Biography of Margaret Hamilton

A brief biography for CSU33012-Software Engineering

Introduction

Where would the discipline of software engineering be today if not for Margaret Hamilton. The American computer scientist, systems engineer, and business owner who has been credited with coining the term computer science and giving legitimacy to the discipline after extraordinary and historic efforts. She is a pioneer in her own right, her programmes put human beings on the moon, the systems she built gave credibility to the field of software engineering and her ideologies behind the process of software development have shaped the development of the field and maintains its importance and relevance in today's rapidly changing environment.

In this biography I will explore how Margaret Hamilton became the renowned pioneer that she is and the impact she has made on the field of software development and the wider of computer science that encapsulates it.

Early life and Education

Margaret Elaine Heafield was born August 17, 1936, in Paoli, Indiana, to Kenneth Heafield and Ruth Esther Heafield. Heafield has two younger siblings: David and Kathryn. Heafield's Family later relocated to Michigan where Margaret attended Hancock High School and graduated in 1955. She went on to study mathematics at the University of Michigan in 1955 before transferring to Earlham College where her mother was a student. Heafield earned a BA in mathematics with a minor in philosophy in 1958.

In the summer of her graduation, June 15th 1958 Hamilton married her first husband, James Cox Hamilton, a senior majoring in chemistry in Earlham University. She briefly worked at a public school in Boston, Indiana teaching mathematics and french while her husband completed his undergraduate degree. The Hamilton family later relocated Boston, Massachusetts,

Although she intended to pursue graduate study in abstract mathematics at Brandeis University, Hamilton found herself working for Edward Norton Lorenz, in the meteorology department at MIT. At MIT she began developing software for predicting weather conditions, programming on the LGP-30 and the PDP-1 computers at Marvin Minksy's Project MAC. Hamilton's work here would later contribute to Lorenz's publications on chaos theory.

Between 1961 and 1963, Hamilton was involved in the Semi-Automatic Ground Environment (SAGE) project at MIT Lincoln Laboratory. The SAGE project was the first U.S air defense system. She notably wrote software for the prototype AN/FSQ-7 computer (the XD-1), used by the U.S. Air Force to search for possibly unfriendly aircraft.

At the Lincoln Laboratory Hamilton stood out, at a conference, AGC – Conference 1: Margaret Hamilton's introduction, Hamilton describes an early achievement of hers:

"What they used to do when you came into this organization as a beginner, was to assign you this program which nobody was able to ever figure out or get to run. When I was the beginner they gave it to me as well. And what had happened was it was tricky programming, and the person who wrote it took delight in the fact that all of his comments were in Greek and Latin. So I was assigned this program and I actually got it to work. It even printed out its answers in Latin and Chinese. I was the first one to get it to work."

Key Moments Achievements

Margaret Hamilton's work on the Apollo Project has given her an immutable place as an iconic American pioneer. Her work was instrumental in getting the Apollo on the moon.

Hamilton initially joined the project as a programmer but quickly saw her responsibilities and role change during the course of the project. Software wasn't an important part of the Apollo program in the beginning however it became clear by 1965 that software was going to be a pivotal part of the programme.

Hamilton saw her role change from programmer to system designs, and eventually she was in charge of all command Module software development to be used for navigation and lunar landing guidance. She then went on to spearhead the team of over 400 engineers credited with developing the software for Apollo and Skylab including the compact digital flight computer which, by using input from astronauts would be responsible for guiding, navigating and controlling the spacecraft.

Hamilton's work was incredibly high stakes,the software had to work the first time the work had to be perfect, it couldn't fail. A major requirement for Hamilton's software was that it needed to be able to detect unexpected errors and recover from them in real time. This was difficult to build as software at the time could only process tasks in a predetermined order. Hamilton overcame this by designing her program to be asynchronous, more important tasks would interrupt less important ones so regardless of surprises the expected work routines would be carried out. She also made the astronauts' environment asynchronous, priority messages would interrupt regular scheduled tasks to alert astronauts of errors or risks. This marked the first time that flight software interacted directly and asynchronously with a pilot.

These failsafes that Hamilton painstakingly implemented into the software are the ones that triggered the alarm just before the lunar landing. The astronauts, who Hamilton had previously been told earlier in the project, had been trained to never make a mistake had made a mistake. Buzz Aldrin had inadvertently hit the rendezvous radar switch. This switch would be vital for the return journey but for now was eating up memory and preventing the Apollo guidance computer from executing all of its tasks. Fortunately Hamilton's failsafe system was prepared for this and the system was smart enough to reboot itself and only carry out the tasks that were essential for landing.

Hamilton reflects upon the event in a letter titled "Computer Got Loaded", published in Datamation, March 1, 1971.

"The computer (or rather the software in it) was smart enough to recognize that it was being asked to perform more tasks than it should be performing. It then sent out an alarm, which meant to the astronaut, 'I'm overloaded with more tasks than I should be doing at this time and I'm going to keep only the more important tasks'; i.e., the ones needed for landing ... Actually, the computer was programmed to do more than recognize error conditions. A complete set of recovery programs was incorporated into the software. The software's action, in this case, was to eliminate lower priority tasks and re-establish the more important ones ... If the computer hadn't recognized this problem and taken recovery action, I doubt if Apollo 11 would have been the successful moon landing it was."

Impact/significance of work

*"When I first came up with the term, no one had heard of it before, at least in our world. It was an ongoing joke for a long time. They liked to kid me about my radical ideas."*7

Hamilton’s impact on software engineering is nothing short of exceptional. Hamilton’s excellence is compounded by the fact that at the time that Hamilton was engrossed in some of her most challenging work; such as her work in the meteorology department of MIT (1959), her work in the SAGE project (1961 - 1963) and the Apollo project, computer science and software engineering were not yet established disciplines.

At the 40th International Conference on Software Engineering held in Gothenburg, Sweden, May 31 Hamilton delivered her address “The Language as a Software Engineer.” During the address to show just how infantile the field of software programming was, Hamilton says “There was no field for software engineering, you were on your own. Knowledge, or lack thereof, was passed down from person to person.”

Hamilton described the discipline as a “wilderness”, she and her contemporaries relied on hands-on learning to develop in their fields.

Hamilton fought hard to bring software engineering into legitimacy so that it, and those building it, would be given their due respect. During Hamilton’s work on the Apollo program she noted in

In a letter from Margaret H. Hamilton, Director of Apollo Flight Computer Programming MIT Draper Laboratory, Cambridge, Massachusetts, titled "Computer Got Loaded", published in Datamation, March 1, 1971, Hamilton remembers a significant day in her career.

“It was a memorable day when one of the most respected hardware gurus explained to everyone in a meeting that he agreed with me that the process of building software should also be considered an engineering discipline, just like with hardware. Not because of his acceptance of the new 'term' per se, but because we had earned his and the acceptance of the others in the room as being in an engineering field in its own right.”

Hamilton also worked in a time where sexism in the industry was rampant

Vogel describes the sexism in his article “The Spitting Image of a Woman Programmer: Changing Portrayals of Women in the American Computing Industry, 1958-1985” in the IEEE Annals of the History of Computing.

Vogel says that “Programming, initially known as ‘coding,’ was originally seen as a low-status clerical task and was therefore gendered female.

In fact in the documentary, ‘Moon Machines’, Hamilton describes how the guidance computer used an innovative method known as "core rope memory": wires were roped through metal cores in a particular way to store code in binary. This was used to overcome memory issues for the guidance systems that would take Buzz Aldrin to the moon. Hamilton explains that “The programs were woven together by hand in factories. And because the factory workers were mostly women, core rope memory became known by engineers as "LOL memory," LOL standing for "little old lady." Even in the midst of history where her work as a software engineer was pivotal, Hamilton was still witnessing a feminisation of the discipline and disregard for the complexity of the task.

References

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