Grace Hopper

“Grace Hopper is the mother of computing” – It is precisely for this reason that, at a time when the gender wage gap for software engineers hovers at 30%, I have sought inspiration and have been enthused to explore and write about this intelligent, determined and dedicated woman and of course her incredibly unique, successful and influential life.

Often referred to as “Amazing Grace”, Grace Hopper, born Grace Murray, (9 December 1906 – 1 January 1992) is a pioneering figure in the development of modern computing and programming theory. Not only this, but she also retired as a US Navy rear admiral. She is recognised for her work in developing computer technology, helping to devise UNIVAC I, the first commercial electronic computer, and in developing the programming language COBOL (common business orientated language). Though Hopper received many rewards during her time, being a woman, she constantly had to prove herself. She is famous for saying: “ If you do something once, people will call it an accident. If you do it twice, they call it a coincidence. But do it a third time and you’ve just proven a natural law!”.

Early Life

Hopper was a curious child. At the age of 7, she dismantled her alarm clock to figure out how it worked. This intellectual curiosity played an integral part in earning her a place among the ranks of the most famous female software engineers.

Hopper pursued her educational ambitions. She studied Mathematics and Physics at Vassar College, graduating Phi Beta Kappa in 1928. She then went on to complete a master’s degree in mathematics at Yale University, which she received in 1930. That same year she married Vincent Foster Hopper, a New York University professor. Despite divorcing in 1945, she kept the surname Hopper. She then went on to teach mathematics at Vassar University, while simultaneously continuing her studies at Yale, earning a Ph.D. in mathematics in 1934. Hopper was one of the first few females to earn such a degree, a major and rare accomplishment in its day. In 1941 Hopper was promoted to associate professor at Vassar University.

World War II

Hopper was a woman of action and the onset of World War II changed her life trajectory. In December 1943, compelled by the War, Hopper decided to join the U.S. Naval Reserve to

assist her country in its wartime challenges. Hopper decided to join the Navy in particular, as it had been her Grandfather's branch of service. Despite being rejected in 1942 due to her weight-to–height ratio, she persevered and was eventually admitted. Perseverance was one of the personality traits that made Hopper a great leader. She later graduated first in her class in June 1944, and was commissioned as a lieutenant.

Given her incredibly strong mathematical background, Hopper was assigned to the Bureau of Ordnance Computation Project at Harvard University. This began a 42-year career with the Navy and her relationship with computers. She became the third programmer of the IBM Automatic Sequence Controlled Calculator, better known as the MARK I, the first electromechanical computer in the United States. Hopper was in awe of the sheer size of the machine, a "fifty-one feet long, eight feet high, and five feet deep . . . beast". Similar to the dissembling of alarm clocks during her youth, she could hardly wait to take it apart and figure it out.

Under the guidance of Howard Aiken, who had developed the MARK I, Hopper and her colleagues worked on top-secret calculations essential to the war effort; computing rocket trajectories, creating range tables for new anti-aircraft guns, and calibrating minesweepers. Hopper also wrote the 561-page user manual for the MARK I. No easy task.

Hopper remained at the Harvard Computation Lab from 1946-1949 under Navy contracts, working on with the MARK II and Mark III computers, turning down a full professorship at Vassar. Interestingly, while trying to repair the Mark II, Hopper discovered a moth wedged in one of the system's relays. She taped this moth to her log book, and thus the phrase, "a bug in the computer", was coined. At the end of her three-year term as a research fellow, she left Harvard due to there being no permanent positions for women.

Hopper received the Naval Ordinance Development Award for her pioneering applications programming success on the Mark Series computers.

Career in Computing

A true visionary, Hopper conceptualized how a much wider audience could use the computer. She felt that this could be achieved by providing businesses with computers that were both application and programmer friendly. In pursuit of this vision, Hopper moved into private industry in 1949, working as a Senior Mathematician at Eckert –Mauchly Computer Corporation. There is no doubt that Hopper held an extremely unusual job for a woman at the time, yet her incredible technical skills and vision gave people no other choice but to listen to her.

At Eckert –Mauchly Computer Corporation, she mastered the programming of the Universal Automatic Computer (UNIVAC I), the first large scale electronic digital computer. She pioneered the idea of automatic programming and explored new ways to use the computer to code. Her creativity and efficient work ethic is visible in her encouragement of the programmers that she worked with to collect and share common portions of code. The use of these "shared libraries" significantly reduced errors, tedium and duplication.

By 1949 programs contained mnemonics that were transformed into binary code instructions executable by the computer. In 1952, Hopper and her team extended this

improvement on binary code with the development of her first compiler, the A-O. The A-O series of compilers translated symbolic mathematical code into machine-readable code – an important step toward creating modern programming languages.

Hopper knew that the key to taking the world of computing to a new level involved the development and refinement of programming languages – languages that could be used by people who were neither mathematicians nor computer experts. In 1953, Hopper proposed the idea of writing programs in words, rather than symbols. However, this idea was dissed by her peers who told her that she "couldn't do this because computers didn't understand English". But as we have seen before, through her perseverance and talent this innovative idea was eventually accepted. In pursuit of this belief, Hopper moved ahead with the development of the B-O complier which was to be used alongside the UNIVAC I and UNIVAC II computers. This compiler later became known as FLOW-MATIC, and allowed the UNIVAC computers to "understand" twenty English statements, relating to common business administrative tasks, like billing and payroll calculations. Hopper's project of creating word-based languages helped expand the community of computer users.

As the number of computer languages proliferated, the need for a standardized business language increased. In 1959, Hopper actively participated in the first meetings to formulate specifications for a common business language. She was one of the two technical advisors to the resulting CODASYL Executive Committee. The goal of this committee was of course to develop a common business language that could be used across industries and sectors. The finished product was COBOL, short for "common business orientated language". FLOW-MATIC was one of its main precursors. As one committee member involved in the design of COBOL said: "Without FLOW-MATIC we probably never would have a COBOL". The first COBOL specifications appeared in 1959. Although many people contributed to this effort, Hopper is widely recognized for her work in designing COBOL, developing compilers for it and encouraging its broad adoption. By the 1970s, COBOL was the "most extensively used computer language" in the world. The language has endured for decades and undergone numerous revisions.

Return to the Navy

Hopper retired from the naval Reserve in 1966, but was recalled to active duty one year later due to her pioneering work in the computer industry. She served as the director of the NAVY Programming Languages Group in the Navy's Office of Information Systems Planning and was promoted to the rank of captain in 1973. She persuaded the entire Navy to use COBOL. With her technical skills, she led her team to develop useful COBOL manuals and tools. Under her direction the Navy also developed a set of programs and procedures for validating COBOL compilers. This concept of validation has had a widespread impact on other programming languages and organizations; it eventually led to national and international standards and validation facilities for most programming languages.

Hopper officially retired from the Navy in 1986 as a Rear Admiral. She was one of the oldest serving officers in the service. That same year, she immediately became a senior consultant to Digital Equipment Corporation and remained there for several years, working well into her eighties, until her death in 1992. Hopper was buried with full military honors in Arlington National Cemetery.

A Talented Teacher

Hopper was not only a brilliant mathematician and computer scientist, she was also a great teacher and communicator. In 1959, Hopper was a visiting and then adjunct lecturer at the Moore School of Electrical Engineering at the University of Pennsylvania. In the 1960's and 1970's she taught and lectured at Penn, George Washington University, and for the U.S. Naval Reserve. She also organized many workshops and conferences to promote the understanding of computers and programming.

She was an inspirational professor and a sought-after speaker; in some years she addressed more than 200 audiences. In her speeches Hopper often used analogies, some of which have become legendary. She once presented a piece of wire about a foot long, and explained that it represented a nanosecond, since it was the maximum distance electricity could travel in wire in one-billionth of a second. She often contrasted this nanosecond with a microsecond - a coil of wire nearly a thousand feet long. The aim of such analogy was of course to encourage programmers not to waste even a microsecond.

Upon accepting the National Medal of Technology, Hopper said, "If you ask me what accomplishment I'm most proud of, the answer would be all the young people I've trained over the years; that's more important than writing the first compiler". It is worth noting, that she was the first woman to receive the nation's highest technology award as an individual.

Legacy

When Grace Hopper died, the world lost an inspiration to women and computer scientists everywhere. Her outstanding contributions to computer science benefited academia, industry, and the military. Her early recognition of the potential for commercial applications of computers, and her leadership and perseverance in making this vision a reality, paved the way for modern data processing. It is these qualities that put her at the forefront of computing.

Hopper is remembered today through the 'Grace hopper Celebration of Women in Computing Conference'. This is a technical conference that encourages women to become part of the world of computing. Furthermore, the Association for Computing Machinery also offers a Grace Murray Hopper Award. Finally, in 2016, Hopper was honored with the Presidential Medal of Freedom, the U.S. nation's highest civilian honor, in recognition of her "lifelong leadership role in the field of computer science"

An inspirational woman she certainly was.

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