**Grace Murray Hopper**

(9 December 1906 - 1 January 1992)

Grace Brewster Murray Hopper was a computer pioneer and naval officer. She received a master’s degree (1930) and a Ph.D. (1934) in mathematics from Yale. One of the first three modern “programmers,” Hopper is best known for her trailblazing contributions to the development of computer languages. Known as irreverent, sharp-tongued, and brilliant, she enjoyed long and influential careers in both the U.S. Navy and the private sector.

**Background**

The daughter of Walter Fletcher Murray (Yale B.A. 1894, Phi Beta Kappa) and Mary Campbell Van Horne, Grace Brewster Murray was born in 1906 in New York City. Her father owned an insurance company. She was educated in private schools, and the family summered in Wolfeboro, New Hampshire.

In 1928 she graduated Phi Beta Kappa from Vassar College with degrees in mathematics and physics. In 1930 Hopper received her master’s degree in mathematics from Yale. In 1931 she began teaching mathematics at Vassar while pursuing her doctorate at Yale under computer pioneer Howard Engstrom. In 1934 she completed her Ph.D. in mathematics and mathematical physics from Yale. During a one-year sabbatical from Vassar, Hopper studied with the famous mathematician Richard Courant at New York University.

Hopper came of age at a time of unusual opportunity for women. A relatively high number of women were receiving doctorates in the 1920s and 1930s — numbers that would not be matched again until the 1980s. World War II also created opportunities for women to enter the workforce in greater numbers. Nonetheless, Hopper’s success in a male-dominated field and in male-dominated organizations, including the U.S. Navy, was exceptional.

**Work**

After the bombing of Pearl Harbor and the United States’ entry into World War II, Hopper decided to join the war effort. She was initially rejected because of her age and diminutive size, but she persisted. Taking a leave of absence from Vassar, where she was an associate professor, Hopper joined the U.S. Naval Reserve (Women’s Reserve) in December 1943 and was assigned to the Bureau of Ships Computation Project at Harvard University.

There she worked for Howard Aiken, another computer pioneer, who had developed the IBM Automatic Sequence Controlled Calculator, better known as the Mark I, one of the earliest electromechanical computers. One of the first three computer “programmers,” Hopper was responsible for programming the Mark I and punching machine instructions onto tape. She also wrote the 561-page user manual for the Mark I.

The close relationship between the American military and the early computer industry, nurtured first by World War II and then the Cold War, shaped Hopper’s career path. Hopper and her fellow officers in the Harvard lab worked on top-secret calculations essential to the war effort — computing rocket trajectories, creating range tables for new anti-aircraft guns, and calibrating minesweepers.

In addition to their work for the Navy, Hopper and her colleagues also completed calculations for the army and “ran numbers” used by John von Neumann in developing the plutonium bomb dropped on Nagasaki, Japan.

After the war Hopper turned down a full professorship at Vassar in order to remain at Harvard, becoming a research fellow in engineering sciences and applied physics. During this time she helped develop the Mark II and Mark III computers as Harvard continued to receive funding contracts from the Navy. One evening in 1945 while working on the Mark II, Hopper and her colleagues encountered a problem.

They took the machine apart and found a large moth. Although the term “bug” had been used by engineers since the 19th century to describe a mechanical malfunction, Hopper was the first to refer to a computer problem as a “bug” and to speak of “debugging” a computer.

In 1946 Hopper left active service when the Navy turned down her request for a regular commission because of her age. Shortly thereafter Hopper left Harvard when it became clear she would not be promoted or granted tenure. In 1949 she joined the Eckert-Mauchly Computer Corporation in Philadelphia as senior mathematician. The company, which was soon acquired by Remington Rand, had developed the first electronic computer (the ENIAC) under army contracts.

In Philadelphia Hopper undertook some of her most influential work. As head programmer for Remington Rand, she worked on the UNIVAC I (Universal Automatic Computer). In 1952 her programming team developed the first computer language “compiler” called A-0. Compilers translated mathematical code into machine-readable binary code, and they would eventually make it possible to write programs for multiple computers rather than a single machine.

Next her team developed Flow-Matic, the first programming language to use English-like commands. Unlike earlier computer languages such as FORTRAN, which used mathematical symbols, Flow-Matic used regular English words. Hopper felt that data processors, who were not typically mathematicians or engineers, would be more comfortable using word-based languages.

In a 1980 interview she explained, “What I was after in beginning English language [programming] was to bring another whole group of people able to use the computer easily … I kept calling for more user friendly languages. Most of the stuff we get from academicians, computer science people, is in no way adapted to people.”

As the number of computer languages proliferated, the need for a standardized language for business purposes grew. In 1959 COBOL (short for “common business-oriented language”) was introduced as the first standardized general business computer language. Although many people contributed to the “invention” of COBOL, Hopper promoted the language and its adoption by both military and private-sector users. Throughout the 1960s she led efforts to develop compilers for COBOL. Her biographer Kurt Beyer calls her “the person most responsible for the success of COBOL during the 1960s.” Her influence was significant; by the 1970s COBOL was the “most extensively used computer language” in the world.

Throughout her career in the private sector, Hopper had remained a Navy reservist. In 1966 age restrictions forced her to retire from the Navy as a commander. She later called it “the saddest day of my life.”4 Seven months later, however, at the age of 60, she was recalled to active service. Increasing operations in Southeast Asia were taxing the Navy’s capacities, and her help was needed to standardize the Navy’s multiple computer languages. Nicknamed “Amazing Grace” by her subordinates, Hopper remained on active duty for 19 years. She retired from UNIVAC, a division of Sperry Rand, in 1972.

Hopper became a well-recognized figure toward the end of her life. She was the recipient of more than 40 honorary degrees, and many scholarships, professorships, awards, and conferences are named in her honor. In 1972 she received Yale’s Wilbur Lucius Cross Medal. In 1991 President George Bush awarded Hopper the National Medal of Technology, the nation’s highest technology award; she was the first woman to be so honored as an individual. In 1996 the Navy commissioned the *U.S.S. Hopper*, a guided missile destroyer. Kurt Beyer, author of “Grace Hopper and the Invention of the Information Age,” suggests that Hopper achieved so much attention and even “celebrity” late in life because a Republican Congressman from Illinois saw an interview with Hopper on “60 Minutes” in 1983. After seeing the interview he successfully introduced a bill to have Hopper promoted to the rank of commodore.

At the age of 79, Hopper retired as a rear admiral. She was the oldest serving officer in the U.S. Armed Forces. That same year she went to work as a senior consultant in public relations at the Digital Equipment Corporation, where she worked up until a year before her death in 1992. Hopper was buried with full military honours in Arlington National Cemetery.

In 2016 Hopper posthumously received the Presidential Medal of Freedom, the nation’s highest civilian honour, in recognition of her remarkable contributions to the field of computer science.