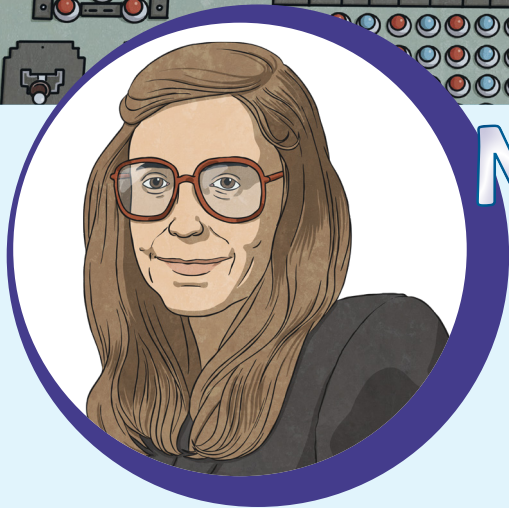


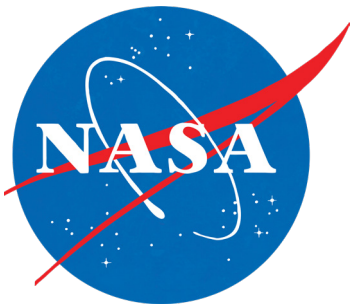


Margaret Hamilton

Margaret Hamilton is an extraordinary scientist. Blazing a trail through the competitive and often male-dominated world of aeronautical engineering, she paved the way for women and girls dreaming of a career in the sciences.

Early Life & Family

Born on 17th August 1936 to her parents Kenneth and Ruth Esther Heafield, Margaret spent her first years in Paoli, Indiana, USA, before her family relocated to Michigan. Margaret attended Hancock High School and graduated in 1954. She studied mathematics and philosophy at Earlham College in Indiana. She married her husband James in 1958 and her daughter, Lauren, was born the following year.



A Pioneer of Software Engineering

In the early 1960s, Margaret began working at the Lincoln Laboratory at the Massachusetts Institute of Technology (MIT). She was involved in the development of a radar defence system called SAGE (Semi-Automatic Ground Environment). The software was designed to identify enemy aircraft.

Following her time in the Lincoln Laboratory, Margaret changed departments, transferring to MIT's Instrumentation Laboratory. It was here that she first became involved in space technology. MIT's Instrumentation Laboratory was responsible for providing aeronautical technology for the National Aeronautics and Space Administration – NASA.

What Is Software?

Software is a set of instructions and rules that tells a computer what to do or how to perform a task. Margaret Hamilton was one of the first people to coin the phrase 'software engineer'.

The Apollo Program

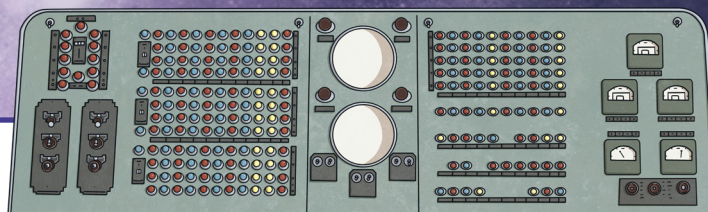
Margaret led a team of scientists to develop software to navigate and control the lunar capsule during the groundbreaking Apollo missions. Margaret's personal work was focused on an error-detection system that would be able to recover important flight information in the event of a computer fault.



On 20th July 1969, as the capsule approached the surface of the Moon, the onboard computers suddenly began flashing warning messages and alarms. The mission was in jeopardy; Mission Control had to decide whether to abort. However, they had such confidence in Margaret and her team that they only hesitated for a second. Margaret's trouble-shooting software saved the mission.

At a time when computer science was still in its infancy, Margaret's achievements were monumental. Her ingenuity contributed to a successful mission and led to the famous Moon landing of Apollo 11 in 1969, allowing Neil Armstrong and Buzz Aldrin to cement their places in history by walking on the Moon.

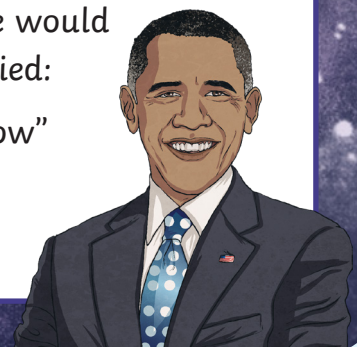
At the time of the moon landings, the onboard computer had only 72 kilobytes of computer memory – today an average mobile phone has almost a million times more!



Legacy

Margaret's achievements have since been recognised in many ways. In 2016, she was awarded the Presidential Medal of Freedom by Barack Obama and she has since been immortalised with a set of brick toys made in her honour as part of a Women of NASA collection. In a 2019 interview, Margaret was asked what advice she would give to young women seeking a career in computer science. She replied:

"Don't let fear get in the way and don't be afraid to say 'I don't know' or 'I don't understand' – no question is a dumb question. And don't always listen to the so-called experts!"



1. Where did Margaret spend her first years of life? Tick one.

- ☐ Lincoln
- ☐ Paoli, Indiana
- ☐ Michigan
- ☐ Massachusetts

2. Underline the part of this sentence that tells you what NASA stands for.

MIT's Instrumentation Laboratory was responsible for providing aeronautical technology for the National Aeronautics and Space Administration – NASA.

3. Look at the section called **The Apollo Program**.

Find and copy the words which mean 'the vessel that the astronauts travelled in'.

4. Fill in the missing words.

Her _____ contributed to a successful mission and led to the famous Moon landing of Apollo 11 in 1969, allowing Neil Armstrong and Buzz Aldrin to _____ their places in history by walking on the Moon.

5. How many kilobytes of memory did the computer on Apollo 11 have?

6. How do you think Margaret felt the moment the capsule landed successfully on the Moon?

7. How do you predict space travel will change in your lifetime?

8. Summarise the impact that Margaret Hamilton had on the world of computer science in 30 words or fewer.

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Award 1 mark for:

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lunar capsule

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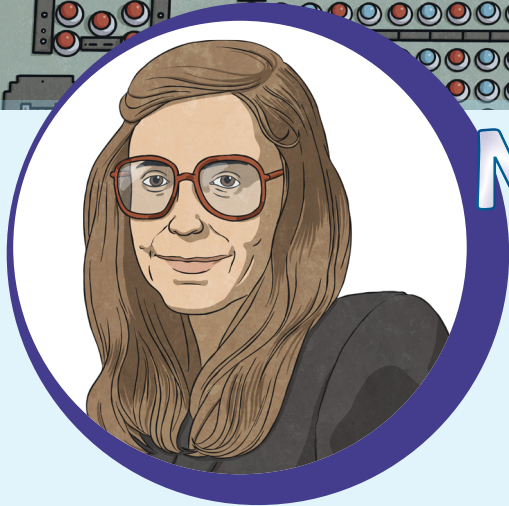
Pupils' own responses, such as: I think Margaret would have felt a mix of relief and pride. She would have been relieved that the mission had been a success and very proud of her contribution to it.

7. How do you predict space travel will change in your lifetime?

Pupils' own responses, such as: I predict that there will be tourist travel to space, maybe even weekend trips to the Moon. I also think that astronauts and aeronautical scientists will continue to explore and discover new things about the universe.

8. Summarise the impact that Margaret Hamilton had on the world of computer science in 30 words or fewer.

Pupils' own responses, such as: Margaret Hamilton had a huge impact. She made the the Moon landings possible and opened the door to careers in computer science for girls and women all over the world.

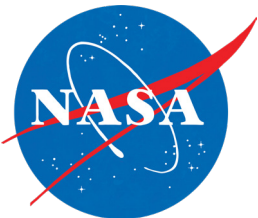


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A Pioneer of Software Engineering

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What Is Software?

Software is a set of instructions and rules that tells a computer what to do or how to perform a task. Margaret Hamilton was one of the first people to coin the phrase 'software engineer'. She believed this title was most appropriate, as engineering was the best description of what she and her colleagues were doing using their coding skills.

The Apollo Program

Margaret led a team of scientists who were charged with the task of developing software to navigate and control the lunar capsule during the groundbreaking Apollo missions. Margaret's personal work was focused on an error-detection system that would be able to recover vital flight information in the event of a computer malfunction during the mission.



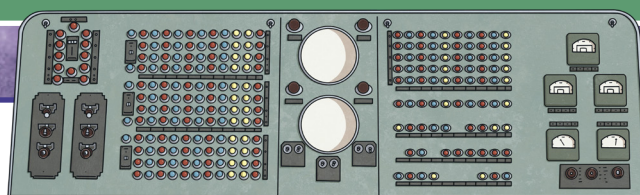
As it turned out, Margaret's software proved to be crucial to astronaut safety – her code helped to save the mission when there was an error during the flight.

On 20th July 1969, as the lunar module approached the surface of the Moon, the onboard computers suddenly began flashing warning messages. The mission was in jeopardy and Mission Control had to decide whether to abort. However, they had such confidence in Margaret and her team that they only hesitated for a second. In a later interview, Margaret commented:

“It quickly became clear that the software was not only informing everyone that there was a hardware-related problem, but that the software was compensating for it.”

Margaret's achievements were monumental at a time when computer science was still in its infancy. Her ingenuity contributed to a successful mission and led to the famous Moon landing of Apollo 11 in 1969, allowing Neil Armstrong and Buzz Aldrin to cement their places in history by walking on the Moon.

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1. When did Margaret graduate from Hancock High School? Tick one.

- ☐ 1936
- ☐ 1945
- ☐ 1954
- ☐ 1958

2. Underline the word which tells you that Margaret's team were doing something that had never been done before.

Margaret led a team of scientists who were charged with the task of developing software to navigate and control the lunar capsule during the groundbreaking Apollo missions.

3. Look at the section called **Legacy**.

Find and copy one word which suggests Margaret's work will never be forgotten.

4. What was the name of the mission which successfully landed on the Moon in 1969?

5. Fill in the missing words.

_____ is a set of instructions and rules that tells a computer what to do or how to
_____ a task.

6. Look at this sentence from the text.

Margaret Hamilton is an extraordinary scientist. Blazing a trail through the competitive and often male-dominated world of aeronautical engineering, she paved the way for women and girls dreaming of a career in the sciences.

What impression does this opening sentence give you of Margaret?

7. List the **two** ways the text tells us Margaret has been recognised for her contribution to computer science.

- _____
- _____

8. Summarise the incident that took place during the Moon landing mission.

9. Discuss how you think the world of science would be different today without Margaret and her team's groundbreaking work.

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Award 1 mark for:

- groundbreaking

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immortalised

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The name of the mission which successfully landed on the Moon in 1969 was Apollo 11.

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What impression does this opening sentence give you of Margaret?

Pupils' own responses, such as: This opening sentence gives me the impression that Margaret was a pioneer in her field. She did things that no one had done before and in doing it she opened doors for women and girls across the world to pursue careers in science.

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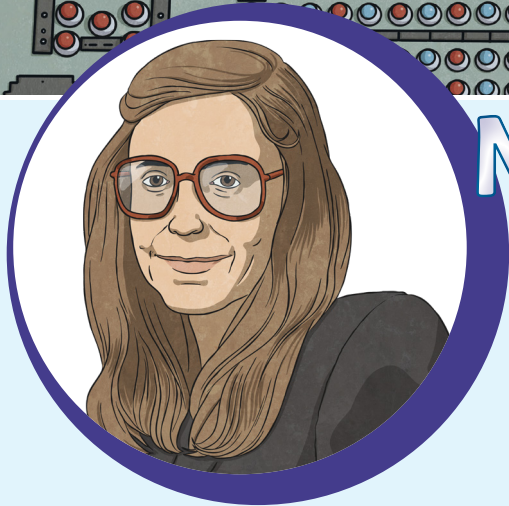
- **A Presidential Medal of Freedom from Barack Obama.**
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8. Summarise the incident that took place during the Moon landing mission.

Pupils' own responses, such as: When the lunar capsule was about to land, alarms and warnings started to show on the onboard computers. Mission Control had to decide whether to abort the mission but they trusted Margaret's work and her software functioned perfectly to get the mission back on track.

9. Discuss how you think the world of science would be different today without Margaret and her team's groundbreaking work.

Pupils' own responses, such as: I think the world of science would be different today without Margaret's work. Firstly, the mission to the Moon may not have been successful, delaying all the advancements in space exploration. Secondly, Margaret's achievements were hugely significant in ensuring that women were recognised for their abilities in the world of science and computing.



Margaret Hamilton

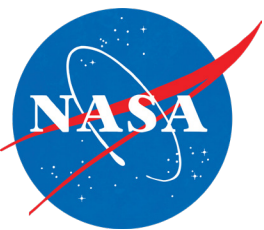
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Margaret spent a short time as a high school mathematics teacher before moving her family to Boston. Her plan had been to continue her studies in abstract mathematics (a complex area of mathematics which often involves algebra and geometry) at Brandeis University. However, she was offered an opportunity to work in a software programming team at the Massachusetts Institute of Technology (MIT). While working at MIT, she developed software to predict the weather and completed postgraduate research (studying or research after someone has already completed their first degree) in meteorology.



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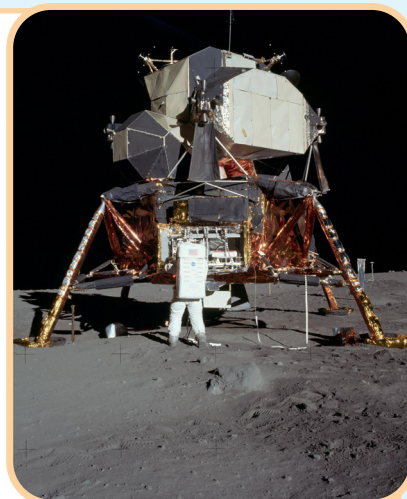
Following her time in the Lincoln Laboratory, Margaret changed departments again; this time to MIT's Instrumentation Laboratory (known today as the Charles Stark Draper Laboratory). It was here that she had her first taste of space technology as the lab was responsible for providing aeronautical technology for the National Aeronautics and Space Administration – NASA.

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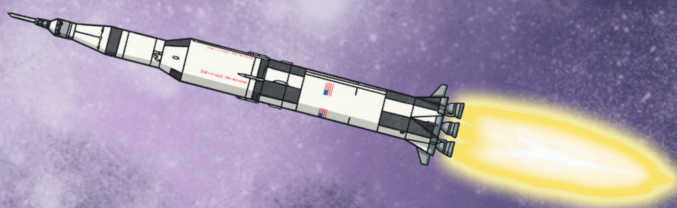


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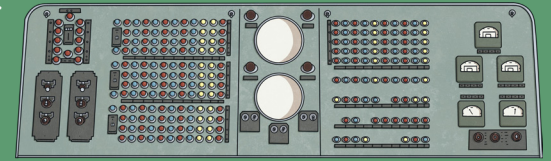
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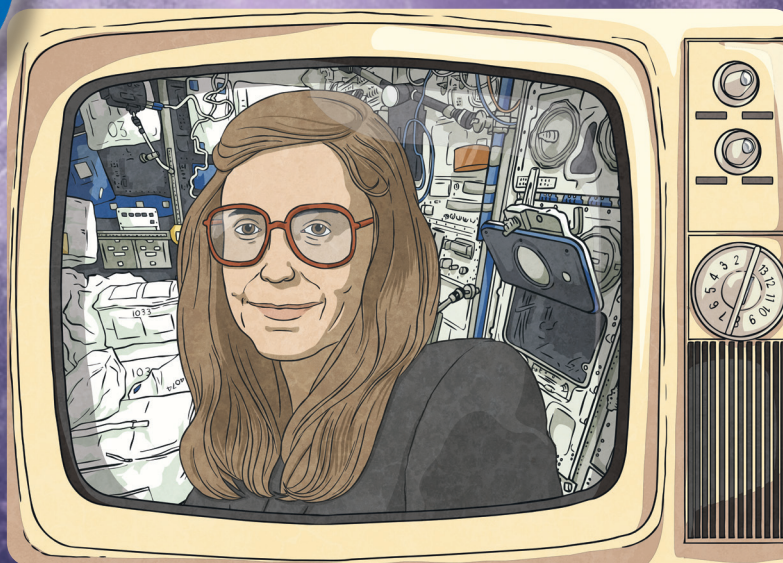
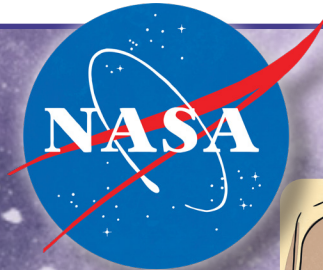
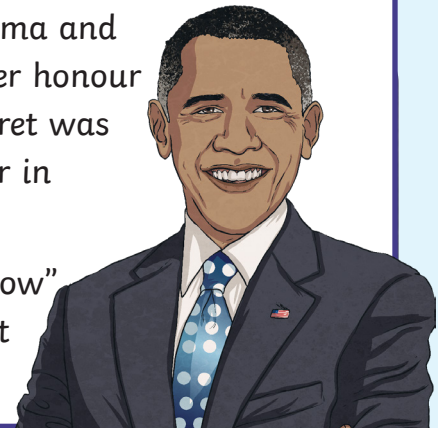
At the time of the Moon landings, the onboard computer had only 72 kilobytes of computer memory – today an average mobile phone has almost a million times more storage space! In order to tell the lunar module what to do, Margaret's team had to punch holes into paper cards and feed them into the computer. It was so large that it filled an entire room but had no screen interface to control it.



Legacy

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"Don't let fear get in the way and don't be afraid to say "I don't know" or "I don't understand" – no question is a dumb question. And don't always listen to the so-called experts!"



1. When was Margaret's daughter born? Tick one.

- ☐ 1958
- ☐ 1959
- ☐ 1936
- ☐ 1963

2. Number the steps from 1–4 to show the order that they happened.

- ☐ Margaret's code helped achieve the successful Moon landing.
- ☐ Margaret attended Hancock High School.
- ☐ Margaret took a position at MIT.
- ☐ Margaret received the Presidential Medal of Freedom.

3. Look at the section called **The Apollo Program**.

Find and copy a phrase which means 'the early stages of development'.

4. Fill in the missing words.

While working at MIT, she developed software to predict the weather and completed
_____ research in _____.

5. Where did Margaret plan to study abstract mathematics?

6. Explain your understanding of the word **software**.

7. Summarise the dramatic events during the Apollo 11 mission.

8. Why do you think Margaret chose to start using the term '**software engineer**'? Use evidence from the text to support your ideas.

9. Look at this quote from Margaret Hamilton.

"Don't let fear get in the way and don't be afraid to say "I don't know" or "I don't understand" – no question is a dumb question. And don't always listen to the so-called experts!"

Discuss what this tells you about Margaret's personality.

10. Look at this quote. It is from an interview with Margaret on the 40th anniversary of the Moon landings.

"It quickly became clear that the software was not only informing everyone that there was a hardware-related problem, but that the software was compensating for it."

What else do you think Margaret may have said during this interview?

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Margaret planned to study at Brandeis University.

6. Explain your understanding of the word **software**.

Pupils' own responses, such as: Software is the set of rules or instructions that a computer follows in order to perform a task. Computer programs and apps are made up of software written by software engineers or computer scientists.

7. Summarise the dramatic events during the Apollo 11 mission.

Pupils' own responses, such as: During the Apollo 11 capsule's final approach towards the Moon's surface, the onboard computer began flashing up warnings and alarms. The Mission Control team on Earth had to decide whether to abort the mission. They decided to trust Margaret's software and it worked perfectly. The software identified the faults and was able to ensure the capsule and astronauts landed safely.

8. Why do you think Margaret chose to start using the term '**software engineer**'? Use evidence from the text to support your ideas.

Pupils' own responses, such as: I think Margaret chose to start using the term 'software engineer' because she wanted the title of her role to communicate the importance of her contribution to the project. She felt that her team was also engineering just in a different way to those scientists who were physically building the capsule.

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Pupils' own responses, such as: This quote tells me that Margaret has a strong and determined personality. She is not afraid to speak her mind and strives to achieve what she knows she is capable of.

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Pupils' own responses, such as: I think Margaret may have spoken about her pride in the achievements she has reached during her career as well as her hopes for the future of women in the world of technology.