The History of the Twentieth Century
Episode 340
"The Ultra Secret"
Transcript

[music: Fanfare]

At the beginning of the war, British intelligence took over from the Poles the task of decrypting messages sent through the German Enigma machine. Fortunately for them, they already had on the payroll one of the world's leading mathematicians.

Welcome to *The History of the Twentieth Century.*

[music: Opening War Theme]

Episode 340. The Ultra Secret.

Alan Turing was born on June 23, 1912. His father, Julius Turing, worked in the Indian Civil Service. His mother, born Ethel Stoney, was the daughter of an Anglo-Irish family. The Turings had two children; the first was another son, John Turing, born while his parents were living in India.

Baby John came down with a case of dysentery at the age of six weeks, which convinced his parents that their children should grow up in England and not India. Alan, the younger son, was born in London, while his father was in England on leave from the Indian Civil Service. When the elder Turings returned to India, they left their two sons behind in England with another family, which was common practice among families within the Indian Civil Service.

At the age of 13, Alan Turing was sent to Sherborne School, a boarding school for boys in the town of Sherborne in Dorset. He was sent off to school along a route that took him by boat to Southampton, and from there he was to ride by train to Sherborne. Unfortunately for young Alan, the great British General Strike of 1926 broke out just at that point in his journey. The railway workers walked out, and Alan was stranded in Southampton. He joked about disguising himself as a shipment of milk, as milk was the one cargo the striking railway workers were still willing to transport.

In fact, he had his bicycle with him and so he cycled the sixty-two miles to Sherborne. It took him two days, with a stopover at an inn for the night. He arrived at school a day late, but his determination to get to school despite the obstacles made the local newspaper and instantly made him popular at the school, especially among the teachers. That didn't last. The school offered a classical education, while Alan was far more interested in science, and especially mathematics.

Alan developed a close relationship with another student, Christopher Morcom, while at Sherbourne. Alan was gay, which in our time has led to speculation that this relationship was a romantic one. No one can say for sure, but it was certainly a very close friendship, whatever else it may or may not have been, a friendship that ended abruptly with Christopher's untimely death from tuberculosis in 1930, when he was 18 and Alan was 17.

As a side note, I'd like to mention that I lost an aunt to tuberculosis just a month after the passing of Christopher Morcom. My aunt was 22. Two years later, her brother, my uncle, died of the same illness, also at the age of 22. I mention this because in our time, we forget how dangerous infectious diseases like tuberculosis could be, even among young people, and in the relatively recent past.

Christopher's death hit Alan hard. He remained in touch with the Morcom family for many years afterward. The family endowed a Christopher Morcom Prize at the school. The first student of Sherbourne School to be awarded the Morcom Prize would be Alan Turing.

After graduating from Sherbourne School, Turing studied mathematics at King's College, Cambridge. In 1935, he published his first paper and was elected a Fellow of the College.

King's College was a good fit for Alan, not least because homosexuality was largely accepted there. Students of the classics were all aware of the laid-back attitude of the ancient Greeks to romantic relationships between men, and there was the College tradition of free debate, which made it possible to use the Greek precedent to argue the validity of same-sex relationships in modern times.

In 1936, Turing completed his most important work, a paper titled "On Computable Numbers, with an Application to the *Entscheidungsproblem*." That's quite a mouthful, so let me explain. I'll start with Alan Turing's own real-world analogy: Suppose you are given a puzzle to solve. Maybe it's a math problem, a sorting problem, a Rubik's cube, a Sudoku. Suppose you tackle the problem, but after a long session of hard work, you have not found a solution. At this point, you would likely turn to the person who gave you the puzzle and ask them to confirm that the puzzle is indeed soluble.

That's the essence of the *Entscheidungsproblem*. You can prove that a problem is soluble by solving it, of course, but if you can't solve it, that doesn't necessarily prove it can't be solved. It may simply mean that the problem is too difficult for *you*, but someone else may solve it someday. It would be handy to have a method that could analyze any problem to see if it can be solved and return a yes/no answer.

To put it in mathematical terms, you want a method to analyze a proposition to see if it can be proved or not. It was our old friend, the German mathematician David Hilbert, who raised this problem. I talked about Hilbert in episode 307. Hilbert laid out a goal of creating a perfect logical system that was both consistent and complete. Kurt Gödel demonstrated that this was impossible; any system had to be either incomplete or imperfect. Well, Hilbert had also laid out a third goal, that within this perfect system, it would also be possible to determine which propositions can be proved and which cannot. And thus, just a few years after Gödel published his result, Turing published his, completing the work of proving that Hilbert's imaginary perfect system could not exist.

To prove this, Turing proposed an imaginary machine. This is hard to describe without pictures, so bear with me. This machine processes a strip of paper of any length. The strip of paper is divided up into individual cells, and each cell contains a 1 or a 0, and the machine itself is capable of assuming a number of different states. Let's call these states A, B, C, and so on.

At any given time, the machine is looking at one cell on the strip of paper. The machine is capable of reading the number on the strip and its own state, and then consulting a table for instructions on what to do next. The instructions might include the machine changing itself to a different state, or writing a new number onto the cell it is looking at, or moving the strip of paper one step to the left or right, or some combination of these things.

So for example, if the machine is looking at a cell that contains the number 1 and it is in state B, it will consult the table, cross-referencing B and 1, and then execute whatever instruction is there. An example instruction might be, "Change your state to C and move the strip one step to the left."

Turing's paper demonstrates that this simple imaginary machine can solve any mathematical problem, if it has the proper table of instructions to work with. He then considers a second machine of the same type that is meant to predict whether the first machine can successfully solve a given problem, and shows that no such machine can give the right answer in every case.

That's a lot of math talk, and if it's passing you by, don't worry about it. I will note, however, that these imaginary machines became known as "Turing machines," after their creator. When I described a Turing machine to you a few minutes ago, you may well have thought that it sounded very much like what the processor in a modern computer does, and if you did, congratulations, you are correct. Turing's paper laid out the theoretical basis for what we would now call a digital computer. He had shown that such a machine would be incredibly versatile, and here was where mathematicians began to think about ways in which such a machine could be constructed and used to solve mathematical and logical problems.

So by 1938, when he was still just 26 years old, Alan Turing was a famous name…among mathematicians, anyway.

In the previous episode, I reminded you about Britain's highly successful codebreaking operation during the First World War, based in Room 40 of the Old Admiralty Building in Whitehall. Room 40 did not cease operations after the war; the British Cabinet decided to maintain a peacetime codebreaking office with about fifty employees. It was named the "Government Code and Cypher School," GC&CS for short, and its official purpose was to advise and assist other British government agencies in the use of codes and ciphers. Its real purpose was to study the codes and ciphers used by foreign governments.

A member of the GC&CS staff, Frank Adcock, "retired" from the agency and took up a professorship at King's College in Cambridge, but in fact Professor Adcock was still working for his former employer on the side. His role was to recruit talented people from King's, who would agree to serve in the GC&CS if needed, in time of war. Adcock recruited eleven King's College Fellows for the agency; one of them was Alan Turing.

As you know, on September 1, 1939, Germany invaded Poland. On September 3, Britain declared war on Germany. The following day, September 4, Alan Turing began working for the GC&CS.

[music: Bach, "Prelude in D Major"]

During the war, GC&CS operated out of Bletchley Park, a country house in Buckinghamshire. Bletchley Park was built in the late 19th century in a mishmash of architectural styles. In 1938, Sir Hugh Sinclair, the head of Britain's Secret Intelligence Service, or MI6, purchased Bletchley Park to house GC&CS in the event of war. When the government declined to pay for the property, Sir Hugh put up the £6,000 purchase price out of his own pocket.

Alas for Sir Hugh, he died in November 1939, just two months into the war, at the age of 66. He was succeeded as chief of MI6 by the 49-year-old Stewart Graham Menzies. GC&CS was headed by the 58-year-old Alastair Denniston, who had worked in Room 40 since its inception in 1914. Denniston was one of the British representatives at that July 1939 meeting in Poland that I told you about last time, where the Polish Cipher Bureau revealed to British and French intelligence officials their work on decryption of the German Enigma ciphers.

Bletchley Park had been chosen as the location to house GC&CS during the war because it was outside London, but conveniently located near the Bletchley train station, which sat at the junction of a rail line to London and a line connecting Oxford to Cambridge, thus making it easy to reach from the capital or from either university.

Over the course of the war, the codebreaking operation at Bletchley Park outgrew the main house and the outbuildings, forcing the uprooting of the gardens and lawns and the construction of temporary wooden huts to accommodate the overflow. By the end of the war, more than 8,000 people would be working there.

You'll remember from last week's episode the Polish bombes, devices that simulated Enigma machines in all six possible rotor combinations. I told you how the Germans added two new rotors to the mix shortly before the war began. That meant that instead of six possible rotor combinations, there were now sixty. The Polish Cipher Bureau did not have the resources to build a bombe with sixty sets of rotors, but the British did. Hundreds of bombes were constructed during the war, in Britain and later in the United States, until by the last months of the war, decryption of German military messages was becoming routine.

The British code name for the Enigma decryption project was Ultra. But how did Ultra work? In order to make use of these bombes, you might use a piece of text that you believed might reasonably appear in the message. To give a simple example, during the Western offensive, one might guess that the German word for *attack*, which is *Angriff*, might frequently appear in orders sent to the front lines. The bombe is capable of testing different rotor settings to see if any of them decode the intercepted message to the word *Angriff*.

In the natural course of things, sometimes German messages are captured in land or naval combat, which gave the codebreakers samples of what typical German messages might look like. Individual transmitting and receiving stations had their own call signs, so that was something to look for. Another example: many German messages began with TO and a colon, then naming the individual for whom the message was intended. The way you say that in German is AN, A-N, plus a colon. Enigma didn't have provisions for punctuation, so the German practice was to use the letter X to indicate a punctuation mark; thus, many German messages began with A-N-X, which gave the bombes something to chew on. A common sentence in German military reports was *Keine besonderen Ereignisse*, which roughly means, "nothing special to report."

Bletchley Park catalogued names of people, ships, units, and common bits of German military jargon that could be used to help decrypt messages. The code breakers called these words and phrases *cribs*. One useful source of cribs was messages that the Germans transmitted in a simpler cipher, one that was already broken, which were then encoded into Enigma and relayed. The British would sometimes plant their own cribs. For example, the grid reference system used by the German Navy was known, so the RAF might lay mines at a certain location, then the code breakers would hunt for that grid reference when German naval vessels reported the mine fields.

German radio operators who used Enigma sometimes inadvertently helped the code breakers. For example, they were supposed to choose a new wheel setting for each message, but lazy code operators would keep using the same settings, or choose and easy an obvious setting, like AAA, or use a person's name or a simple word as the setting, or they would simply move one or two rotors a notch or two and call that a "new" setting. I mentioned this sort of thing last time and compared it to using *password* as your password. These shortcuts gave the crew at Bletchley Park some quick and easy starting points when testing rotor settings.

In one famous case, one of the analysts, Mavis Lever, looked at an Enigma-encoded message and something immediately struck her as being wrong. She looked at it for a moment and realized the letter L was completely absent from the text. By the way, this tells you something about the sort of people who were recruited for this job. They needed puzzle solvers. People who were good at cryptic crossword puzzles and such. The sort of person who could glance at a page of letters and immediately say, “Hey, there aren’t any Ls here.”

Remember that Enigma never encodes a letter to itself. That means that one plausible explanation for a coded message with no Ls in it is that the message itself was nothing more than a long string of Ls. This was because German radio operators were sometimes ordered to send test messages, and this particular radio operator was feeling lazy and simply kept hitting the L key over and over again, because it’s the key on the far right of the keyboard, closest to the right hand. Once Mavis realized this was what happened, working out the rotor and wiring settings was child’s play. It was the best crib you could have asked for.

Alan Turing was one of the leading cryptanalysts at Bletchley Park. He helped design the British bombes used to analyze Enigma messages. He had a reputation as an eccentric. He was an avid cyclist and long-distance runner. He used to go running as a way of relieving the stress of working at Bletchley Park. On some occasions when he was required to attend a meeting in London, he would run the forty miles from and to Bletchley. His co-workers called him “Prof,” as in, short for professor, though ironically, Alan Turing did not and never would hold the title of professor.

Early in the war, Turing turned to the problem of cracking the naval Enigma cipher, which was more difficult because the German Navy did a better job of encoding the Enigma settings sent out at the beginning of every message. He solved it in a few weeks, and along the way developed some novel statistical techniques to help decode Enigma. For example, if you had two Enigma messages that had been encoded on machines with the same settings, you could match them up and look for cases where the same letter appeared at the same location in both messages, indicating that those letters matched in the original message as well. Statistically speaking, it is likely those matching letters represent a common letter, like E, which gives you some ideas as to where to begin testing.

Turing also developed a statistical method for deriving likely settings for the rotor on the right, based on the pattern of letters in the coded text.

In the spring of 1940, the GC&CS did a remarkable thing; they hired a woman mathematician to work on the Ultra project. Her name was Joan Clarke, and she had studied mathematics at Cambridge. She was gifted and quickly rose through the ranks. Special arrangements had to be made to take her out of the clerical pay grades women were assigned to and get her paid what she was worth.

Alan Turing and Joan Clarke hit it off right away, socially. They played chess together, talked mathematics together, and hung out together, but it was a shock to her when Turing proposed marriage. Evidently Joan Clarke was one of the few people Alan Turing had ever met that he could imagine spending his life with. He confided to her that he was gay; she said she didn’t mind. You need to understand that in 1940, the enlightened view of homosexuality was as an unfortunate and perhaps harmful character flaw, like let's say, compulsive gambling, which a person could overcome, or at least learn not to indulge in, as opposed to our view of it as an innate characteristic and part of a person's identity, so that was a remarkable choice on Joan's part. In any case, the marriage never took place; Turing later broke off the engagement.

Decoding naval Enigma messages was a matter of particular concern at Bletchley Park, in order to listen in on U-boat communications. For this reason, capture of Engima equipment was always helpful. In February 1940, the British captured the German U-boat *U-33* and recovered a couple of rotors. In April 1940, during the fighting in Norway, they captured a German patrol boat, including its Enigma machine, rotor setting tables, and a stack of messages that gave Bletchley Park some insight into German Navy cribs.

But there followed a long drought, with no new information, and thought was given on how to capture another German boat. An officer in Naval Intelligence, Commander Ian Fleming, proposed Operation Ruthless in September 1940, which would work like this: When the British spotted a suitable small vessel in the English Channel, they would launch a captured German bomber with a German-speaking British crew dressed in Luftwaffe uniforms, done up with blood and fake bandages. This bomber would follow behind a returning German bombing raid, radio a distress call, then crash into the Channel. The crew would board a rubber dinghy and let the bomber sink. When the German boat came to rescue them, they would overpower the crew and return it to an English port.

It does sound like something out of a James Bond novel, doesn't it? Unfortunately, they couldn't find the right German boat at the right place and time to make it work, and the operation was called off. But then in May 1941, German U-boat *U-110* attacked a British convoy and sank two ships, but was then forced to surface by the escort ships. At fate would have it, the commander of *U-110* was Kapitänleutnant Fritz-Julius Lemp, the same officer who, as commander of *U-30*, had sunk the British passenger liner *Athenia* on the first day of the war and was almost court-martialed for it. You recall I told you that story a couple episodes back.

Lemp ordered his crew to abandon ship and scuttle the U-boat, but after the crew got away, they saw that the boat was not sinking. Lemp tried to swim back to his boat to destroy the secret materials, but he didn't make it. He either drowned or, according to one German sailor, was shot by the British. Either way, the British got hold of the boat's Enigma machine and code books.

By 1941, the British were getting solid, reliable intelligence from Bletchley Park, but there was the problem of how to use it without giving the game away. When the British learned the location of a German U-boat in the Atlantic or an Italian convoy in the Mediterranean, they would first send a search plane to "find" the enemy before attacking, to make it look as if the search plane was responsible for the discovery. Other search planes would be assigned other searches at the same time, lest any of the reconnaissance pilots begin wondering why their planes always found the enemy.

On one occasion, the RAF needed to quickly attack an Italian convoy that originated from Naples and there was no time to send a spotter plane to arrange a fake discovery, so after the attack, British intelligence sent a radio message to Naples, thanking an imaginary spy in that city for providing the information. There was no such spy, but the message was sent using a code the Germans had broken; they received the message, decoded it, and accepted it as the explanation for the attack.

The head of Germany's U-boat fleet, Karl Dönitz, had his suspicions. As the *Kriegsmarine* increased the numbers of U-boats on patrol in the North Atlantic, logically its submarines should be finding British convoys more often. Yet this was not the case. This caused Dönitz to question whether Enigma had been compromised, and he ordered a security review, but the review concluded that Enigma was unbreakable and offered alternative explanations, which Dönitz accepted. These alternative explanations blamed the problem on British spotter planes, British huff-duff technology, and British radar systems, all of which were more advanced than what Germany had. The review concluded the British were continually improving their detection of German U-boats and warning the convoys away from them.

I should mention that the accusation has been made that Winston Churchill and the British military had advance warning of the devastating bombing of the city of Coventry on November 14, 1940, episode 328, through Enigma decrypts, but took no action to oppose it, so as not to give away the information that Enigma had been compromised. This is not true and has been thoroughly debunked. In fact, Enigma decrypts had revealed that a major bombing attack was coming, but the British did not have information on which city was the target. Churchill in fact expected it would be London.

By late 1941, in spite of their successes, the GC&CS lacked the staff and equipment to keep up with the increasing volume of German messages they were intercepting. Winston Churchill visited Bletchley Park in September and gave a brief speech expressing appreciation for their work. This gave the lead cryptographers sufficient encouragement to send a letter directly to the prime minister a month later to request more funding. Alan Turing was the lead signatory to this letter, but he was not the only one. The letter noted that the additional funding they were requesting was small compared to most other wartime projects, yet it had great potential to shorten the war.

Churchill read the letter and ordered that GC&CS immediately be given whatever they wanted. This meant expanded staff and building more bombes, although Turing and the other signatories never knew for certain that their letter was behind the increase in resources.

It's worth noting that some three-quarters of the staff at Bletchley Park were women, many of them members of the Women's Royal Navy Service, frequently referred to as Wrens. When the staff at Bletchley Park peaked at 8,000 late in the war; 6,000 of these workers were women.

At the beginning of 1942, the United States was in the war, German U-boats were attacking ships off the US coast, and British Intelligence representatives traveled to the US to brief the Americans on Enigma and to suggest that American cryptanalysts focus on breaking Japanese codes and leave Enigma and other German codes to them. Unfortunately for the British, on February 1, the *Kriegsmarine* switched to a four-rotor Enigma machine and suddenly Bletchley Park was unable to decrypt a single German naval message, which wasn't a good look while they were trying to convince skeptical Americans of their skill in decoding Enigma.

In November 1942, with the Naval Enigma problem not yet solved and the U-boat threat near its peak, Alan Turing traveled to the United States to serve as liaison to the American code breakers. When they presented their own theories on cracking Enigma, he gently demonstrated why they wouldn't work. Turing traveled to the National Cash Register Company in Dayton, to consult with the engineers. NCR had won a government contract to build cryptanalysis bombes for US intelligence. The Americans, who had access to more engineers and more resources, where ultimately able to build more and better bombes than the ones at Bletchley Park.

Turing also consulted with engineers at Bell Labs in New Jersey. Bell Labs, you'll recall, was the research subsidiary of AT&T, the American Telephone and Telegraph Company, the communications giant, which, because of its ubiquitous presence, Americans had become accustomed to calling simply "the phone company." Bell Labs worked out an entirely different and more efficient way to build a bombe. Instead of relying on rotors that duplicated the rotors in an Enigma machine, the Bell bombes used telephone switching relays to mimic the connections of Enigma rotors, which allowed them to cycle through different rotor combinations much faster.

The British had sent Alan Turing to Bell Labs because they wanted help on a project of concern to the prime minister. Churchill spoke regularly with Franklin Roosevelt and sometimes with Joseph Stalin over the telephone, but had good reason to fear the Germans were listening in. There already existed scramblers, devices to encode audio signals that could be decoded at the other end, but made the audio unintelligible to anyone listening in. The trouble with them was that they were simple devices, and once someone understood the principle, it was not difficult to duplicate the technology and listen in anyway.

Turing consulted with Bell Labs to design a much more secure system. This one broke the audio signal into ten frequency bandwidths, then reduced these signals to numbers. The numbers were then combined with another flow of numbers derived from random sounds produced by a phonograph record and transmitted to the receiver, which would have an identical phonograph record playing synchronously to reproduce the flow of numbers in order to remove them from the incoming signal before converting it back into sound.

Unlike a text message, which can be encoded and decoded at the operators' leisure, audio signals had to be encoded and decoded rapidly enough to keep up with a human conversation. In our time, the technology to do this is readily available to run on our personal computers. Indeed, right now I am using software that converts my voice to digital code in real time to record this podcast, and you are listening to my voice on a device that converts it back into a reproduction of my voice in real time. Many of you are accomplishing this feat on devices that fit into your pocket.

The device built at Bell Labs would not fit into your pocket. In fact, it filled an entire room, weighed fifty tons, required a dozen people to operate it, and it took fifteen minutes to set up a phone call because, as you can imagine, synchronizing those phonograph records on either side of the phone call was no simple task.

The device was formally known as Project X-61753, but it acquired the nickname "The Green Hornet," after the radio program, because human voices that ran through the system came out sounding a little buzzy, like a bee. When Alan Turing returned to England and gave his assurances that the machine was reliable, the British accepted delivery of one.

Much of the work of the prime minister, the British War Cabinet, and the senior military was taking place in an underground bunker complex in Whitehall, known as the Cabinet War Rooms, built just before the war to protect the government in the event of an enemy bombing London, which became reality just months after the facility became available. There wasn't enough room for The Green Hornet down there, so it was installed in the basement of Selfridge's Department Store on Oxford Street, and it was now possible for Churchill and Roosevelt to confer across the Atlantic with confidence that no Germans were listening in.

I've been to the Cabinet War Rooms, and I have seen for myself the room from which Winston Churchill communicated with Franklin Roosevelt. From the outside it was made to look like a lavatory, just across the hall from the prime minister's bedchamber, but it was always locked and the indicator always showed OCCUPIED. It was explained to the staff that this was a private loo for the prime minister's use only, when in fact it was where Churchill was sharing his eloquent perorations with the President of the United States.

[music: Bach, "Fugue in D Major"]

After the war, Turing's codebreaking work at Bletchley Park was kept under the Official Secrets Act, meaning Turing was barred from telling anyone what he had done during the war. He continued to do some consulting work for British Intelligence. He worked for a while on early designs for computers, but this was complicated because his work was based on experience he had gained working for GC&CS, but he couldn't explain that to anyone else.

In 1948, Turing took a position at the University of Manchester. In 1950, he published another remarkable paper, titled "Computing Machinery and Intelligence," in which he addressed the question of whether it would be possible to build a computer with an intelligence comparable to that of a human being. Turing believed it could, and offered a famous thought experiment: Imagine a human being conversing over a teletype machine with an unseen person who might be a human or a computer. Turing suggested that if, after conversing with the unseen person for a reasonable time, the human were not able to distinguish a computer from a human being, then that computer could be said to have a human level of intelligence.

The Turing Test became famous. When I was young, in the early days of computers and before the story of Ultra had been made public, it was for the Turing Test that Alan Turing was best known. The paper succeeded in its goal, which was to make the case that machine intelligence was possible, although, and if you don't mind my editorializing a bit, time has proven the Turing Test inadequate. Computer programs that could convincingly simulate human conversation, at least for a short time, existed by 1970, though they were certainly not intelligent. In our time, as I record this, the big news in computing is ChatGPT, a large language model that can carry on convincing conversations, even write essays, but is certainly not intelligent. Turing's mistake, I think, was in overestimating the difficulty in simulating human conversation. It turns out our conversations are not nearly as clever or original as we thought they were, and I wonder if the Turing Test hasn't persuaded too many engineers that their goal should be simulating chit-chat, rather than actual creative thinking.

In 1952, at the age of 39, Alan Turing began a romantic relationship with Arnold Murray, a 19-year-old unemployed laborer. Shortly afterward, Turing's house was burgled. Murray told Turing he knew who the perpetrator was; it was a friend of his. Turing reported this to the police, who proceeded to charge Turing and Murray with "gross indecency," which was the criminal law term for gay sex at the time. Turing pleaded guilty and was offered parole, on the condition that he undergo therapy and hormone treatment with synthetic estrogen, which was intended to reduce his sex drive. This was commonly known at the time as "chemical castration." The treatment made Turing impotent and caused him to grow breasts.

His criminal conviction cost Turing his security clearance, which ended his consulting work for GC&CS, which by then was known as the Government Communications Headquarters, or GCHQ. It is still known by that name today.

Alan Turing died two years later, on June 7, 1954, from cyanide poisoning. He was 41 years old. An inquest was held and his death was determined to have been suicide, although there is some controversy about that. Turing had become interested in biology and chemistry and was doing chemical experiments in a spare room, leading some to believe his death was an accident.

The British and US governments continued to keep their work on Enigma secret for a total of 29 years. The project was only revealed to the public in 1974. It is not clear why it was kept secret for so long.

There exist numerous streets, prizes, buildings, and conferences named after Alan Turing. He is depicted in a number of statues and busts. In 1999, *Time* magazine named Alan Turing one of the 100 most important people of the twentieth century. In 2002, he won 21st place in a BBC poll of the 100 Greatest Britons.

As I'm sure most of you know, the year 2016 saw the release of a film, *The Imitation Game*, about Alan Turing and the Ultra Project, written by Graham Moore, directed by Morton Tyldum, and starring Benedict Cumberbatch as Turing. The film isn't bad, although it minimizes the contributions of others at Bletchley Park and completely omits the work of the three Polish mathematicians Marian Rejewski, Henryk Zygalski, and Jerzy Różycki from the Polish Cipher Bureau, who probably saved GC&CS a year or two worth of work, in favor of a presentation that depicts Turing as cracking Enigma virtually single-handed through the sheer power of Cumberbatch's acting, while his co-workers display attitudes ranging from indifference to contempt. Also, Cumberbatch's portrayal of Turing is heavily influenced by posthumous diagnoses of autism some have applied to Alan Turing, and he is depicted as having great difficulty socializing or understanding social cues. There is little evidence of this in the real Alan Turing's life. In fact, he was noted for his sense of humor and had amicable relationships with his colleagues at Bletchley Park.

Gay sex was legalized in England in 1967. In 2009, a British software engineer, John Graham-Cumming, began petitioning the British government to apologize for Alan Turing's prosecution. That same year, Prime Minister Gordon Brown did offer just such an apology on behalf of the British Government.

In 2011, a movement began to advocate for a posthumous pardon for Alan Turing. This proposal ran into some difficulty, because pardons are normally granted only in cases where the convicted person is believed to be actually innocent, while Turing was indeed guilty of the act for which he was prosecuted, which was indeed a criminal offense at the time, and it raises questions about the thousands of other men who were prosecuted under the same law.

In 2013, Queen Elizabeth II granted a posthumous royal pardon to Alan Turing. In 2017, Parliament passed an act which, among other criminal justice reforms, offered a pardon to every man convicted of "gross indecency." This act is informally known as the Alan Turing Law.

In 2021, the Bank of England released a new £50 note, the design of which includes a portrait Alan Turing.

We'll have to stop there for today. I thank you for listening, and I'd especially like to thank Frank for his kind donation, and thank you to Amy for becoming a patron of the podcast. Donors and patrons like Frank and Amy help cover the costs of making this show, which in turn keeps the podcast available free for everyone, so my thanks to them and to all of you who have pitched in and helped out. If you'd like to become a patron or make a donation, you are most welcome; just visit the website, historyofthetwentiethcentury.com and click on the PayPal or Patreon buttons.

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I'm pleased to be able to tell you that a short story of mine appears in the recently released fantasy anthology, *Artifice and Craft*. It's a collection of stories about magical artifacts. It is available as an ebook or a paperback at Amazon, Barnes and Noble and Kobo.

And I hope you'll join me next week, here on *The History of the Twentieth Century*, as we cross the channel and examine what was going on within the German leadership, as Adolf Hitler, weary of the war with Britain he never wanted, begins planning the war he actually wants. A Crime against the Future, next week, here, on *The History of the Twentieth Century*.

Oh, and one more thing. Any discussion of the Allied project to decrypt Enigma invites the question: what effect did the Ultra project have on the war? On the one hand, some historians confidently declare that Enigma shortened the war by as much as a year or two. At least one has proposed that the war might have been lost without Ultra, although that seems like a stretch. It certainly saved lives on the Allied side.

Other historians are more likely to minimize Ultra and say that it shortened the war in Europe by three months at most; that is, if Germany was not beaten by August 1945, the atom bomb would have settled the war in Europe anyway.

Another historical question to ponder is to what degree the achievements in decrypting Enigma led postwar British and American leaders to overestimate the power of their armed forces and cause them to be reckless in places like Korea, the Suez, and Vietnam.

[music: Closing War Theme]