Biography of an Influential software engineer - Margaret Hamilton

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Margaret Hamilton is credited as being the first “Software Engineer” as her work in the Apollo 11 space mission had coined a new era of Software Development and progress which has easily made her one of the most influential Software Engineers that has ever lived. Although it was never her intention to program and develop software, her work has planted a legacy of a structure of coding and a means of adequate testing which ultimately allowed the Apollo 11 mission to be the first spacecraft to land on the moon and for Neil Armstrong to set foot on its surface.

Coming from rural America, Margaret studied Mathematics in Earlham College in Richmond, Indiana. Her pursuit of mathematics led her to enroll into MIT where she was involved in the Semi-Automatic Ground Environment (SAGE) project, which was the first U.S. air defense system ever developed. This was a continuation of “Project Whirlwind” which was aimed to track and predict the movement of weather systems using large scale computers. At this time (early 1960’s), computers had very little computational power and required a lot of low level programming to make them run successfully. Along with that, computers at that time were known to frequently crash, therefore making a reliable product was a relatively challenging prospect in the first place. To achieve an intensive process like weather mapping at this era was a huge accomplishment in itself as even today’s standards of computers would struggle to compute this. Within SAGE, she notably wrote software to identify enemy aircraft over the United States of America.

This was her first introduction to an approach of programming where her code needed to work 100% of the time and not just partially, as a mis-detection of an enemy aircraft could be devastating to America. Hamilton herself said “SAGE was one of the first jumping off points where I became interested in the subject of software reliability.” (https://futurism.com/margaret-hamilton-the-untold-story-of-the-woman-who-took-us-to-the-moon”). With her efforts at SAGE, she got accepted into the Apollo 11 project which was notably her most recognised work.

Margaret became Team Leader of the guidance and control systems department of the Apollo 11 rocket to the moon. Her team mostly comprised of non computer programmers who had undertaken a large task. At this age in America, Computer Programming was not taught in public schools. This created a new learning curve for Margaret and her team as they had to work out any problems on their own as no code bases existed for them to learn and develop from. Along with this there was the added pressure of a time limit with JFK quoting - “I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth.” (Congress, May 25 1961, https://www.jfklibrary.org/). With this timeline, it left less than nine years to learn, develop and test her work and deploy a working and safe model that would send a man to the moon.

Software Engineering up to this point never existed as there was never a need for a highly structured bundle of code. It was a new frontier of exploration for Software Engineering, just like the mission to the moon itself. New methods of thinking, creating and formalising had to be developed to allow Margaret and her team to develop their ideas into a real safe working model. Along with this, NASA (National Aeronautics and Space Administration) gave the team an unlimited budget which allowed them to freely develop the software in any way that suited. According to Hamilton “We evolved our ‘software engineering’ rules with each new relevant discovery” This is a very interesting quote as it is very relatable to the modern day with the use of Github. As projects encounter problems or new features, they ultimately change the outlook of that project to allow it to adapt to the new requirements. This allowed Margaret and her team to formulate a structure of coding that would allow efficient and easily understandable set of code to deploy for the mission. With that, it would also improve the efficiency of the coding by her team as there was an agreed format to which the code was to be implemented.

Margaret’s area of work was mainly concerned with software interrupts and exceptions of the landing sequence to the moon. This allowed the spacecraft to prioritise the tasks given to the computer for execution. (i.e. the highest priority job will be executed first then followed by the next lower priority task). This allowed the spacecraft to deal with the vast array of sensors onboard and allowed them to be processed in an organised fashion in real time. Without any order, this would have caused chaos, for

example, if all the sensors were to call the onboard computer at once, it would crash the system as it would not be able to handle all the data as computers were not able to process a large stream of inputs. On July 16, 1969, Apollo 11 took off from Kennedy Space Center for the moon. On board there was a crew of three; Neil Armstrong, Buzz Aldrin and Michael Collins.

All went to plan until the final descent onto the moon when alarms for 'System Overflows' flooded the cockpit due to one of the switches for the secondary radar being incorrectly switched on. This caused the onboard computer to overload due to taking input from the two radar systems instead of one. Although the alarms sounded, the computer was able to prioritise the tasks and allow for a safe landing on the moon. According to Hamilton herself - "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. The computer, rather than almost forcing an abort, prevented an abort. 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." (Hamilton, Margaret H. (March 1, 1971). "Computer Got Loaded". *Datamation* (Letter). p. 13. ISSN 0011-6963). This key piece of software might have been the start of a new era where human and computer collaborated together to accomplish the mission as a team rather than one or the other taking full control. This allowed the mission to continue as the astronauts could clear the error and let the computer sort out the problem. As the mission was a success, Margarets code was further used on missions as it served as a basis for quality structured code that allowed the next generation of Software Engineers to follow. The true scale of her work is shown in the picture below where the books as tall as her contain all the code necessary for the Apollo 11 mission, all neatly structured and organised which is a great attribute to her hard work and dedication to the field of Software Engineering.

In conclusion, Margaret Hamilton's work played a key role of the Apollo 11 Mission and ultimately allowed America to set foot onto the surface of the Moon. Without her preparation for errors to occur and her methods of implementing and testing her work, the result of the mission may have taken a different course. Although she did not step on the Moon herself, her work is just as important as the cause of the mission itself. Her rigorous design methods have become the foundation of many modern Software Engineering techniques today which has made her one of the most influential Software Engineers to have ever lived.

https://en.wikipedia.org/wiki/Margaret_Hamilton_(scientist)

Sources

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