The Work and Impact of Margaret Hamilton

Margaret Hamilton effectively invented the term "software engineer", a computer pioneer who proved critical to the success of the first moon landing in 1969. In this short biography we will discuss her life and work, and her legacy in the world of software engineering. I will also provide a brief insight as to what inspired me to write about Margaret Hamilton.

Personal Life

Margaret Hamilton (née Heafield) was born in Paoli, Indiana on August 17, 1936. In 1958, Hamilton graduated in math with a minor in philosophy from Earlham college. While there, she met James Hamilton, whom she married in June 1958, the summer after graduating.

Margaret Hamilton taught high school mathematics for a year, with plans to later accept an assistantship position and attend graduate school to study abstract math. Instead, Hamilton took a position at Massachusetts Institute of Technology (MIT) where she worked under Prof. Edward Lorenz, developing weather prediction software. Here, Hamilton learned what a computer was and how to write software.

MIT and NASA

From 1961-1963, Hamilton worked on the US SAGE air defense system at Lincoln Laboratory, writing software to detect enemy aircraft. She became the first programmer to join the MIT Instrumentation Laboratory, which had received the NASA contract to build on-board flight software for the Apollo project, as well as being the first woman they hired. Here, Hamilton led a team developing software to run on computers aboard the command module, Columbia, and the lunar module, Eagle, as well as the systems software they shared.

With astronauts' lives at stake, this software needed to be completely reliable, to be able to detect an error and recover from it in real time during the mission. Hamilton herself focused specifically on software to detect system errors and to recover information in a computer crash, both of which proved critical in the 1969 moon landing. Hamilton's Priority Displays error detection and recovery programs allowed the on-flight software to communicate asynchronously and in real time with the astronaut, to interrupt and replace their normal displays with priority displays warning them in case of an emergency.

Just before the Apollo 11 landing, this software kicked in, not only warning of a hardware-related problem, but compensating for it by restarting and re-establishing the highest priority tasks, effectively allowing the astronauts to proceed with the landing.

"Software Engineering"

It was during this time that Hamilton coined the term "software engineering", in an effort to legitimise her field as an engineering discipline. While it was an ongoing joke for a while, software eventually gained the same respect as any other technical discipline.

A Change in Strategy

A mother of one, Hamilton regularly brought her young daughter, Lauren, to work with her on weekends. One day, while her mother was running a simulation of a lunar mission to test in-flight programs, Lauren crashed the simulator by activating a program which was supposed to be run prior to launch midway through the simulation. This incident inadvertently caused Hamilton to rethink her strategy, and led to her suggestion of a program change that would prevent a pre-launch program being selected during flight.

Her suggestion was initially dismissed under the pretense that astronauts were too well trained to make such an error. When a similar incident occurred on board Apollo 8, however, Hamilton was given permission to change the program and add backstops.

A Move Towards The Private Sector

Hamilton's work guided further Apollo missions to successful moon landings while also benefiting Skylab, the first U.S. space station, in the 1970s. In 1972 Hamilton left MIT, and in 1976 co-founded the company Higher Order Software. She launched Hamilton Technologies Inc. 10 years later, in 1986, with the aim of providing products and services to "modernize the planning, system engineering and software development process in order to maximize reliability, lower cost and accelerate time to market." (Hamilton Technologies Inc.)

It was here that Hamilton developed the Universal Systems Language (USL), based on a preventative "development before the fact" philosophy that doesn't allow the majority of errors into the system, preventing the need to test for errors later into the life cycle. USL has evolved through the years and presented software developers with solutions to what were previously considered impossible problems. The automation of USL is the 001 Tool Suite, an integrated environment for automatically generating reliable software systems, models and simulations.

Accolades

Over the past six decades, Hamilton's work has had a huge impact on software engineering. Hamilton has been the recipient of various honours. She was awarded the NASA Exceptional Space Act Award in 2003, acknowledging her contributions to software development and granting her the largest financial prize ever awarded by the agency to one person until that time. In 2016, Barack Obama presented her with the Presidential Medal of Freedom for her contribution to science and space travel. In 2017, her achievements were memorialised when a Margaret Hamilton LEGO minifigure was released as part of the Women in NASA collection.

Legacy

From her early days with NASA to her current standing as a software engineering legend and luminary, Margaret Hamilton helped pave the way for an industry, now one of the biggest and most profitable in the world, to change our perceptions of technology.

From a personal perspective, I found Hamilton's story to be hugely inspiring. I'd never heard of Hamilton, much less known about her impact on the world of software engineering, prior to this assignment. I started my research for this essay by reading about a number of different software engineers, from Linus Torvalds to James Gosling and many more, all massively accomplished people, but none really peaked my interest until I found an article on Margaret Hamilton.

I'd always been fascinated by space growing up, and naturally knew about the 1969 moon landing, so learning about that mission from a software engineering perspective was really interesting. Hamilton's work offers some insight into the many applications of software, and reiterates the fact that a career in software engineering can be moulded to fit any subject in which you hold an interest.

I believe many people, and especially young, female, prospective software engineers can find a role model in Margaret Hamilton. As a software developer, the thought of writing code by hand seems almost outlandish nowadays, but that's exactly what Hamilton and her team did. The image used on page 1 depicts Hamilton standing beside the collection of work completed by her team during the Apollo mission. For a woman to hold a position of such authority and importance in a time and industry dominated by men is also highly encouraging.

It is for these reasons that I chose to complete this assignment on the admirable work and lasting impact of Margaret Hamilton.

Bibliography

Andrew, S & Dillinger, K (2019), "Her software put men on the moon. Fifty years later, Margaret Hamilton got a glowing moonlit tribute", CNN, 19 July 2019
Available at:
https://www.cnn.com/2019/07/19/us/apollo-11-margaret-hamilton-50th-anniversary-trnd/index.html
[Accessed 1/10/19]

Cameron, L, "What to Know About the Scientist Who Invented the Term "Software Engineering", IEEE Computer Society, online
Available at:
https://www.computer.org/publications/tech-news/events/what-to-know-about-the-scientist-who-invented-the-term-software-engineering
[Accessed 1/10/19]

Computer History Museum, online
Available at:
https://www.computerhistory.org/fellowawards/hall/margaret-hamilton/
[Accessed 1/10/19]

Corbyn, Z (2019), Interview - "Margaret Hamilton: 'They worried that the men might rebel. They didn't'", The Guardian, 13 July 2019
Available at:
https://www.theguardian.com/technology/2019/jul/13/margaret-hamilton-computer-scientist-interview-software-apollo-missions-1969-moon-landing-nasa-women
[Accessed 1/10/19]

Encyclopaedia Britannica, online
Available at:
https://www.britannica.com/biography/Margaret-Hamilton-American-computer-scientist
[Accessed 1/10/19]

George, A (2019), "Margaret Hamilton Led the NASA Software Team That Landed Astronauts on the Moon", Smithsonian.com, 14 March 2019
Available at:
https://www.smithsonianmag.com/smithsonian-institution/margaret-hamilton-led-nasa-software-team-landed-astronauts-moon-180971575/
[Accessed 1/10/19]

Hamilton Technologies Inc., online
Available at:
http://www.htius.com/
[Accessed 3/10/19]