



Margaret Hamilton

BIOGRAPHY OF AN INFLUENTIAL SOFTWARE ENGINEER

Ciara Newman | MSISS | 24/10/2018

Early Life

Margaret was born on August 17th 1936 in Paoli, Indiana, U.S.A to Kenneth Heafield and Ruth Esther Heafield. After graduating from Hancock High School in 1954, she began studying mathematics at the University of Michigan in 1955. She went on to earn a B.A. in mathematics with a minor in philosophy in 1958 from Earlham College, Indiana. This is where she met James Hamilton, and subsequently married. Upon graduating, she taught mathematics in high school in order to financially support her husband whilst he attended Harvard Law School. Although Margaret intended to study abstract mathematics at Brandeis University, she accepted an interim position at MIT instead. Here she began developing weather predicting software for professor Edward N. Lorenz on LGP-30 and PDP-1 computers and pursued further work in meteorology. This was of a time where there were no formal studies of computer science and all experience was gained on the job training.

Career

As a working mother in the 1960s – Margaret Hamilton was an anomaly. In 1961 Margaret joined the Lincoln laboratory at MIT. Here she worked on the Semi-Automatic Ground Environment (SAGE) Project, the first American air defense operation. She wrote software for the first AN/FSQ-7 portable computer, a decade before the birth of Microsoft. Notably, she crafted software to identify enemy aircraft. The SAGE project was created by MIT, to create a system that could predict weather patterns. This software was then employed by the military and developed to detect potential Soviet attacks throughout the Cold War.

Her work on the SAGE project made her a standout candidate for a developer role at NASA for Apollo flight software. She went on to join the Charles Stark Draper Lab at MIT, which was working on the Apollo space mission.

Hamilton was given the task of engineering software in the event the mission – Saturn Booster Test - was to abort. This was at a time where there were no earlier software projects to build from – everything was built from scratch. As she was new to the programming world, they never thought the mission would actually abort and thereby gave her this seemingly insignificant task. Funnily enough, Margaret named the program – ‘forget it’. Little did she know this would become a vital mechanism as it actually came into action during the mission. Overnight, Hamilton became well-respected for her ingenuity and reliability. It was here that she became concerned with software reliability - “When the computer crashed during the execution of your program, there was no hiding. Lights would be flashing, bells would be ringing and everyone, the developers and computer operators, would come running to find out whose program was doing something bad to the system”.

Subsequently, Hamilton lead the team that engineered the in-flight software for NASA’s Apollo lunar modules – which would land on the moon - and command modules – which

would orbit the moon while the lunar module was on the moon's surface and subsequently house the astronauts on their journey home. She designed software which included Priority Displays error detection and recovery software. This allowed regular displays to be over ridden by priority displays in the event that the mission went off course. In her own words, this software was vital as the missions were 'man-raided' and lives were on the line if the software were to fail. Alongside this software, she created systems that enabled the on-board software to communicate in real-time with the astronaut. This software was vital as 3 minutes before a Lunar module reached the Moon's surface, alarms were triggered. The program indicated that the computer could not complete all of its calculations in time and would need to postpone some of them. This was because the computer was being asked to do 6400 calculations per second whilst 90% of its focus was on the landing. Hamilton's software enabled the computer to prioritise the landing of the spacecraft first! Hamilton's priority displays resolved and warned the astronauts of this issue, enabling them to act accordingly. Without her work, the mission may have never landed. This is why Hamilton's work has been described as 'the foundation of ultra-reliable software design.' – Dr. Paul Curto. This fast tracked her to becoming an acclaimed expert in error checking. Her software always went above and beyond the specification – allowing for every circumstance possible to be averted.

NASA were so impressed with the software she engineered that they adapted it for Skylab - the first US space station and the space shuttle – which ran over 100 successful missions. She fulfilled this role alongside serving as Director of the Software Engineering Division at MIT. Whilst at MIT, she wished to give their software 'legitimacy' and respect, as within other engineering disciplines. This led to her coining the phrase 'Software Engineering' – to give her field the respect and regard it deserved amongst other scientific and engineering disciplines.

Business

By the 1970's, Hamilton founded her own company – Higher Order Software. Here they specialised on error prevention and fault detection. They created a product named USE.IT based on methodology developed at MIT. This software was used in numerous government operations. She moved on and founded Hamilton Technologies in 1985. The company centred around the USL – Universal Systems Language. The work in HTI continues to this day, centring around her development before the fact mantra. It is geared towards projects in which safety is paramount and errors are not an option. She continues to work to evolve technology for huge players such as Boeing, HP, IBM NASA and the US Navy.

Acknowledgements

- In 1986, she received the Augusta Ada Lovelace Award from the Association of Women in Computing.

- In 2003, she was awarded the NASA Exceptional Spaced Act Award – including 37200 dollars, the largest sum awarded to anyone in NASA’s history.
- In 2009, she received the Outstanding Alumni Award from Earlham College.
- In 2016, she accepted the Presidential Medal of Freedom from Barack Obama, the most prestigious honour any American civilian can receive.
- In 2017, she received a ‘Computer History Museum Fellow Award’ which is only awarded to figures whose ideas have shaped and changed the world.
- Her original code for the Apollo 11 mission was later uploaded to Github:
<https://github.com/chrislgarry/Apollo-11>

Later Life

Margaret and James went on to have one daughter – Lauren, and two grandchildren. Margaret would often bring her daughter to the lab with her. While Lauren slept on the floor, Margaret continued engineering software. Unfortunately, Margaret and James divorced.

Legacy

Margaret Hamilton paved the way for the software engineering industry – worth over a trillion dollars – for decades to come. Not only was she a pioneer within the Science, Technology, Engineering and Mathematics space, she was a pioneer for women everywhere. This was at a time where women were encouraged to stick solely to being a wife and managing the home, at the time in Ireland women even had to have their husbands written permission to work. Margaret single-handedly paved the way for women everywhere in the software engineering realm, whilst raising a child and being a mother. She continues to inspire people everywhere and is an inspiration in bridging the gender gap in fields heavily dominated by men – such as the computer science space.

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