**Level 1: Charles Babbage & Ada Lovelace**

1. Who was Charles Babbage?
   1. When and where was he born?

**Charles Babbage was born on December 26th, 1791 in London (believed to have been born in Southwark).**

* 1. What was his main contribution to computer science?

**His main contribution to computer science was that he was credited with inventing the first mechanical computer that eventually led to more complex electronic designs.**

1. What is the "Difference Engine" proposed by Charles Babbage?
   1. What did it do?

**The Difference Engine was made to compute values of polynomial functions. It was created to calculate a series of values automatically.**

* 1. How did it work?

**The Difference Engine mechanized not just a single calculation, but a whole series of calculations on several variables to solve a complex problem. It went far beyond calculators in other ways as well. Like modern computers, the Difference Engine had storage—that is, a place where data could be held temporarily for later processing—and it was designed to stamp its output into soft metal, which could later be used to produce a printing plate.**

**The Difference Engine performed only one operation. The operator would set up all of its data registers with the original data, and then the single operation would be repeatedly applied to all of the registers, ultimately producing a solution.**

* 1. How was it similar to modern computers?

**Modern computers are built to carry on arithmetic or any other logical operation. The Difference Engine was built to only calculate arithmetic.**

1. Who was Ada Lovelace?
   1. When and where was she born?

**Ada Lovelace was born on December 10th, 1815 in London, England.**

* 1. What was his main contribution to computer science?

**Her main contribution to computer science was that she was the first to recognize that the Analytical Engine had applications beyond pure calculation and published the first algorithm intended to be carried out by such a machine. As a result, she is sometimes regarded as the first to recognize the full potential of a "computing machine" and the first computer programmer.**

* 1. What is the computer language that is named after her?

**The computer language Ada, created on behalf of the United States Department of Defense, was named after AdaLovelace.**

1. What is the "Analytical Engine" worked on by Ada Lovelace?
   1. What did it do?

**The Analytical Engine was, or would have been, the world's first general-purpose computer.**

* 1. How did it work?

**The basic parts of the Analytical Engine resemble the components of any computer sold on the market today. He called the CPU the "mill." Memory was known as the "store." He also had a device -- the "reader" -- to input instructions, as well as a way to record, on paper, results generated by the machine. Borrowing the same technology used by the Jacquard loom, a weaving machine developed in 1804-05 that made it possible to create a variety of cloth patterns automatically, data would be entered on punched cards. Up to 1,000 50-digit numbers could be held in the computer's store. Punched cards would also carry the instructions, which the machine could execute out of sequential order. A single attendant would oversee the whole operation, but steam would power it, turning cranks, moving cams and rods, and spinning gearwheels.**

* 1. How was it similar to modern computers?

**The Analytical Engine was very similar to modern computers today. It had its own CPU (the mill), memory (the store), and device (the reader). It could carry our mathematical calculations, like what the computers of today can easily do.**

**Level 2: Alan Turing**

1. Who was Alan Turing?
   1. When and where was he born?

**Alan Turing was born on June 23rd, 1912 in Maida Vale, London, England.**

* 1. What was his main contribution during World War II?

**During World War II, Turing served the Allied forces by breaking German military codes, particularly those used by the German navy. Enigma technology was continuously altered throughout the war, making the challenge of breaking German ciphers extremely difficult.**

* 1. What were his main contributions to computer science after World War II?

**After World War II, Alan Turing went on to invent and improve technologies that sparked a technological revolution he would never see. His 1950 paper, Computing Machinery and Intelligence, is considered the first cogent attempt at describing in detail how computers could one day "think".**

1. What is the "Enigma" that Alan Turing worked on during World War II?
   1. What was the "Enigma code" used by the Germans and how did it work?

**The Enigma was a type of enciphering machine used by the German forces to send messages securely. The Germans increased its security at the outbreak of war by changing the cipher system daily. This made the task of understanding the code even more difficult. Turing played a key role in this, inventing – along with fellow code-breaker Gordon Welchman – a machine known as the Bombe. This device helped to significantly reduce the work of the code-breakers.**

* 1. Why was it so important for Britain to "crack" the Enigma code?

**During the autumn of 1939 and the spring of 1940, Turing and others designed a code-breaking machine known as the Bombe. For the rest of the war, Bombes supplied the Allies with large quantities of military intelligence. By early 1942 the cryptanalysts at Bletchley Park were decoding about 39,000 intercepted messages each month, a figure that rose subsequently to more than 84,000 per month—two messages every minute, day and night. It was important for the British to crack these codes because they could figure out what the Germans were going to do next, so they could intercept them and devise plans for defeating them.**

* 1. How did Alan Turing solve the puzzle?

**Turing oversaw Hut 8, a section at Bletchley Park (the British World War II code breaking station) tasked with solving encoded German naval messages. He devised a range of code-breaking tools for cracking German ciphers, including an electromagnetic device called the Bombe, which countered the infamous German Enigma machine. The Bombe was able to assist the allies in cracking German codes from the Enigma machine.**

* 1. Why was Turing's work kept top secret?

**Turing’s work was kept top secret because his code breaking efforts had to legally been kept a secret. Much of his work was destroyed after World War II (proposed by Winston Churchill) to keep what he did secure and secret. If his work hadn’t have been kept secret during the War and word had gone out, it would have reached the Germans eventually, leading them to pursue Turing and change their code even more drastically. Additionally, had Turing’s work not have been kept secret, and if the Germans changed their code again, Britain may have not won the war.**

1. Many people call Alan Turing the "Greatest Unknown Hero of World War II". Provide some examples of the impact of his work that would support this claim.

**There are many understandable reasons as to why Alan Turing is called “The Greatest Unknown Hero of World War II”. For one, most of his work was unknown to the general public until after his death; as such, many people did not know what he did to help the allies during the war. He was the one that helped to crack the Enigma Machine’s code; had he not have done this, the Allies wouldn’t have been able to spy on the Germans, leading them to not being able to intercept them. Turing is often credited as the one that helped the Allies win World War II, and for good reason; he cracked the Germans’ code for secret messages.**

1. How did being gay affect Alan Turing's life and work as a computer scientist?
   1. How did being gay affect his work during World War II?

**In 1941, Turing proposed marriage to Hut 8 colleague Joan Clarke, but their engagement was short-lived. After admitting his homosexuality to his fiancée, he decided that he could not go through with the marriage. Additionally, due to being homosexual going against the law the time, he most likely felt some sort of guilt or anxiety from hiding this, knowing that he would be prosecuted if he told someone.**

* 1. How did being gay affect his work after World War II?

**Alan Turing’s house was burgled on January 23rd, 1941, and after reporting it to the police, he admitted to being gay. He was arrested and both men were charged with "gross indecency". Turing's conviction led to the removal of his security clearance and barred him from continuing with his cryptographic consultancy for the Government Communications Headquarters (GCHQ). He was denied entry into the United States after his conviction in 1952, but was free to visit other European countries.**

* 1. How did Alan Turing's life end?

**Unfortunately, Alan Turing’s life ended on June 8th, 1954, to cyanide poisoning. It is unknown if he had inhaled cyanide fumes accidentally from the lab next door; however, an apple laid half-eaten next to him, leading many to believe the cause of his death was suicide.**

1. Many people call Alan Turing the "Father of Computer Science". Provide some examples of the impact of his work that would support this claim.

**Alan Turing is known as the Father of Computer Science for many reasons. He formed the concept of the algorithms and computations with one of his inventions, the Turing machine. The Turing machine is a hypothetical machine thought of by Alan Turing in 1936. Despite its simplicity, the machine can simulate any computer algorithm, no matter how complicated it is. This formed the basis of modern computers today, because they can solve problems with ease, like how the Turing Machine can simulate any type of computer algorithm. Additionally, during World War II, he developed a machine that helped break the German Enigma code. He also laid the groundwork for modern computing and theorized about artificial intelligence.**

**Level 3: Other Great Contributors**

1. Who was John von Neumann?
   1. When and where was he born?

**John Von Neumann was born on December 28th, 1903 in Budapest, Austria-Hungary.**

* 1. When and why did he move to America?

**He moved to America in 1933. He was offered a lifetime professorship on the faculty of the Institute for Advanced Study in New Jersey when that institution's plan to appoint Hermann Weyl fell through.**

* 1. What was his contribution to mathematics & science?

**The field of game theory was one of his main contributions; it explains that in zero sum games where players are aware of all moves, there is a pair of strategies for both players to minimize their maximum losses. He worked out key steps in the nuclear physics involving thermonuclear reactions and the hydrogen bomb.**

* 1. What was his contribution to computer science?

**John Von Neumann contributed important ideas to the U.S. Army’s hard-wired ENIAC computer. He modified ENIAC to run as a stored-program machine. He wrote the sorting program for the EDVAC link, and worked on Artificial Intelligence along with Alan Turing.**

1. What was the "ENIAC" computer and the "von Neumann Machine"?
   1. What did it do and how did it work?

**The “ENIAC” (Electronic Numerical Integrator and Computer) was the first programmable general-purpose electronic digital computer, built during World War II by the United States. It was designed for the specific purpose of computing values for artillery range. It used plug boards for communicating instructions to the machine; this had the advantage that, once the instructions were thus “programmed,” the machine ran at electronic speed.**

* 1. How is it related to modern computers?

**ENIAC is related to modern computers because it’s all electronic and can be programmed to execute complex sequences of operations, much like the computers we have today.**

* 1. Explain how a "von Neumann Machine" applies to modern PCs.

**“von Neumann Machine” refers to the early computer developed by von Neumann himself. It included three components used by most computers today: a CPU; a slow-to-access storage area, like a hard drive; and secondary fast-access memory (RAM ). The machines stored instructions as binary values (creating the stored program concept) and executed instructions sequentially.**

1. Who was Grace Hopper?
   1. When and where was she born?

**Grace Hopper was born on December 9th, 1906 in New York City, United States.**

* 1. What were some of her contributions to computer science?

**She was a pioneer in developing computer technology, helping to devise UNIVAC I, the first commercial electronic computer, and naval applications for COBOL (common-business-oriented language).**

1. What was the "COBOL" computer language that Hopper helped to develop?
   1. How was COBOL different from other computer languages of the time?

**COBOL was different from other computer languages of the time because it was the first English-like computer language designed for business use.**

* 1. Is COBOL still in use today? Explain your answer.

**COBOL is still in use today. In 2006 and 2012, Computerworld surveys found that over 60% of organizations used COBOL and that for half of those, COBOL was used for the majority of their internal software. Some businesses have migrated their systems from expensive mainframes to cheaper, more modern systems, while maintaining their COBOL programs.**

1. Who is Tim Berners-Lee?
   1. When and where was he born?

**Tim Berners-Lee was born on June 9th, 1955 in London, England.**

* 1. Why was he knighted by Queen Elizabeth II?

**He was knighted by Queen Elizabeth II in the 2004 New Year Honors "for services to the global development of the internet", and was invested formally on 16 July 2004.**

* 1. What is his contribution to computer science?

**He made a proposal for an information management system in March 1989, and he implemented the first successful communication between a Hypertext Transfer Protocol (HTTP) client and server via the internet in mid-November the same year. Most notably, he is known as the inventor of the World Wide Web.**

1. List some ways that your life would be different if Tim Berners-Lee did not invent the World Wide Web.

**If Tim Berners-Lee did not invent the World Wide Web, my life would be very different today. I wouldn’t be able to access billions of pages on the internet; this leaves me with no way to do school work online or to do research. I’d be cut from social media and sharing sites, and I wouldn’t be able to read news or articles online. I wouldn’t even be here typing all of this out, because there would be no way for me to access the GitHub repository to download this document, and I wouldn’t be able to do research on any of the heroes of computing.**

**Level 4: Presentation**

Pick one of the above "heroes" of computer science and prepare a brief presentation about their life and contributions.

Your presentation will be shared with other students in the class in a "trade show" format. (When we return from Christmas break.)

Your presentation should be shared with Mr. Nestor through Google Docs or via email at p0079141@pdsb.net.