nu, an honor society for women in home economics.

Morgan rose to full professor and achieved distinction as an influential researcher. Her 254 publications contribute to a fundamental understanding of vitamins and vitamin deficiencies. Later in her career, Morgan established a link between dietary fat and serum cholesterol and the decline in bone density among women over the age of fifty. Morgan’s daunting tenure as chair or co-chair of her department stretched from 1916 to 1954. “She had a sublime confidence in her rightness and a genius for disregarding nonessentials and relaxing when the opportunity presented itself,” said her colleague Ruth Okey, one of several women Morgan hired.⁶⁴ As chair, however, Morgan did not achieve her goal of changing the name of the department from home economics to nutrition. An active researcher until 1954, Morgan was named faculty research lecturer at UC Berkeley in 1950, the first woman to be so honored.⁶⁵ In 1965, at the Agnes Fay Morgan Research Symposium, she acknowledged the work of her women students: “The credit that I have been given so generously for the research done in our department should be shared by the young women who had the ideas, carried out the experiments and wrote up the results. I encouraged them, criticized, and added my interpretation of the data. They should be standing here beside me, about 100 able dedicated women.”⁶⁶ After she retired, her ambition was finally fulfilled. The department was renamed Department of Nutritional Science in 1960, and the former home economics building was renamed Agnes Fay Morgan Hall in 1961.

⁶³ Margaret Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore: Johns Hopkins Press, 1982), 300.

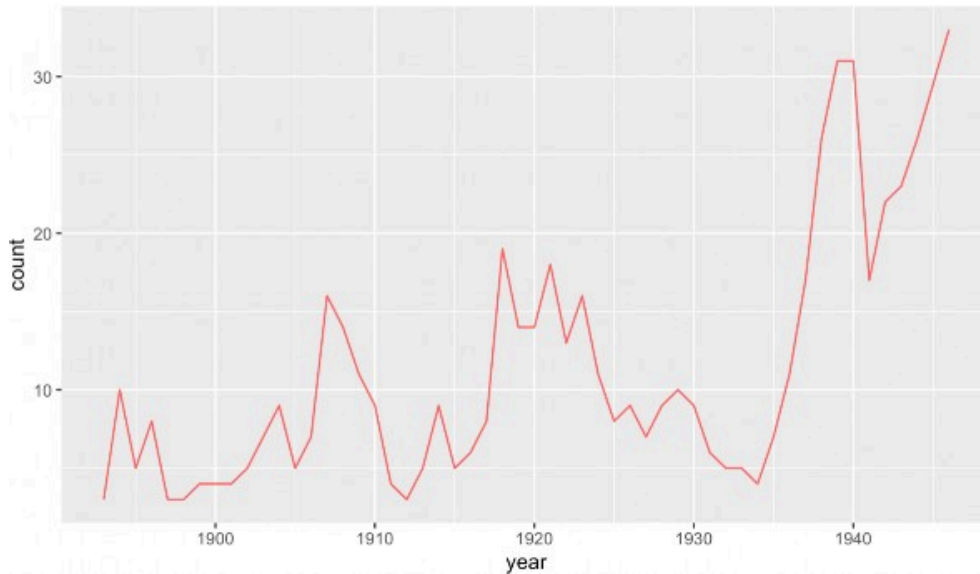
⁶⁴ Ruth Okey, Barbara Kennedy, and Johnson Gordon Mackinney, University of California: Agnes Fay Morgan: Home Economics: Berkeley. In Memoriam, May 1969.

⁶⁵ Agnes Fay Morgan, American Chemist and Nutritionist,” <http://www.chemistryexplained.com/Ma-Na/Morgan-Agnes-Fay.html>.

⁶⁶ Agnes Fay Morgan, “Closing Remarks,” Morgan Research Symposium, 1956, UC Berkeley. Morgan’s papers are in the Bancroft Library at UC Berkeley

Engineering

Number of Female Students in the College of Engineering, 1893-1946



Source: Zachary Bleemer, Cliometric Data Project, UC Berkeley

At the time of the charter of the University the inclusion of civil, mechanical arts and mining engineering disciplines in the curriculum was mandated by the State. The College of Engineering was created in 1931, evolving from the Colleges of Mechanics and Civil Engineering. However, few women students enrolled and graduated with degrees in engineering, fewer than one hundred between 1868 and 1960. Women who did not seek a degree in engineering registered as “special students.” Information on individual undergraduate women engineering students in the early decades has been difficult to track. Fortunately, three early engineers are well known: Elizabeth Bragg, the first woman to graduate with an engineering degree in 1876; Caroline Baldwin, class of 1892, one of the first women to earn a PhD in science in America; and Julia Morgan, the first woman to receive a California architectural license.



Elizabeth Bragg (Civil Engineering BS 1876).

Credit: Catalyst Magazine, College of Chemistry at UC Berkeley, May 27, 2020

“We were looked on as interlopers”

Elizabeth Bragg (1858–1929) graduated with a degree from the department of civil engineering, the first woman at Berkeley to do so. She wrote a thesis called “Solution of a Peculiar Problem in Surveying.” About her student days, Bragg said: “The professors were kind enough to the girls when they stood well, but there was no consideration for them because they were girls...It is true that for the most part we were looked on as interlopers, but we went right along and attended to our work...Oh, yes, we were looked upon as queer and forward for wanting to [be at] the university and we felt conspicuous, but the little things did not count, and I look back on those days as one of genuine pleasure.”⁶⁷ Bragg’s photograph is familiar in histories of Berkeley engineering, but ironically she never worked professionally as an engineer. In a Class of ’76 circular from the University of California, the following entry was posted: “Miss Elizabeth Bragg, Ph.B., has spent most of her time since Commencement in search of recuperation and pleasure. At least that is all she had to say between dances at the University Party.”⁶⁸ She became a teacher, married an engineering classmate, but left teaching to raise two sons. Bragg was “known for her civic work of the most useful kind” in San Francisco.⁶⁹ Elizabeth Bragg’s sister, Adah Bragg (1862–1952), earned a degree in

⁶⁷ San Francisco Chronicle, March 31, 1901, “The Women Pioneers of the University of California”, P. 34.

⁶⁸ First-Year Circular of the Class of ’76, University of California, January 1, 1877. Reprinted in *Matrix* 8, no. 4, College of Engineering, June 1976

⁶⁹ Reinhardt, op. cit. 44

chemistry at Berkeley in 1881 and taught school before marrying and raising a family of three sons. Bragg's career contrasts sharply with the professional careers of two women engineering graduates who followed her almost twenty years later, Caroline Baldwin '92, and Julia Morgan, class of 1895.



Caroline Baldwin (Mechanical Engineering BS 1892).

Credit: *The Blue and Gold Yearbook*, 1892, Bancroft Library, UC Berkeley

Caroline Willard Baldwin (Morrison) (1869–1928) earned a bachelor's degree in engineering in 1892 from the College of Mechanics at Berkeley, ranking third in her class. She was selected to speak at commencement. Baldwin went on to graduate study at Cornell University and was the first woman to receive a PhD in physics from Cornell in 1895. She ranked third in her class at Cornell.⁷⁰ Her paper "A Photographic Study of Arc Spectra" was published in 1896 in the *Physical Review*.⁷¹ Equipped with a doctorate, Baldwin nonetheless taught physics at a vocational secondary school in San Francisco associated with UC Berkeley, the California School of Mechanical Arts, now Lick-Wilmerding School. She co-authored a textbook *Physics Course of the California School of Mechanical Arts*. Baldwin married Charles Morrison and had two sons, which would have disqualified her for a position in higher education at that time. In responding to the Cornell Alumni Association sometime later, she described herself as a *housewife*.

⁷⁰ "Caroline William Baldwin First Woman to Earn a PhD in Science," *Steemit*, 2018.

<https://steemit.com/history/@poias/caroline-willard-baldwin-first-women-to-earn-a-phd-in-science/>

⁷¹ Caroline Willard Baldwin. "A Photographic Study of Arc Spectra. I". *Physical Review (Series I)*. 3 (5): 370–380, 1896.



Julia Morgan (Civil Engineering BS 1895) studied architecture in Paris after graduating from UC Berkeley in 1894. Credit: Special Collections and Archives, California Polytechnic State University, San Luis Obispo

Julia Morgan (1872–1957) is Berkeley’s best-known engineering alumna. She graduated in civil engineering because her real interest, architecture, was not yet offered at Berkeley. Morgan’s life was a succession of “firsts.” She grew up in a prosperous middle-class family in Oakland. At Cal she joined the Kappa Alpha Theta sorority, whose members later commissioned her to build many of their residences in Berkeley, as well as a house for the Delta Zeta sorority. The Association of Women Students lobbied for a campus meeting space similar to the exclusive Senior Men’s Hall, so they raised the money to build the Senior Women’s Hall. Morgan donated her services for the new space, initially called Girton Hall after the first women’s college at Oxford University. Dedicated in 1911, Senior Women’s Hall (Girton Hall) survives intact after removal to the UC Botanical Garden in 2014. Morgan worked on the Hearst Memorial Mining Building and the Greek Theater under the campus architect, John Galen Howard. Morgan also partnered with Howard on the construction of the Hearst Memorial Women’s Gymnasium, containing one of the neoclassical ornate swimming pools for which she was famous. Morgan’s designs have endured on the Berkeley campus.

Morgan was part of a small group of students invited by the well-known Bay Area architect Bernard Maybeck to study architectural design in his home. Maybeck encouraged Morgan to apply for postgraduate study at the École des Beaux Arts in Paris. On her third try, she was the first woman ever to be accepted there and to receive a “Certificate” in 1902. Morgan opened her practice at a time when women’s clubs and organizations were gaining prominence, and many of her buildings were designed as spaces for women. Morgan’s work in the progressive era reflects the new status of women’s leadership in the California women’s movement, in public health, politics, and social issues. Her first commission was El Campanil on the Mills College campus, in which she pioneered the use of reinforced concrete. As Julia Morgan scholar Karen McNeill explains, the YWCA symbolized the growing influence of women in the Progressive Era.⁷² The YWCA engaged Morgan to design thirty buildings in California and the Southwest. She designed a cottage for the campus YWCA, a popular meeting place for women located just outside Sather Gate, and the YWCA in San Francisco’s Chinatown. Morgan designed the Women’s City Club in Berkeley to house activities of various women’s clubs. This nationally registered landmark included a swimming pool, an auditorium, a theater, and a residence for single women. At its opening in 1930 the club boasted four thousand members.

Over the course of her career, she designed more than seven hundred buildings in California, including the showcase Hearst Castle at San Simeon. Scholarship on Morgan is ongoing at Berkeley, where the School of Environmental Design houses her papers. Morgan was included in a *New York Times* series on remarkable people whose deaths had previously gone unreported in the newspaper.⁷³ During the 150 Years of Women History Project, Julia Morgan has been prominently featured.⁷⁴ Her architecture is the subject of a definitive 1998 photographic study by Sara Boutelle, *Julia Morgan, Architect*.⁷⁵ A new biography of Morgan, *An Intimate Biography of the Trailblazing Architect*, was published in 2022.⁷⁶

⁷² Karen McNeill. “Women Who Build,” *California History*, Vol. 89, no. 3, 2012, 41-74

⁷³ Alexandra Lange “Overlooked No More: Julia Morgan Pioneering Female Architect,” *New York Times* · March 6, 2019

⁷⁴ See Ivan Natividad, “Berkeley’s Julia Morgan Collection Shows Alumna Designed Spaces for Women,” *Berkeley News*, March 30, 2020.

⁷⁵ Sara Boutelle. *Julia Morgan, Architect*. New York: Abbeville Press, 1988

⁷⁶ Victoria Kastner. *Julia Morgan: An Intimate Biography of the Trailblazing Architect*. San Francisco: Chronicle Books, 2022.



Lillian Moller Gilbreth (English Literature BS 1900). Credit: Rutgers University Archive

Lillian Moller (Gilbreth) (1878–1972), the most prominent professional female engineering alumna, actually majored in English literature. An Oakland resident, Lillian Moller attended Berkeley as an undergraduate over her father’s protests. She received a bachelor’s degree at the top of her class in 1900. As the first female valedictorian, she shared the stage with President Benjamin Ide Wheeler as a senior speaker at her graduation. Wheeler reportedly advised her to wear a ruffled gown and reminded her, above all, “Don’t imitate a man.” Looking back, Gilbreth wrote in 1968 that she had assumed there was no prejudice against women students; “consequently, it was a surprise, and a painful one, to aim for a Phi Beta Kappa Key only to learn there would be no girls on the list ‘because when it came to finding a job, men needed this honor more than women did.’”⁷⁷

After earning a master’s degree in literature from Columbia University in 1902, Lillian Moller enrolled at Berkeley with the goal of acquiring a PhD in psychology. In the meantime, she had married a fellow engineer, Frank Gilbreth. Berkeley would have required her to spend a final year in residence to complete her degree. In order to join her husband in the east, she transferred to Brown University to complete her PhD in psychology. At the time she already had five children. Her book *The Psychology of Management: The Function of the Mind in Determining*,

⁷⁷ Lillian Gilbreth, quoted in Irving Stone (ed.), *There Was Light: Autobiography of a University; Berkeley 1868–1968* (New York: Doubleday, 1970), 85.

Teaching and Installing Methods of Least Waste was based on the doctoral thesis she had planned to submit to UC Berkeley.⁷⁸ This book is regarded as a seminal work in the field of industrial management.

The Gilbreths were a formidable engineering team. They carried out time-motion studies, often involving their children, to increase industrial speed and precision. Lillian Gilbreth related the psychological awareness of workers' satisfaction on the factory floor to the analysis of their efficiency. She probed the human element in the new field of industrial management. As early as 1912, the Gilbreths pioneered the use of "micromotion" movies in factories to observe the steps involved in repetitive tasks. The pair studied the "human factors," now called ergonomics—the application of psychological and physiological principles to the engineering and design of products, processes, and systems. The goal of human factors is to reduce human error, increase productivity, and enhance safety and comfort with a specific focus on the interaction between the human and the objects being manufactured.

Lillian Gilbreth broke new ground in the area of assistance to the disabled; for example, she developed systems for veterans who were injured and disabled in World War I and designed the layout of an ideal kitchen for a person with heart disease. After her husband's sudden death in 1924, Lillian Gilbreth found herself the sole parent of a dozen children. She resolutely carried on with the management consulting firm that the couple had started. Later she applied their principles of industrial efficiency to the domestic sphere. In 1954 Gilbreth wrote *Happier Living through Saving Time and Energy*,⁷⁹ about efficiency in housework. With twelve children, Gilbreth always had full-time help at home. Gilbreth extended her experiments into the home in an effort to find the "one best way" to perform household tasks. Until recently, the public has remembered Gilbreth as the mother of twelve in the popular memoir *Cheaper by the Dozen*, on which two movies were based.⁸⁰ Increasingly, though, she is publicly acclaimed and widely acknowledged as the founder of the field of industrial engineering.

⁷⁸ Lillian M. Gilbreth, *The Psychology of Management: The Function of the Mind in Determining, Teaching and Installing Methods of Least Waste* (New York: Sturgis and Walton, 1914).

⁷⁹ Lillian Gilbreth. *Management in the Home: Happier Living Through Saving Time and Energy*.: Dodd-Mead, 1954.

⁸⁰ Ernestine Gilbreth Carey and Frank Gilbreth, *Cheaper by the Dozen* (Thomas Crowell, 1948), a biographical account written by two of Lillian Gilbreth's children. They wrote a sequel, *Belles on Their Toes*, in 1952.

Lillian Gilbreth was the first woman engineer elected to the National Academy of Engineering (NAE), the highest honor accorded an engineer. She served as personal consultant to Thomas J. Watson of IBM and to President Herbert Hoover. Belatedly, Gilbreth received two honorary degrees from Berkeley, and, at the urging of Nobel Prize winner and Berkeley Chancellor Glen Seaborg, she was chosen UC Berkeley alumna of the year in 1954. Like Julia Morgan, Lillian Gilbreth has received renewed attention during the celebration of 150 Years of Women at Berkeley in 2020-2023.⁸¹

“The Mechanics Building...Sanctuary of Man”

Between 1900 and 1940 at Berkeley, few women earned engineering degrees. No women were awarded engineering PhDs, in comparison to doctoral degrees granted to women at Berkeley during this time in the fields of astronomy, botany, mathematics, physiology, and zoology. Attitudes toward women engineering students were not encouraging. Women graduate students did not benefit from honors or professional societies for women such as those in botany, zoology, math, chemistry, and economics. An official Berkeley engineering publication of 1919 displayed a photograph with this caption: *“The Mechanics Building, a picturesque ivy-grown fortress, home of the Departments of Mechanical and Electrical Engineering, sanctuary of man, where he may be forever inviolable by the female of the species.”*⁸²

After 1910, women began to challenge their unequal status on campus more directly. During the First World War, the enrollment of women increased to 53 percent, and they claimed leadership positions formerly held by men. Gaining the right to vote in 1920 was a step towards gender equity and presaged the optimism of the 1920s. Similarly, during World War II women took over as President of ASUC, Editor in Chief of the Daily Cal newspaper and of the Blue and Gold Yearbook. In post war years, an influx of veterans returned to campus after 1945

⁸¹ Among Gilbreth’s posthumous honors is the National Academy of Engineering’s Lillian M. Gilbreth Lectureship for Young Engineers, established in 2001, which offers outstanding younger engineers the opportunity to make presentations at NAE’s Annual and National Meetings. Seven current Berkeley EECS faculty have delivered Gilbreth Lectures: Tsu-Jae King Liu, Connie Chang-Hasnain, David Tse, Alexander Bayen, Armando Fox, Ana Arias, and Rikky Muller. National Academy of Engineering, “Armstrong Endowment for Young Engineers: Gilbreth Lectures,” February 18, 2020, <https://www.nae.edu/Activities/Projects/31202>.

⁸² Carl Abel, *The Campus*, University of California, Campus Photographs, Berkeley, 1919.

under the GI Bill while women were encouraged to return to traditional roles. On campus and in the country, the “silent 1950s” were a decade of conservatism. But in the 1960s the women’s liberation movement was gaining steam and everything changed.

The onset of World War II opened doors for women engineers. When the United States entered the war after the bombing of Pearl Harbor in 1941, young men abandoned their studies to enlist, and as a result more women began enrolling in university classes. In 1939 women represented 38 percent of undergraduates and 31 percent of graduate students. By 1944, women’s representation had increased to 63 percent of the student body of 5,830 undergraduates. Women on campus assumed leadership positions formerly held by men. Harriet Nathan, class of 1941, was the first woman managing editor of the *Daily Cal* newspaper. Historians agree that the demands of war gave women more opportunities to work in nontraditional places like shipyards and factories. The *California Monthly* alumni magazine urged women to train for war work: “Girls, run, don’t walk...to start your war industry training now. The most exciting array of job opportunities to ever confront the college trained woman awaits you.”⁸³ A 1942 Berkeley publication entitled *University Training for War Service* stated that “University women can best serve their country and their own interests by preparing for employment in a nationally useful field.” Women students were being urged to prepare for work that would contribute to the war effort by studying nontraditional subjects like chemistry, engineering, geology, physics, math, and statistics.

The number of women chemistry majors, for example, quadrupled during this period, but the number of engineering degrees granted to women at Berkeley increased only slightly. Professor Morrough O’Brien, chair of mechanical engineering, created a successful program to teach engineering drafting skills to women high school graduates with one year of college. Every one of the graduates found jobs in drafting for war production in the Bay Area. Fourteen women obtained engineering bachelor’s degrees between 1940 and 1950. Between 1950 and 1960, fifteen women graduated with engineering bachelor’s

⁸³ Charles Dorn, “A Woman’s World: The University of California, Berkeley, During the Second World War,” *History of Education Quarterly* 48, no. 4 (November 2008): 534–564. He quotes Catherine Sibley, “Lady Fingers in War,” *California Monthly* 50, no. 4 (1943): 14.

degrees, slightly more than one per year. The Free Speech Movement, civil rights and anti-war protests spurred campus women to organize in the decade of the 1960s. In 1970 Professors Elizabeth Colson (anthropology) and Elizabeth Scott (statistics) were asked to write a report to the Academic Senate on the status of women. “The Report on the Subcommittee on the Status of Academic Women on the Berkeley Campus”⁸⁴ dramatically raised awareness and turned the tide in terms of hiring women. Colson, Scott and their committee demonstrated differential treatment of and discrimination against women at Berkeley at every level, from faculty hiring to admission of women graduate students.



Jessie Cambra (Civil Engineering BS 1942).

Credit: Magazine of the Society of Women Engineers, Conference Brochure 2009

Jessie Giambroni Cambra (1919–2008), a civil engineering alumna of the class of 1942, related this anecdote about the difficulty she had in taking the required undergraduate surveying class: “I came to engineering because it was a challenge and they said I couldn’t get in. I asked, ‘*Where in the catalogue does it say they can’t get in?*’ I wasn’t allowed to take the field trip for surveying in Fremont in the summer, because it was hotter than hell and men didn’t wear *uppers*. Dean Derleth said I could take any other course instead, and if I baked him *a couple of pies*, he would give me a degree.”⁸⁵ Even in wartime, Cambra reported being told she

⁸⁴ Elizabeth Scott and Elizabeth Colson. “Report of the Subcommittee on the Status of Academic Women on the Berkeley Campus.”

https://psychology.berkeley.edu/sites/default/files/department/senate_report_on_status_of_women.pdf

⁸⁵ Jessie Cambra, ’42, Interview with Mary Breunig, Alumni Office, College of Engineering, November 29, 1967.

should have been home cooking. Cambra worked first for Bechtel Engineering, where she earned less than her male counterparts and was given a bicycle while men got a car. Cambra devoted thirty-six years to the Alameda County Department of Public Works and was director when she ended her tenure. The Society of Women Engineers named Jessie Cambra the “Woman of Achievement” in 1979. She was in excellent company; MIT professors Mildred Dresselhaus and Sheila Widnall received the same award in the 1970s, as did Grace Murray Hopper earlier. Cambra is an example of a trailblazer whose story is little known.

In 1947 a department of chemical engineering was founded at Berkeley. Marge d’Wylde has traced alumnae of the College of Chemistry and the Department of Chemical Engineering in her 2020 detailed historical essay about chemistry at Berkeley.⁸⁶ The first woman to earn a bachelor’s degree in the new department was Marie Lavering in 1950. Three women earned PhDs in chemical engineering in 1980: Georgiana Lobien Schererman, Gail Green Greenwald, and Sadie Salim, followed the next year by Ellen Prusinski Pawlikowski. Professor John Prausnitz led a lab in thermodynamics, which was chosen by two of these four women. He said “Ellen and Georgie were the ones who decided to work with me, not the other way around. I was very pleased to have them and welcomed them being there.”⁸⁷



Helen Joyce (Pease) Peters (Civil Engineering BS 1951). Credit: Find A Grave.

Helen “H. J.” Peters (1929–2002) was a pioneering woman in groundwater hydrology who earned a BS in civil engineering in 1951. She attended Cal in the

⁸⁶ Marge d’Wylde. “150 Years and Counting: Co-education and the College of Chemistry” Catalyst Magazine, College of Chemistry, UC Berkeley, May 27, 2020, V 15

⁸⁷ d’Wylde, *idem*, 12.

era when most of her classmates were veterans returning from World War II and studying under the GI Bill. She wrote that it was “her duty to find blind dates for the students who otherwise had little contact with girls.”⁸⁸ Peters did not mind being in a male-dominated field: “If anything, it helped. Being an oddity, people were always trying to help me.” On her first field trip, she had to be chaperoned by the wife of a fellow engineer. Peters was the fourth woman to become registered in California as a civil engineer and the first woman engineer at the California Department of Water Resources (DWR), where she began a 40-year career as a student aid in 1950. Peters was an internationally recognized specialist in groundwater hydrology and management, advising the U.S. Department of the Interior and U.S. Geological Survey. She also worked for governments in Australia and Morocco. In her first professional assignment at DWR, she supervised field crews documenting water use and availability in the Klamath River Basin. These reports formed the groundwork for the Klamath River Compact formed between Oregon and California in 1957 to facilitate orderly development, use, and conservation of water resources. As chief of flood forecasting, she adapted to California’s needs and converted the flood center to the drought center during the most severe drought in California history from 1976-77.⁸⁹ She was affiliated with the American Society of Civil Engineers, Society of Women Engineers, American Geophysical Union, and UC Berkeley Engineering Advisory Council.

A Relatively Recent History: Women Doctoral Graduates in Electrical Engineering and Computer Sciences

The fifty-one year history of graduate women in the current Department of Electrical Engineering and Computer Science dates only from 1973, when the Department of Electrical Engineering merged with Computer Sciences to form a single department.⁹⁰ Between 1969 and 1981 at Berkeley ten women earned PhDs in computer science (CS). Not one of them had majored in the new discipline of computer science as undergraduates. Seven women earned doctorates in electrical

⁸⁸ *California State Employee Newsletter*, September 29, 1967.

⁸⁹ “Helen Peters, pioneering woman in groundwater hydrology,” Class Notes, Forefront, College of Engineering, University of California, Berkeley, Spring 2003.
<https://engineering.berkeley.edu/wp-content/uploads/files/docs/2003Spring.pdf>

⁹⁰ From the earliest days at the University electrical engineering courses were taught in the College of Mechanics. The Colleges of Mechanics and Civil Engineering were combined to form the College of Engineering in 1930, containing the department of Civil Engineering and the department of Mechanical and Electrical Engineering.

engineering (EE). The first woman to earn a doctorate in electrical engineering was Kawthar Zaki in 1969, before the merger of electrical engineering and computer science.⁹¹ Of the first PhDs fifteen half chose careers in academia: Kawthar Zaki, Dana Angluin, Barbata Grosz, Faye Duchin, Estela de Llinas, Rabab Ward, Anne Louise Radimsky and Patricia Daniels.

**First Women PhDs in the Electrical Engineering and Computer Sciences
Department at UC Berkeley ⁹²**

Year of PhD	Electrical Engineering	Computer Science
1969	Kawthar Zaki	
1972	Rabab Kreidieh Ward	Carol Ziegler
1973		Anne-Louise Radimsky Faye Duchin
1974	Patricia Daniels	Anne Cottrell
1975		Nancy McDonald
1976	Ileanna Gross Krumme	Dana Angluin
1977	Estela Soria de Llinas	Barbara Grosz
1978	Ana Flora Humes Karel Youssefi	
1979		Paula Hawthorn Marie-Anne Neimat
1981		Barbara Simons

⁹¹ “Dr. Kawthar Zaki Was the First Female Professor Hired Within the College of Engineering at the University of Maryland,” A. James Clark School of Engineering, Department of Electrical and Computer Engineering, April 3, 2017.

<https://ece.umd.edu/news/story/dr-kawthar-zaki-was-the-firstfbpfemale-professor-hired-within-the-college-of-engineering-at-the>

⁹² This table is derived from data developed by Anne MacLachlan tracing doctoral recipients at UC Berkeley. Source: to 1916: California Alumni Association (1916), *Directory of Graduates of the University of California 1864-1916*. University of California (1918), *Annual Report of the President of the University, 1918-1919*.



(L) Kawthar Zaki (EE MS 1966, PhD '69). Credit: University of Maryland, College Park

Kawthar Abdelhamid Zaki (1940–) was the first woman to earn a PhD in electrical engineering at UC Berkeley in 1969 and first female professor hired in the College of Engineering at the University of Maryland. Born in Egypt, she came from a large family and worked hard to convince her father “that a girl’s education is important” too.⁹³ She graduated from Ain Shams University in Cairo with a BS in electrical engineering and specialized in communications, ranking second in the class of 1962 as the only female student. Zaki decided to immigrate with her husband to Berkeley in 1964, where he earned a scholarship for graduate studies. She took English classes at the local high school and earned admission to the PhD program in electrical engineering at UC Berkeley, studying under Emeritus EE Professor Andrew Neureuther. Her dissertation was titled “Numerical Methods for the Analysis of Scattering from Nonplanar Periodic Structures.”

When her husband got a job offer in Maryland, Zaki applied for and received a teaching position at the University of Maryland (UMD) in College Park in 1970. As a visiting assistant professor, she was the first woman hired in the electrical and computer engineering department, facing immediate resistance from male colleagues who “were very upset...often asking, ‘why is she here?’ ‘Why is she not home raising her kids?’”⁹⁴

⁹³ Women of Egypt Network. “Egypt’s Minister of Immigration Awards 1st Woman to Earn a PhD in Electrical Engineering at Berkley (sic) University.” February 10, 2022. <https://womenofegyptmag.com/2022/02/11/egypts-minister-of-immigration-awards-1st-woman-to-earn-a-phd-in-electrical-engineering-at-berkley-university/>

⁹⁴ *ibid.*

Zaki found more support from faculty colleagues after winning the 1971 UMD College Park Campus' George Corcoran Teaching Award, which changed her appointment to a tenure-track assistant professor. In 1991, she received the IEEE Fellow Award for contributions to the analysis of dielectric waveguides and their applications in microwave filters and oscillators. Her research areas span electromagnetic simulation, computer-aided design, and millimeter-waves systems and devices. She has contributed to over 200 publications and holds six patents on filters and dielectric resonators. In 2022, Egypt's Minister of Immigration honored Zaki with a life achievement award.



Rabab Kreidieh Ward (EE PhD 1972, MS 1969). Credit: University of British Columbia

Signal processing pioneer **Rabab Kreidieh (Ward)** (1943–) was the first woman appointed as professor in engineering in both Canada and Zimbabwe. She has published over 500 referred papers and articles, and holds eight patents. Born and raised in Beirut, Lebanon, she graduated from high school with the highest marks only to be denied admission to the American University of Beirut because the Dean of Engineering believed it would “cost them a lot of money to train [her] as a woman... [and] they will not get their investment back.”⁹⁵

Kreidieh earned her bachelor's degree in electrical engineering at Cairo University in Egypt in 1966. Resolved to enter academia, she won a full scholarship from the Lebanese government to study at UC Berkeley where she became the second woman to earn a PhD in Electrical Engineering (1972). She lived in the

⁹⁵ Dr. Behnaz Ghoraani, “The First in Series to Highlight Women in Signal Processing: Rabab Ward,” Signal Processing Society, August 2019.

<https://signalprocessingsociety.org/newsletter/2019/08/first-series-highlight-women-signal-processing-rabab-ward>

International House, where she met her husband Peter Ward, a civil engineer whose new faculty position at the University of British Columbia (UBC) moved the couple to Vancouver.⁹⁶ After 18 months, Kreidieh was hired as a sessional lecturer at UBC to teach “whatever courses they had no one to teach. This was the first time that [she] felt women were discriminated against.”⁹⁷ Her career trajectory changed in 1975 when the University of Rhodesia (now the University of Zimbabwe) hired both Kreidieh and Ward as new engineering faculty. However, political instability from the Rhodesian Bush War forced the family to return to Vancouver in 1979.

Nine years after she completed her PhD, Kreidieh was finally given a tenure-track assistant professor role in 1981. Her research focused on signal, image, and video processing and detection, which contributed to real-life applications in television, medical imaging, and brain computer interfaces. As a trailblazing academic, she co-founded the Society for Canadian Women in Science & Technology and introduced K-12 programs to support girls interested in STEM. She became the first woman in electrical engineering to become a Fellow of the Royal Society of Canada in 1999 and has supervised 47 PhD and over 50 Master’s students to date. She has numerous accolades including the Norbert Wiener Society Award (IEEE, 2008), Centennial UBC Dean’s Medal of Distinction (2016), and election to the National Academy of Engineering in 2020 for “innovative applications of signal processing to industrial and bioengineering problems.”⁹⁸ When asked about her most important achievement, Kreidieh replied without hesitation: UBC’s Killam Award for Excellence in Mentoring, the university’s highest, “is the dearest to my heart.”⁹⁹

⁹⁶ “Through the Decades: the 60s and 70s.” International House Times (newsletter), 2022-23 Fall/Winter. <https://ihouse.berkeley.edu/sites/default/files/ihtimesfall2022-web.pdf>

⁹⁷ Ghoraani, *ibid.*

⁹⁸ National Academy of Engineering. <https://www.nae.edu/224736/Professor-Rabab-K-Ward>

⁹⁹ Dr. Behnaz Ghoraani, *ibid.*



Anne-Louise Guichard (EECS MS '67, PhD '73).
Credit: Accreditation Board for Engineering and Technology

Anne-Louise Guichard (Radimsky) (1941–2020) was a computing pioneer in post-World War II America and champion for diversity in science. The native of France attended one of the best schools for aerospace engineering, École Nationale Supérieure de l’Aéronautique (also known as SUPAERO) and majored in systems theory with a specialization in avionics. She was conducting research at the Centre d’Études et de Recherches en Automatisation when she came across the opportunity to study computer science in the U.S. on a scholarship. She started at UC Berkeley in 1966 and earned a PhD in computer science in 1973 with a dissertation titled “Semantic-Analysis of English Text by Computer.” Radimsky was hired at UC Davis as the first woman faculty member in computer science. She also taught upper-division computer science courses at the California State University, Sacramento. She also devoted much time to professional organizations, acting as a Senior Member of IEEE, Vice-Chair of the ACM (Association for Computing Machinery) Sacramento Chapter, member of the Society of Women Engineers and Sigma Xi. At the Accreditation Board for Engineering and Technology (ABET), Radimsky served as a commissioner on the CAC from 2006 to 2011 and re-joined the Commission in 2016 for her second five-year term. She had been serving on the CAC Executive Committee (ExCom) as a Member-at-Large since 2019. In her 20 years of service, Radimsky participated in 25 accreditation visits, including several program visits throughout the Middle East.



Faye Duchin (CD PhD 1973). Credit: Rensselaer Polytechnic Institute

Faye Duchin (1944–) grew up in Bayonne, NJ, and graduated in psychology at Cornell. After hitchhiking through Europe and living in Paris during the late 1960s she entered Berkeley’s CS graduate program in 1969. At first she was discouraged by CS: “I was nearly ready to drop it because computer hardware, software, and analysis weren’t really my thing.” However, she was able to turn her interest into a viable computer science model and did her dissertation on the recently passed rent control at Berkeley: “It was great, I loved Berkeley.”¹⁰⁰ She obtained her PhD in computer science in 1973 with a dissertation titled “Rents, Rent Control, and Non-Profit Rent Schedules: Analysis and Computer Simulation,” advised by Michael Stonebreaker. Duchin studies sustainability with an interdisciplinary approach. Her book *Structural Economics: Measuring Change in Technology, Lifestyles, and the Environment* is a good example.¹⁰¹ From 1977-1996, Duchin was on the faculty of New York University, where she worked on computer models with Nobel Laureate in economics Wassily Leontief. She succeeded Leontief as director of the economics research center there. In 1996 Rensselaer Polytechnic Institute (RPI) approached Duchin with an offer to be dean of the School of Humanities and Social Sciences (H&SS). Although she originally had no desire to be dean, her mentor Leontief was nearing retirement and so she accepted the position and became a professor of economics and dean of H&SS at RPI. As dean she urged students to study broadly: “You’re getting a fine education in math, and science, and technology, but in order to advance to a position of leadership, you

¹⁰⁰ Raymond Lutzky. “Dean Duchin has varied background.” Polytechnic Online, vol.127, no.2, November 11, 2001.

¹⁰¹ Faye Duchin. *Structural Economics: Measuring Change in Technology, Lifestyles, and the Environment*. Island Press, 1998.

need to have a broad understanding of the world we live in, especially post-September 11.”

Duchin’s research is concerned with ways of achieving economic development while avoiding environmental disasters. She makes use of mathematical models of individual economies and the world economy to analyze alternative scenarios about the future. She is active in the integration of input-output economics with industrial ecology, rooted in engineering, and with social science approaches to sustainable consumption. Her most recent research focused on the future demand for land and fresh water, particularly for the production of food.

“Based on the results of my empirical studies, I became convinced of the need for changes not only in technologies but also in household lifestyles, in particular household decisions regarding diet, housing and transportation,” Duchin said. “The plausibility and implications of such scenarios need to be explored in a global framework, and I have developed a new model of the world economy for this purpose.”¹⁰²



Patricia Daniels (EECS BS 1964 & PhD '74). Credit: Seattle University

Patricia Daniels was a leader in engineering education. She earned a bachelor’s degree in electrical engineering and computer science (EECS) from UC Berkeley in 1964 and continued to pursue doctoral studies there. Her dissertation was titled “Vestibular Unit Activity in the Alert Monkey During Visually and Rotationally Induced Eye Movements,” advised by Edward L. Keller. She spent most of her

¹⁰² This profile is based on Professor Duchin’s website at RPI:
<https://web.archive.org/web/20161224094141/http://www.economics.rpi.edu/pl/people/faye-duchin>

academic career at Seattle University. Daniels is Professor Emerita of electrical and computer engineering (ECE) at Seattle University, where she served as Professor and Chair, as well as Associate Dean of Science and Engineering. She is an Affiliate Professor of Electrical Engineering at the University of Washington. Her professional activities include serving as Program Director for the National Science Foundation (NSF) for Undergraduate Education and a member of Phi Beta Kappa. She was a registered Professional Engineer in the State of California.

Professor Daniels has been a leader in engineering education. She chaired the Electrical and Computer Engineering Division of the American Society for Engineering Education (ASEE) and was a member of the Institute of Electrical and Electronics Engineers (IEEE) Committee on Engineering Accreditation Activities. She has been an ABET program evaluator since 1988 and was on the Engineering Accreditation Commission (EAC) from 1996-2005, serving as EAC Chair in 2003-2004. She was an ABET Adjunct Accreditation Director for Engineering from 2012-2014 and is a Fellow of IEEE and ABET.



Dana Angluin (Math BA 1969, CS PhD '76). Credit: Yale University

Dana Angluin (1942–) graduated from Berkeley as a math major in 1969. As an undergraduate, she took computing classes in community college because then none was offered at Berkeley. Angluin got her start doing undergraduate research with Butler Lampson. She received her PhD in computer science in 1976, advised by Turing winner Manuel Blum. Angluin's thesis entitled "An application of the

theory of computational complexity to the study of inductive inference" was among the first works to apply computational complexity theory to the field of inductive inference. She joined the Computer Science faculty at Yale University in 1979 and remained there until her retirement in 2021. Angluin is known for foundational research computational learning theory and distributed computing. Her contribution to distributed computing was recognized by the 2020 Dijkstra Prize, one of the highest honors in this field. She helped establish the theoretical foundations of Machine Learning. More recently, Angluin has focused on the areas of coping with errors in the answers to queries, map-learning by mobile robots, and fundamental questions in modeling the interaction of a teacher and a learner. Dana Angluin received three of the highest awards given at Yale for her excellence in teaching: the Dylan Hixon Prize for Teaching Excellence in the Sciences, the Bryne/Sewall Prize for distinguished undergraduate teaching, and the 2020 Phi Beta Kappa DeVane Medal, for which she were chosen by students elected to Phi Beta Kappa.



Barbara Grosz (CS MS 1971, PhD '77). Credit: Harvard University

Barbara Grosz (1948–), Higgins Professor of Natural Sciences at Harvard University and emerita professor of Computer Science, came to Berkeley as a math graduate at Cornell. Grosz made foundational contributions to the fields of natural-language processing and multi-agent systems. Grosz has been honored for her pioneering work in Artificial Intelligence. As Dean she led the Radcliffe Institute of Advanced Studies and was Founder of the Center for the Study of Language and Information. While directing the Radcliffe Institute, she chaired the Harvard FAS Standing Committee on the Status of Women when it produced the

report entitled “Women in the Sciences at Harvard,” She co-founded Harvard's Embedded Ethics program, which integrates teaching of ethical reasoning into core computer science courses. to integrate ethical reasoning and philosophy into the computer science curriculum. Grosz is a member of the National Academy of Engineering, Fellow of the American Academy of Arts and Sciences, and American Philosophical Society. Among her many awards are the 2009 ACM/AAAI Allen Newell Award, the 2015 IJCAI Award for Research Excellence and the 2017 Association for Computational Linguistics Lifetime Achievement Award. One would hardly guess that Grosz had difficulty finding a doctoral advisor, until Professor Martin Graham stepped in to help.



Estela Soria de Llinas (Physics BS '66, MEng 1968, EE PhD '77).
Credit: EECS Dept. at UC Berkeley

Estela S. de Llinas (1941–) was born in Córdoba, Argentina to a middle class Spanish family and attended the National University of Córdoba on a scholarship in 1960. Before she finished her Bachelor's, she married a fellow Physics student and the couple emigrated to the United States to attend UC Berkeley. She recalls being “almost always the only woman in the Physics courses”¹⁰³ while completing her degree in physics in 1966. As a graduate student in engineering, she noted that there were no female professors or fellow woman colleagues in her courses. Her PhD dissertation, “Parameter Identification in a Cardiovascular System,” dealt with

¹⁰³ Magdalene L. Crowley. “Fall '17 Alumni Spotlight: Estela Llinás,” EECS Newsletter, August 20, 2017. <https://newsletter.eecs.berkeley.edu/2017/08/alumni-spotlight-estela-llinas/>

the identification of parameters for a model of the aorta system. It was supervised by architecture and civil engineering professor José Nestor Distefano, who suddenly died in 1975 and left her academically stranded. She found Charles A. Desoer and Jerome Sackman as advisers and officially graduated 1977.

Llinás and her growing family moved to Pittsburgh, PA when her husband accepted a teaching position at Carnegie Mellon University. She worked as a Systems Engineering Software Consultant at Westinghouse Electric, where she was “the only woman engineer and was often ‘confused’ for a secretary.”¹⁰⁴ She was offered a lecturer position in mechanical engineering at the University of Pittsburgh, Main Campus in 1981. Her research covers systems control, optimization, and stability. Two years later, she accepted a tenure-track position as Associate Professor in Engineering and Mathematics at the University of Pittsburgh, Greensburg. Her academic experience includes visiting professorships at Universidad de Guanajuato, México; University of California, Berkeley; and Universidad Nacional de Córdoba. She also was post-doctoral assistant at the Institute of Hydromechanics in Zürich, Switzerland. Llinas has been a champion for women in the field throughout her career.



Ana Flora Pereira de Castro Humes (EE MEng '75, PhD '78).

Credit: The Brazilian National Council for Scientific and Technological Development (CNPq)

Ana Flora Pereira de Castro Humes was born in Brazil and earned her bachelor's degree at the University of São Paulo (USP)'s Polytechnic School in

¹⁰⁴ *ibid.*

1968. She went on to earn masters and doctoral degrees in electrical engineering at UC Berkeley with a dissertation titled “General Stability Criteria for Multi-input Multi-output Multidimensional Digital Systems,” advised by control systems pioneer Professor Eliahu Jury. She returned to Sao Paulo as Teaching Assistant in 1972, was promoted to Assistant Professor in 1975, and earned tenure as a Full Professor of Applied Mathematics and Statistics in 1978.¹⁰⁵ Her research focused on continuous optimization, flexible manufacturing systems, and two dimensional digital filters, supported by a fellowship at the São Paulo State Research Support Foundation (FAPESP). She taught at the USP’s Institute of Mathematics and Statistics (IME) and co-authored two textbooks, *Noções de Cálculo Numérico* (1984) and *Programação Linear, Um Primeiro Curso* (1986).¹⁰⁶ It is probable that Humes met and married fellow Brazilian graduate student Carlos Humes Jr. (EECS PhD 77) at UC Berkeley, who also enjoyed a long career as full professor at USP . Ana Humes left USP in 1997 for visiting professor roles at Camilo Castelo Branco University and Mauá Institute of Technology, joining the latter as an instructor in 2002.



Paula Hawthorn (CS PhD 1979). Credit: Paula Hawthorn

After graduating the University of Houston as a math major, **Paula Hawthorn** (1943–) planned to be a secondary school math teacher, a career that took a detour.

¹⁰⁵ Brazilian National Council for Scientific and Technological Development (CNPq). Retrieved March 1, 2024. http://buscatextual.cnpq.br/buscatextual/visualizacv.do?jsessionid=159D2974D7BA6805BEA61F92BF40A4E1.buscatextual_0 Since this link is difficult to access consistently, comparable information can be found at <https://www.escavador.com/sobre/2909049/ana-flora-pereira-de-castro-humes>.

¹⁰⁶ *Noções de Cálculo Numérico* (1984) was authored by A. F. P. C. Humes, I. S. H. Melo, L. K. Yoshida, W. T. Martins and published by McGraw-Hill in São Paulo. *Programação Linear, Um Primeiro Curso* (1986) was authored by C. Humes Júnior & A. F. P. C. Humes and published by SBMAC (Sociedade Brasileira de Matemática Aplicada e Computacional) in Rio de Janeiro.

She was barred from teaching in Texas after being arrested in a civil rights demonstration. Instead, she went to work at Texaco where she became intrigued by computers. Hawthorn was a single mother of two when she entered graduate school. She earned her doctorate in computer science from Berkeley under the supervision of Michael Stonebraker in 1979. With fellow grad students Barbara Simons, Susan Eggers, and Marie-Ann Niemat, she co-founded the student group Women in Computer Science and Engineering (WiCSE). She also co-founded the CS Reentry Program with fellow student Barbara Simons, which encouraged women and minorities who had degrees in other fields to return to school and prepare for a graduate degree in computer science.¹⁰⁷ In 1996, Hawthorn became the first woman honored with the CS Distinguished Alumni Award. In 2022, a graduate fellowship in the College of Data Sciences was named for Paula Hawthorn.

During her career Hawthorn worked at Hewlett-Packard, Lawrence Berkeley National Laboratory, Britton Lee and a number of start-up companies. Hawthorn continues her activism to prevent gun violence. She is the secretary of Soldiers Against Violence Everywhere (SAVE) Oakland; the Co-Chair of the Oakland/Alameda County Chapter of the Brady Campaign To Prevent Gun Violence, secretary of SAVE; Co-chair of the St. Paul's Episcopal Church (Oakland) Social Justice Committee and a member of the Oakland Safety and Services Oversight Commission.

¹⁰⁷ Sheila Humphreys and Ellen Spertus. "Leveraging an Alternative Source of Computer Scientists: Reentry Programs," ACM SIGSE Bulletin, Vol. 34, No. 2, June 2002.



Barbara Simons (CS PhD 1981). Credit: Democracy Alliance, Verified Voting

Barbara Bluestein Simons (1941–) attended Wellesley College for one year and then transferred to Berkeley. She got married at the end of her sophomore year and dropped out as a junior to become a mother full-time for nine years. An “older student” she earned her Ph.D. in Computer Science from University of California, Berkeley in 1981. Advised by Richard Karp, Simons’ research focussed on compiler optimization, scheduling theory, and algorithm analysis and design. While at Berkeley, Simons co-founded the student organization Women in Computer Science and Engineering (WiCSE) and co-founded the CS Reentry Program for women and minorities along with Paula Hawthorn and Susan Eggers. After graduating Simons joined the Research Division of IBM where she focused on compiler optimization, algorithm analysis and design and scheduling theory. Her work on clock synchronization won an IBM Research Division Award. Over the course of her career, Simons became increasingly engaged with technology policy and regulations. She also embarked upon an influential career guiding U.S. government policy on technology. Simons founded ACM’s US Public Policy Committee (USACM) in 1993. On retirement from IBM, she was elected President of the Association for Computing Machinery (ACM), the nation’s largest educational and scientific computing society. She has been advocating to end electronic voting since 2002, which she has strongly criticized as being poorly designed and easy to hack.¹⁰⁸ She currently serves as a Board Chair of the Verified Voting Foundation, a non-profit organization that advocates for legislation to

¹⁰⁸ Jill Leovy. “The Computer Scientist Who Prefers Paper.” *The Atlantic*, December 2017.

promote safe and transparent voting.¹⁰⁹

Two Women Appointed to Electrical Engineering and Computer Science Faculty Seventeen Years Apart



Susan Graham, the first female faculty member in CS at UC Berkeley. Credit: Peg Skorpinski

The first two women EECS faculty attained their degrees from other institutions. A Stanford PhD, **Susan Graham** (1942–) became the first female faculty member when she was appointed Assistant Professor of Computer Science in 1971 in the College of Letters and Science. This occurred two years before Computer Science merged with Electrical Engineering to form a single department. After the merger with the College of Engineering, Graham became not only the first woman faculty member in CS but also the first female faculty member in the entire College of Engineering. After she joined the faculty, Graham married a colleague in Computer Science. At the time that her tenure case came up, the administration conducted a nepotism review because that policy prevented two close relatives from appointments in the same department, except by special permission of the Chancellor. Her promotion was approved by Chancellor Bowker.¹¹⁰ Graham remained the sole woman faculty member in EECS for seventeen years. She commented on her appointment:

I was the first woman in that department, but it was a very small department. Two

¹⁰⁹ Barbara Simons. An interview conducted by Janet Abbate, IEEE History Center, July 11, 2002.

¹¹⁰ Susan Graham, an oral history conducted by Janet Abbate, IEEE History Center, July, 2002.

years later, that department got merged into the one I'm in now (EECS), which is the one in Engineering; so I was transferred into the College of Engineering, and thereby became the first woman faculty member in the College of Engineering.

And it wasn't because they wanted a woman; they inherited me rather than hiring me. That was the case for a long time, that I was the only woman in the college. There were periods when, in other departments, a woman would be hired, be here for a few years, and leave again or not get tenure. I think it was seventeen years before there was another tenured woman in the College of Engineering.¹¹¹

Susan Graham holds the title of Pehong Chen Distinguished Professor of Electrical Engineering and Computer Science Emerita and special advisor to the Associate Provost of the new College of Computing, Data Science and Society (CDSS). She advises CDSS research and policy initiatives, particularly in the areas of artificial intelligence and public interest technology. Among the numerous honors Graham has received are: the ACM SIGPLAN Career Programming Language Achievement Award (2000), the ACM Distinguished Service Award (2006), the Harvard Medal (2008), the IEEE von Neumann Medal (2009), the ACM/IEEE Ken Kennedy Award (2011), and the Computing Research Association Distinguished Service Award (2012). Graham has played a pivotal role nationally on key advisory committees: the U.S. President's Information Technology Advisory Committee (PITAC), the President's Council of Advisors on Science and Technology (PCAST). She served as the Chief Computer Scientist for the NSF-sponsored National Partnership for Advanced Computational Infrastructure (NPACI) from 1997 to 2005, and as Vice-Chair and then Chair of the NSF-sponsored Computing Community Consortium. Susan Graham remained the sole woman in the Department of Electrical Engineering and Computer Sciences until 1988.

¹¹¹ *ibid.*



Avidah Zakhor, the second female faculty member in EECS at Berkeley. Credit: Peg Skorpinski

Avidah Zakhor (1964–) was hired in 1988 as Assistant Professor of Electrical Engineering, the second woman faculty member in EECS. In her more than three decades at Berkeley Zakhor has published 70 journal papers and 245 conference papers and contributed significantly to the fields of signal processing, computer vision, and 3D imaging. She has advised 20 PhD students and 52 MS students to date. Professor Zakhor holds 17 U.S. patents. She co-authored three monographs with her students.

Zakhor graduated first in her class at California Institute of Technology in just three years, and earned a PhD from MIT. For the twenty-four year old assistant professor, gaining the respect of the administrative staff was a challenge. “I didn’t feel anything special being the first appointed woman in EE. The main issue I had was to get the staff (particularly the female staff) to take me seriously. At one point, I had to get a senior faculty member to come and introduce me to the staff on the 5th floor of Cory Hall and tell them explicitly that they should do the jobs I ask them to do for my courses.”¹¹² Zakhor was candid in stating an opinion shared by many women, that professional women in STEM with equivalent abilities have to work harder than men due to “this inherent bias” and that women make greater sacrifices in order to balance family and career. “I know a lot of women who deliberately don’t choose academic careers in science and engineering, because they see that what it takes to succeed conflicts with their personal goals of raising children and having a family. The ones who choose it anyway sacrifice even more

¹¹² Avidah Zakhor. Personal communication, February, 2016.

than men in my opinion, because they have to fight against this inherent bias that's ingrained in the system. If the men are working 80 hours a week, you work 85 hours. You have to continually prove that you're better."¹¹³ Currently Professor Zakhor holds the Qualcomm Chair of Electrical Engineering. She has been a brilliant and successful entrepreneur. Zakhor co-founded three companies which have had significant impact on industry: OPC technology in 1996, which was later acquired by Mentor Graphics in 1998. OPC technology supplied Optical Proximity Software to the semiconductor industry to enhance yield in the lithography stage of integrated circuit manufacturing. Her second company UrbanScan Inc. founded in 2005 was acquired by Google in 2007. UrbanScan developed the first large scale automatic urban mapping system and was used for 3D modeling of buildings in Google Earth. She founded Indoor Reality in 2015 to develop technologies for rapid 3D mapping and visualization of buildings and assets. Indoor Reality was acquired by a large European construction supplies company in 2019. Among her many honors are: the 2022 winner of phase 2 Department of Energy E-Robot competition; 2018 Electronic Imaging Scientist of the year; 2018 Scientist of the Year, International Achievement Research Center; and the 2004 Okawa Foundation Prize. She was elected as a Fellow of the IEEE in 2002. She was listed as "50 women in Robotics you need to know" by Women in Robotics in 2022.

Conclusion

The stories of these talented and determined women richly deserve recognition for their resolve and their achievements. Many succeeded despite bias, insufficient resources and under-appreciation of their research. Academic women were hired in instructor titles or if in tenure track positions as professors, they advanced slowly. Some moderated their ambition and lowered their goals to suit an academy that did not yet treat them as equals. Nonetheless, these scholars paved the way for all the women who have followed them. Their perseverance and contributions have opened doors for recent generations of women scientists and engineers at UC Berkeley and elsewhere. It has been a pleasure to discover their achievements. The 150W History Project salutes women pioneers in science and engineering at Berkeley as part of the ongoing history of women at Berkeley.

¹¹³ Bonnie Azab Powell, Quoted in "The Hungry Mind: Professor Avidah Zakhor." April 2005, UC Berkeley News. Avidah Zakhor <https://www2.eecs.berkeley.edu/Faculty/Homepages/zakhor.html>

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