ENIAC, the first general purpose electronic computer ever developed, was publicly unveiled to great acclaim in February 1946. ENIAC was an acronym for the Electronic Numerical Integrator and Computer and was one of a number of classified inventions funded by the US Army during World War II. Designed to factor ballistic trajectories for Army weapons, ENIAC wasn’t completed in time to help the United States win World War II. But, the human predecessors of this amazing machine would hone their mathematical skills and prove their home front worth when they became the Top Secret Rosies of World War II.
In the fall of 1941 Doris and Shirley Blumberg were entering their final year of study at the prestigious Philadelphia High School for Girls. They were planning to attend college, though had not yet settled on their majors. With orchestra concerts and community dances to attend, they minds were often on other things. But, when the Japanese attacked Pearl Harbor on December 7, 1941, their futures, along with those of every other American, was now in limbo.
Math whizzes since their junior high days, the twin sisters had been avid members of the Girls High Math Club. As the graduation for the class of 1942 loomed, Doris and Shirley were called to the main office where Principal Olive Eli-Hart showed them a letter from the US War Department, asking for girls with math skills to serve as human computers for the Army.
Feeling it was their patriotic duty to help the war effort, the twins agreed to join approximately 60 other young women at the University of Pennsylvania where they would be trained to complete high level differential equations for air and ground weapons. Signing on ‘for the duration’, these young women hoped their secret work would help bring a speedy end to the war. They did not know how it would change their own lives, nor could they know that they were helping to usher in the computer age that would change the world.
Slide a- the Abacus

Human computing is a very old activity- It has been around since humans needed to count. The Ancient Mesopotamian units of measurement were based on counting tokens dating to the Neolithic period (6000 bc).

The Abacus, a human driven counting tool, was first recorded in Chinese history in the 2nd century BC, yet is still in use today in many part of Africa and Asia.

Slide b- the Slide Rule

The term “computer” dates from the mid 1600s and was a professional title given to people who spent their lives computing. With the rise of Astronomy and Architecture in the 1600’s, the need for mathematical computations increased. The slide rule- an analog computer invented in the 1600’s, was developed to assist human computers in their work.
Astronomy calculation and weather calculations required massive amounts of computing work.

In order to complete complex calculations, teams of people worked in parallel or tandem, dividing the work into steps.

This is an 1891 photograph of a group of human computers employed at the Harvard University observatory. Note that all the ‘computers’ are women! Human computing was actually a recognized and respected career path for young women with mathematical skills.
Slide a: Comptometer
Comptometer- a mechanical (or electro-mechanical) computing machine (patented by Dorr Felt, 1887). The Comptometer could be used to add, subtract, multiple and divide.

Slide b: Comptometer
With the expanding development of machines to aid in calculating, human computers would combine hand calculations with machine calculations.

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Slide a- Hollerith operator, circa 1890s
The Hollerith mechanical tabulator was a machine based on punch card technology (patent by Herman Hollerith, 1889).

Slide a- Pantograph operator, circa 1920s
A Pantograph operator punches the cards with the correct information and the Hollerith machine tabulates the cards.

Huge leap in human and mechanical computing: The 1880 census took 8 years to hand tabulate.
Hollerith machines were used to tabulate the 1890 census, which took only 1 year to tabulate.
By the 1930s, Pantographs and desktop electro-mechanical calculators were common business machines and commonly run by women operators (women could receive college training in ‘office machines’).

In addition to Monroe, the Marchant and Friden desktop calculators were also popular models used by American businesses.

Since the 1800s, and the rise of the US industrial economy, women had been employed as human computers. As the US entered World War II, an immediate need arose for women who could use business machines for the ‘business’ of winning a war.
America needs you
Ads section: We want women- images 1, 2, 3, 4

As thousands of women streamed in to factories to fill the jobs left by departing soldiers, the much celebrated Rosie the Riveter became the public face of female war workers. However, there was just as pressing a need for highly skilled female workers in the areas of math, science and engineering.
**Top Secret Rosies:** there were many different types of female computers working on highly classified military projects. Cryptology is the process of making and breaking codes and during WWII, US military women served as Cryptanalysts and code breaking mathematicians for the SIS (Signals Intelligence Service).

**Slide A:** US Waves (Women Accepted for Volunteer Emergency Service) decoding the Japanese Purple code.

**Slide B:** US Wave programming the Bombe, used to decipher the German Enigma code.

Polish, British and American scientists developed the Enigma code breaking machine called the ‘bombe’. The American Bombes were built by the National Cash Register Company of Dayton, Ohio.

**Slide C:** groups of Waves decoding, using rows of Bombes.
All across the nation, military and civilian women worked on secret projects that made use of their mathematical skills.

**Slide A**: Female atomic scientist
Women worked at Los Alamos on the Manhattan project as scientists, engineers and human computers. Their work was crucial to the successful development of the Atomic bomb.

**Slide B**: Here a female scientist is at work for the US Department of Agriculture. With food shortages and food rationing, nutrition was an area of particular concern to the US war effort.

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Slide A: field testing Army weapons
Aberdeen Proving Ground, Maryland: established by the US Army during WWI for munitions testing.
During WWII women were recruited to test all the weapons being developed by the Army.

Slide B:
Known as WOPS- short for Women Ordnance Workers- these women were the first testing point for ballistics tables developed for each weapon.
Ballistics labs:
One of the most pressing mathematical needs was for accurate and up to date ballistics calculations for US weapons on land, sea and in the air.

**Slide A:** A group of Human Computers at Aberdeen doing ballistics calculations.

**Slide B:** With the US entry in to WWII, the increased demand for data necessitated the formation of large teams of human computers, to help create ballistics tables for use by US soldiers in the field.
Due to need, Aberdeen opened a computing lab at The University of Pennsylvania's Moore School of Engineering.

Slide A: ballistics class- Young women with mathematical skills were recruited from all over the nation to serve as human computers in the Philadelphia Computing Section.

Slide B: The women were trained to complete differential equations by hand and by using desktop calculators.
Slide A, B, C and D: examples of hand calculations using the variables of ballistics differential equations.

Slide E: an explanation for solving a differential equation using the Marchant desktop calculator.
Slide A: the Differential Analyzer - a mechanical calculator invented by Vannavar Bush at MIT in 1925. It was state-of-the-art technology in 1942.

Slide B: It was 35 feet long, supported by steel I beams and housed in the air-conditioned basement of the Moore school.

Slide C: Integrators were run by mechanical gears and the machine required three operators to setup ballistics calculations.

Slide D: Because the machine was mechanical, solutions would ‘drift’. Human Computers would regularly check the work of the Differential Analyzer to insure it was producing accurate equations.
Because the Differential Analyzer ran on gears, it needed constant maintenance.

Joe Chapline was a graduate student in engineering at the Moore School and was hired as the 'mechanic' of the Differential Analyzer.

On a given day, the women worked the two day-shifts (8am-4pm, 4pm-midnight) and Joe repaired the machine during the third shift (midnight to 8am).
Slide A: A female human computer using a desktop calculator worked about 40 hours to complete a 60 second shell trajectory...

Slide B: ... while the Differential Analyzer could complete the same trajectory in 15 minutes.

Slide C: However, the human computers had to 'smooth out' the results-

Slide D: - making sure the equations produced by the Differential Analyzer were accurate.
Slide A: Captain Herman Goldstine was the Army supervisor of the Philadelphia Computing Section. In the summer of 1942 Goldstine had commented to Joe Chapline that he had hoped the Differential Analyzer would have completed trajectories at a faster pace. Joe tells him, “You need to meet a guy named John Mauchly who has ideas of how to do this electronically”.

Slide B: John Mauchly was a physics professor doing weather calculations. Inspired by the Differential Analyzer, he envisioned building an electronic version to help with his work.

Slide C: He teamed up with J. Presper Eckert, a brilliant engineering graduate student who thought he could make Mauchly’s ideas work.

Slide D: Thinking that this invention could speed up ballistics calculations, Goldstine took Mauchly to Aberdeen to pitch his idea and the Army agreed to fund ENIAC, the Electronic Numerical Integrator and Computer.
**Slide A:** ENIAC was a modular computer with individual parts that performed different functions. The Machine weighed 30 tons, contained 18,000 vacuum tubes and had 5 million hand soldered joints.

**Slide B:** Input and output was made possible by IBM punch card technology (photo shows Ruth Lichterman on the left and Marlyn Wescoff on the right, two of the six female programmers of ENIAC).

**Slide C:** The female programmers of ENIAC installed ballistics problems by physically plugging in and setting the correct positions to complete a ballistics problem (Betty Jean Jennings is on the left and Francis Bilas is on the right).
Slide A: The ENIAC Women:
In May of 1945 a call went out to the human computers, looking for women interested in serving as programmers for ENIAC.

Slide B: 13 of the ballistics computers applied.

Slide C: There was no precedence for electronic computer programming so Captain Goldstine was at a lose as to what to ask the applicants.

Slide D: Because they would be handling electronic plugs, cables and switches, Goldstine finally asked the interviewees if they were afraid of electricity.

Slide E: Through this process, six women are chosen to be the first computer programmers.

Slide F: But they are unable to see the classified ENIAC until their security clearance is upgraded.
Slide A: ENIAC diagrams
During the summer of 1945...

Slide B: ...as they waited for clearance, the women taught themselves to program ENIAC via paper diagrams.

Slide C: World War II ends before ENIAC is completed but in October of 1945 the women install their first problem, a nuclear trigger for the hydrogen bomb.

Slide D: This first successful problem is also the first time the women have actually seen ENIAC.

Slide B: Betty Jean Jennings (Jean Bartik) on the left and Betty Snyder (Holberton) on the right, devised the problem ENIAC performed for the press. After the successful demonstration officials and guests adjourned to a lavish celebration dinner but the female programmers were not invited to attend.

The US Army had funded the invention of the computer and the Army wasted no time in using ENIAC as a recruiting tool. While female programmers present in Army photographs,

Slide C: …the final Army ads show only a man. From these earliest moments of the computer’s nascent history, women begin to disappear.
Conclusion- Somewhere in the US a young woman is using her computer, downloading music, iChatting with a friend in another country or tweeting about the day's activities. She doesn't know that over 60 years ago the first computer programmers were women or that the first computer manual was written by a woman (Adele Goldstine, ENIAC manual 1946).

Top Secret Rosies: The Female Computers of WWII is a documentary that intends to remedy that by sharing the amazing story of the women and technology that helped win a war and usher in the modern computer age.