Margaret Hamilton

CS33012 - Biography of a Key Software Engineer

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Abstract

Margaret Hamilton is well-known for her work being critical in successfully getting the first humans to the moon and home safely during the 1969 Apollo 11 moon landing. She was a mathematician and computer pioneer who paved the way for the future of the software industry, which is now worth over a trillion dollars, changing the world forever with her legacy. She got her peers and people around the world to acknowledge the importance and intricacy of developing software, by the use of the term "software engineering" to give legitimacy to the field. She is undoubtedly an important figure in the history of programming, but also in the history of the world and having female representation in STEM fields.

How She Started Out In Programming

At the time she started out in software engineering, there were no degrees in computer science, all the knowledge about computers was passed down from person to person. It was a brand new field at the time and people were just starting to discover the world of programming.

She had a degree majoring in mathematics with a minor in philosophy from Earlham College and was planning to attend graduate school in abstract mathematics at Brandeis University. Shortly after graduating from her undergraduate program, she got married and had a child together. Her husband decided to go to Harvard Law School and she decided to wait before continuing her education. She found a job nearby in the Massachusetts Institute of Technology (MIT). It involved working on weather prediction in the laboratory of Professor Edward Lorenz (father of chaos theory). He wanted people with a mathematical background and that is where she learned how to write software. As mentioned earlier, computer science was not a taught discipline, instead, programmers learned by doing. This is how she discovered her passion for software.

SAGE Project

Margaret joined MIT's Lincoln Laboratory to develop the first U.S. air defense system, in the Semi-Automatic Ground Environment (SAGE) project. She wrote software to identify potentially unfriendly Soviet aircrafts during the Cold War. This is when she first became interested in software reliability, trying to understand what causes errors and how to avoid them. This was because anytime her program would crash, it was obvious to everyone with loud bells ringing and

bright lights flashing. Everyone working there would try to figure out what was causing it and who wrote that part of code. This is the project that showed her to be the ideal candidate to lead the software development for the Apollo missions.

Apollo 11

Margaret's husband saw an advertisement in a newspaper that the MIT Instrumentation Laboratory was hiring people for a project to get humankind on the moon. She found out that the laboratory had a contract with NASA to build the flight software for the Apollo projects. She said it sounded like the opportunity of a lifetime and reached out to two project managers to be part of the project immediately. She liked the general idea of travelling to the moon and also that it was something that has never been done before. Margaret was the first programmer they hired, as she had the background for it, unlike the others who were only experienced in working on hardware. She was also the first woman who was hired for the project.

As programming was not yet a course to be taught, her experience from before was invaluable. At first, NASA did not realise the importance that software would hold in the Apollo moon projects. However, it became evident later on that software would play an integral part of getting humans to the moon. As more and more people joined the group, Margaret rose in ranks, having the most experience out of everyone. She became the lead software designer as the Director of the Software Engineering Division at the MIT Instrumentation Laboratory.

Margaret took her role extremely seriously. She knew the software had to be ultra-reliable, but also that it would have to work the first time. She knew it would have to perform error detection and recovery in real time, as human lives were on the line. The team came up with their own rules for building software and paid close attention to bugs and computer crashes as they worked on the project, not having industry standards in place at the time.

During the Apollo 11 mission, Margaret's rigorous development methods truly paid off. Moments before the aircraft was landing, the computer signalled an overload error that could have resulted in the mission failing in the final seconds. However, due to Margaret's strict and thorough approach to software development, the program was written to prioritise tasks according to importance and not sequence, making the landing successful. This led to Neil Armstrong and Buzz Aldrin to be the first people to ever safely make it to the moon. Due to all the measures taken by Margaret during the development process, it was reported

that there were no bugs ever found in her computer code during the actual crewed Apollo missions.

Later Projects and Other Major Achievements

After Apollo 11, Margaret continued to work on NASA's remaining Apollo missions, as well as Skylab, the USA's first space station.

She later co-founded a business with Saydean Zeldin called Higher Order Software (HSO) to continue working on her ideas about error prevention and fault tolerance that she came across during the Apollo missions.

She later left HSO and started her own company called Hamilton Technologies, Inc. which was focused on the Universal System Language (USL) and its associated automated environment, 001 Tool Suite.

Margaret has published over 130 papers, proceeding and reports focusing on original ideas. She was also involved in 60 projects and 6 major programs, each program lasting between 10 to 20 years.

She was awarded the Presidential Medal of Freedom from President Barack Obama in 2016 for her work in leading the development of the flight software for NASA's Apollo missions to get humankind to the moon.

Software Engineering

Margaret Hamilton is one of the people, if not the main person, credited for coming up with the term "software engineering". She has said in an interview with the Guardian that she used the term "engineering" to describe her field out of desperation. Software was not regarded as a legitimate field at the time, despite working on a complex system of systems during the Apollo missions. She was not concerned about popularising the term, but rather gaining the acknowledgement of her colleagues that software development is an engineering field on its own.

Many definitions of the term exist today. According to Wikipedia, software engineering is "the systematic application of engineering approaches to the development of software". Since the term first started being used to describe the process that goes into creating software, it has become widespread and the 2018 September issue of IEEE Software celebrated the 50th anniversary of software engineering.

Why She Inspires Me

It is incredible to me to see a female scientist play such an important role in a world-defining mission that will forever be remembered by people everywhere, especially it being in a strongly male-dominated field. Margaret worked hard and took opportunities that arose around her, without letting anyone else define her path in life. She let her talent and skill speak for her and persevered through challenges during a time that was not favourable to women, especially working mothers.

Although diversity is becoming increasingly important in STEM fields with measures being taken to change the industries to be more inclusive, it is extremely inspiring and crucial to hear stories such as hers that show women and people who may not fit into the stereotype of someone working in an area, such as software engineering, to show that it is possible to do it and that there is room for anyone who shares passion for it. She is a luminary of the software industry and her legacy will live on forever as someone who led the way in a new field that has grown into something greater than anyone could have ever imagined.

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