Grace Hopper

When discussing significant software engineers in history and their impact, it is hard to not talk about the many contributions of Grace Hopper. Hopper, an American computer scientist and United States Navy rear admiral, made many significant developments in the field – from working on one of the earliest electromechanical computers, Mark I, to the creation of the first compiler. Her work led to the development of one of the first high level programming languages COBOL, a landmark in the distinction between hardware and software. She was quick-witted, irreverent and brilliant and made a trail blazing career in both computer science and in the U.S Navy.

Early Life

Grace Brewster Murray Hopper was born in 1906 in New York City to Walter Fletcher Murray and Mary Campbell Van Horne. Hopper was educated in private schools and in 1928 graduated from Vassar College with degrees in mathematics and physics. She would then go on to receive her master's degree in mathematics from Yale in 1931 and began teaching mathematics in Vassar. By the end of 1934 she had completed her Ph. D in mathematics from Yale. Hopper's success in her education in a male-dominated field was exceptional, considering the barriers women faced in education at the time.

Hopper attempted to enlist in the Navy during World War II after the bombing of Pearl Harbour but was rejected due to her age and her unusually small size. However, she was persistent and instead joined the U.S Women's Naval Reserve in 1943 – a testament to her strong-willed personality. There she was assigned to the Bureau of Ships Computation Project at Harvard, working on the IBM Automatic Sequence Controlled Calculator (also known as Mark I) headed by Howard Aiken.

Naval Career and Mark I

The early computer industry's close relationship with the U.S Military played a significant part in shaping Hopper's early career. The Mark I was the first large-scale automatic calculator and a precursor of electronic computers. It could perform 3 subtractions or additions per second and could store 72 numbers, each 23 decimal digits long. Hopper wrote the first computer manual, *A Manual of Operation for the Automatic Sequence Controlled Calculator,* which described how to operate Mark I and was the first extensive regimen of how to program a computer. Her and her team's work using Mark I played a significant role in the war effort – they performed computations of rocket trajectories, the creation of range tables for anti-aircraft guns and even worked on calculations for the Manhattan Project. After the war, Hopper stayed in Harvard as a research fellow and developed the Mark II and Mark III computers while Harvard got funds from the Navy. It was during this time that Hopper coined the phrase of a "bug" in a program, after she found a large moth within the Mark II that was causing malfunctions. In 1946, Hopper left active service in the Navy and Harvard as she was not granted tenure. She later joined in the Eckert-Mauchly Computer Corporation (EMCC) in 1949 as senior mathematician. The company had developed the first electronic computer, the ENIAC.

Development of the Compiler and Flow-Matic

While working with EMCC, Hopper undertook some of her most influential work. Hopper felt that data processors, who were not typically mathematicians, would be more comfortable using word-based languages and she believed that a programming language based on English was possible. However, she was "told very quickly that [she] couldn't do this because computers didn't understand English." This did not stop her, and after 3 years of her idea not being accepted, she developed the first computer language compiler, A, for the UNIVAC I. The first iteration, A-0, converted specifications into machine code that could be fed into a computer multiple times. This allowed for code to be written for multiple machines rather than a single machine. Her and her team next developed Flow-Matic, the first programming language to use English-like commands. This allowed for code to be more easily understandable for data processors and regular people. Hopper explained in an interview in 1980 that her goal was "to bring another whole group of people to be 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." This simple yet extraordinary idea paved the way to the development of the high-level programming languages that we know today. The language also allowed access to non-mathematical people to utilize the power of computers.

Beyond this point, as the number of computer languages grew, it was clear there was a need for a standardized language for business purposes. In 1959, Flow-Matic was developed upon to create COBOL ("Common Business Oriented Language"), the first standardized general business computer language. By the end of the 1970s, COBOL was the most extensively used computer language in the world.

Later Life

In 1966, Hopper retired from her position as commander in the Naval Reserve due to her age. However, several months later she was recalled to active service to help standardize the navy's computer languages. She was nicknamed "Amazing Grace" by her peers because of her work and help during this time. Hopper retired 19 years later in 1986 and found work as a consultant for the Digital Equipment Corporation. Hopper passed away in her sleep in her home in Virginia on New Year's Day in 1992.

Hopper received many awards during her lifetime, even having a U.S Naval destroyer named after her (USS Hopper). She was awarded over 40 honorary degrees from universities across the world and a college in Yale was renamed in her honour. In 2016, she was posthumously awarded the Presidential Medal of Freedom by Barack Obama. There is now a conference named in her honour, the Grace Hopper Celebration, a conference designed to bring the research and careers of women in computing to the forefront.

Apart from being not only an extraordinary mathematician and computer scientist, Hopper was also a talented teacher and communicator. When asked what her greatest accomplishment was, Hopper answered "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". She had many audiences with technical experts, business leaders, young people and the general public – advocating for the adoption of new technologies and being a spokesperson for the evolving

computer industry. It was Hopper's belief that computers would be universally used some day that drove her efforts to make them more accessible and user friendly.

Impact and Conclusion

It is clear from Hopper's inventions alone that her impact was significant and innovatory – the invention of the Compiler and Flow-Matic was a landmark for the progression of more open, user-friendly programming languages to be created and used. The additive layer of abstraction allowed programmers to code more comprehensively and to create more understandable solutions. It also paved the way for the now-familiar distinction between hardware and software. Every high-level programming language today requires a compiler in order to be translated into executable machine code, signifying Hopper's monumental impact.

Hopper also unintentionally pioneered open-source software, as she would publish chunks of code sent to her by programmers for computation, adding them to a library of programs. Information and solutions became more available to programmers this way, making the exchange of knowledge freer. Hopper's contribution to the field of computer science and software engineering is remarkable, and a world without it is now hard to imagine.

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