# Margaret Hamilton (Nee. Heafield)

Margaret Elaine Heafield was born on August 17th, 1936, in a small town called Paoli in Indiana, to Kenneth and Ruth Esther Heafield. The Heafields later moved to Michigan, where Margaret graduated from Hancock High School, later studying Mathematics in the University of Michigan before transferring to Earlham College, her mother’s alma mater. It was here that she met her first husband, James Cox Hamilton, and upon graduation, they both moved to Boston.

It was here in Boston where Margaret Hamilton first started working in software development. In the summer of 1959, Hamilton started working for Edward Norton Lorenz, in the meteorology department of MIT. Her software was used to predict weather, programming chiefly on the LGP-30 (an early off the shelf computer) and the PDP-1 computers at Marvin Minsky’s Project MAC. The PDP-1 is a particularly interesting early computer, famous for being the computer most important in the creation of the hacker culture that exists at MIT. It boasts a long list of computing innovations, including the first text editor, first word processor, the first interactive debugger and the first credible computer chess program, and also, some of the earliest computerized music. Hamilton’s work on these machines contributed to Lorenz’s publications on chaos theory (a branch of mathematics that focuses on the behaviour of dynamical systems that are highly sensitive to initial conditions). The most interesting thing about the start of Hamilton’s career is that, at the time, software engineering did not exist as a discipline. Instead, programmers learned on the job, much like apprentices.

In the summer of 1961, Hamilton moved on to her second major project, the Semi-Automatic Ground Environment (SAGE) at MIT. Working with other programmers, she wrote software for the prototype AN/FSQ-7 computer that would be used by the U.S. Air Force to search for potentially unfriendly aircraft. This was the first of many projects that would establish an aeronautical theme in Hamilton’s software engineering career, with the following project that she contributed software for being a satellite tracking project at the Air Force Cambridge Research Laboratories. Speaking on her time at SAGE, Hamilton talked about the first major project that she was given, where she was given a program that was seemingly impossible, featuring comments in Greek and Latin, which Hamilton succeeded in getting to work. It was this success that made Hamilton a candidate for her future position at NASA.

Hamilton moved on to work at the Charles Stark Draper Laboratory at MIT, the first taste of work on the Apollo space mission that she’d receive. She led a team credited with the development of the crucial software for Apollo and Skylab, the first U.S. space station. Hamilton’s team was responsible for the in-flight software, making use of several algorithms designed by various senior scientists, for the Apollo command module, lunar lander, and Skylab. Along with this, the team developed the systems software, including error detection and recovery software such as restarts and priority displays, which were designed and developed by Hamilton.

A key moment of validation in Hamilton’s career occurred during the Apollo 11 mission, the mission which first landed humans on the Moon. 3 minutes before the lunar lander was supposed to reach the Moon’s surface, several alarms were triggered in the computer system. The astronauts had accidently left the rendezvous radar switch on, which caused these alarms to be triggered. The system became overloaded with alarms, with the guidance computer unable to complete all of its tasks. However, Hamilton’s priority alarm displays interrupted the normal displays of the astronauts to warn them that there was an emergency “go/no-go” situation. Hamilton later said of this that “[the software] was smart enough to recognise that it was being asked to perform more tasks than it should be performing”, and in this instance, the software “[eliminated] lower priority tasks and re-establish[ed] the more important ones”. This approach was unprecedented at the time, and was described as “the foundation for ultra-reliable software design” by Paul Curto, the senior technologist who nominated Hamilton for a NASA Space Act Award.

Hamilton is widely credited for naming the discipline of software engineering. The ridicule that she first experienced for using the term matched the way people thought about the discipline at the time. Her persistence and courage in the face of adversity allowed the field of software engineering to claim its place amongst the other major scientific and engineering fields. Not only this, but Hamilton is also credited as being hugely integral in opening the door for more women to enter and succeed in STEM fields like software. On November 22nd, 2016, Hamilton received the Presidential Medal of Freedom from President Barack Obama for her work on the software for the Apollo Moon missions.

I personally find Hamilton’s achievements immensely impressive for two reasons, firstly because I respect the courage needed to hone your craft and pursue your field even in the face of ridicule. As a woman in STEM in the 1960’s, I can only imagine the hoops Hamilton must’ve had to jump through to earn the respect of her male counterparts, especially in software engineering, a field which in and of itself did not command the respect of its peers.

Secondly, I have always been fascinated with the circumstances surrounding what I believe to be one of humanity’s most impressive achievements, the Apollo Moon landings. The fact that the US were able to reach the Moon in the 1960’s is amazing, but I think that it is an interesting comment on the human psyche that they were driven almost entirely by a desire to beat the Russians. It is a strange reality that if the Cold War was not a factor, there may not have been humans on the Moon for decades.

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