

BUILDING 26

THE ENIGMA, NCR, AND THE WOMEN OF SUGAR CAMP

In the summer of 1987, I took a new job with NCR Corporation in Dayton, Ohio. On my first day I was taken to the offices of my new group in Building 26, an ordinary building at the corner of Stewart St. and Patterson Blvd., at the edge of the NCR campus. In 1987, I had no idea that Bldg. 26 had such an important history. That would not become known until 1992 when the story of the role NCR played in cracking the German Navy 4 rotor Enigma codes was de-classified. Building 26 was the home of the US Naval Computing Machine Laboratory where the combined Navy/NCR team devised and built the NCR machine that broke the advanced 4 rotor Enigma codes in 1942-43. This coding method was used by the German Navy to dispatch their U-boats to attack Allied convoys in the Atlantic. The U-boats were taking a terrible toll on the merchant ships supplying the Allied war effort in Europe. For this reason, the project was second in priority only to the Manhattan Project.

The origins of Enigma came in 1917 in a design by Edward Hebern of the US and it was first used as a business machine. The basic concept was to use three rotors to shift and substitute characters typed into the machine with its keyboard. The operator would set the rotor wheels according to the code settings for the day. So,

an A typed into the first rotor would perhaps become a P in the second rotor, and a T in the third rotor. The receiving operator would set the decoding Enigma machine to the code of the day which then read the T as P, and P as A. Thus the three rotor machine could provide different encypherings up to 10^{23} power.

Arthur Scherbius of Berlin improved on the design in 1923, creating the machine that was eventually used by the German military for encryption. As Hitler came to power in the 1930's, the machine was used by all military branches.

As the German war machine grew, European countries became more alarmed. Polish Intelligence began picking up the encrypted German radio messages and became interested in this new encryption technology. Three Polish mathematicians were brought in to try to crack the code. They did break into Enigma, but Polish authorities did not reveal this until Germany became a threat to Poland.

In July, 1939, Poland invited the British and French code breaking teams to a conference and explained their findings. They also handed over a Polish mock up of the Enigma machine which they had made. This was an extraordinary contribution towards defeating a common enemy, and a priceless gift. The machine and data were handed over to Bletchley Park in England for further development of the code breaking techniques the Poles had been working on to date. Their efforts

resulted in the first decrypted German message in January, 1940. However, it was not until 1941 that the German Naval code was broken.

I believe we have all heard of the efforts to break the Enigma code and the success that the team at Bletchley Park had in doing so, particularly with the German Navy messages. Books, movies, and TV shows have provided insights on the highly secret activities of ULTRA and the capturing of actual Enigma machines and code books from German U-boats and weather ships by the British. ULTRA was the designation adopted by British military intelligence in June ,1941 for information obtained by decrypting enemy communications. This became the standard designation among the Allies for all such intelligence. It was a classification above “Most Secret”. The result of this was that Allied shipping losses dropped and U-boat losses increased in 1941 because the Allies could determine where and when torpedo attacks might occur.

The Germans must have realized someone was reading their “mail” and retaliated in 1942 by adding a fourth rotor to the Enigma. Now, possible combinations grew to 10 to the 26th power. Allied shipping losses nearly doubled in 1942 because the Allies were again unable to decipher the German Navy messages, and were blind to the U-boat positions.

These losses were just unacceptable to the U S Navy, and there was great frustration with the British for not treating the US as equals in the quest for reliable intelligence about U-boat deployment and positions of the wolf packs; multiple submarines working together in attack groups. Progress in breaking into the four rotor machine codes seemed very slow to the Americans, and as the US was now fully engaged in the war effort, but were not being involved in the code breaking project. The Navy was losing more ships than could be replaced, thus slowing the critical flow of troops and war materiel to the front lines in Europe and North Africa. These concerns were voiced to the British resulting in an exchange of deputations between the two Allies with the view of improving the sharing of critical information. However, the British view was that the US should concentrate on breaking the Japanese cyphers and leave the Enigma entirely to them, sending copies of their decrypts to the US Navy as was necessary.

Frustrated even more, the Navy was ready to develop its own version of the “Bombe” (bam(b)) as the code breaking machines were called. The term was first used by the Polish for their early machine because their team liked an ice cream desert by the same name and it stuck. A British Bombe was to be delivered to the Navy to save time in developing the American version, but, even though it was a part of the Holden Agreement which laid out details of Anglo-American cooperation regarding the Enigma, the machine was never delivered.

Against this backdrop, the US Navy's OP-20G, as the crypto analysis group was known, decided it needed to move ahead with its own development of a code cracking machine able to read the 4 rotor Enigma. Bear in mind, this machine was to determine the settings of the rotors which could change message to message or day to day. Initially, the work was given to the M Section of OP-20 led by Howard Engstrom, with design given to a small group of academicians from MIT, who were committed to developing an all electronic solution. Working basically in the dark without much help from Bletchley Park, they produced a draft design document in early 1942.

The search for an experienced engineer to evaluate the MIT design ended with the selection of Joseph Desch, who, since 1938 was the Director of Research at the NCR Electrical Research Laboratory in Dayton, Ohio. Col. Edward Deeds, Chairman of NCR's Board, had a strong working relationship with the MIT group and had provided regular support to MIT's research efforts. It is likely that this relationship was the basis for Joe Desch being nominated to review the design. The only other possibility would have been IBM, but NCR had available manufacturing capacity to actually build the machine once the design was approved.

At 35, Joe Desch was a brilliant "practical" engineer who received his Bachelors Degree from the University of Dayton, and was a floor trained industrial genius, as

savvy about front office politics as he was about state of the art electronics. He had already, and unknowingly made a contribution to the war effort through his invention of an electronic counter capable of making 1 million counts per second; 100 times faster than anything achieved before. His counter was used in the development of the first atomic bomb. And now, he was being asked to evaluate the design for a code breaking machine at MIT.

When Joe and his wife Dorothy visited the team at MIT, Dorothy was completely thrown by people at the welcoming cocktail party greeting Joe as “Dr. Desch”. The young engineers could not fathom that a man of Joe’s importance did not have a PhD.

Desch reviewed the MIT design for an all electronic bombe and concluded that it would not be feasible. It would require 20,000 tubes running at beyond their capacity and creating an enormous amount of heat. Instead, he decided on a major technological leap backwards and proposed that the US bombe could be built using electro-mechanical technology that had been proven in the British designs. It would not be pretty, it would not be elegant, but it would accomplish the task through sheer brute force. Bob Mumma, Joe’s second in command said, “We never had any doubt about it. We knew what we had to do. It was just a matter of time.”

The Navy used the lack of progress at Bletchley Park in breaking the German Navy 4 rotor code as the basis for moving ahead with building an American machine. Desch convinced the Navy that his design would crack the German 4 rotor code and could be produced in a matter of months. The Navy responded using an existing NCR open ended best effort contract, providing everything and anything needed to get the job done. The Navy basically took over Desch, his staff, and his lab in Dayton and assigned the creation of the bombe to them. The project was second only to the atomic bomb development in priority.

In October, 1942, shortly after Desch and his team had been recruited to build the US bombes, the British agreed to train members of the Navy's M Group of OP-20-G to use hand decryption methods and give instructions on how the existing 3 rotor machines were set up. Now we were getting somewhere, and this meant that higher levels of security were required at the Dayton lab.

The Navy had already looked into Desch's background, but now he would need a security clearance of the highest level in order to manage such a high priority project. The Navy was especially concerned about his family members still living in Germany. Joe's mother had immigrated to the US in 1890, and still had relatives there. Joe joked that the Navy found relatives he didn't know he had.

After several days of intense questioning about every aspect of his life Joe said he was done and wanted out of the program. His interrogators told him he was in, that he was cleared, and he should return to Dayton and begin his assignment.

Back in Dayton, Joe quickly learned that the proper clearance was just one step. He would have a plainclothes detail outside his house who would follow him wherever he went. Also, Lt.Cdr. Ralph Meader, the Navy Project Manager, would be quartered in his house because his house was to be made highly secure and Meader needed the security as much as Joe. This was especially tough on the young couple since the house was a two bedroom Tudor cottage. Further, since it was so secure, visiting military and professionals coming to NCR for briefings on the bombe stayed with Desch and slept on the floor. Even Alan Turning, head of the Bletchly Park decryption project slept on the floor. And Dorothy Desch provided breakfast for whomever was there.

Almost instantly, Desch's laboratory staff jumped from 20 to almost 1,000. The lab moved to Building 26 and was named the US Naval Computing Machine Laboratory. The building was converted into a top secret assembly plant for the NCR Bombe. Marine guards patrolled the building and roof, and secrets were kept. The decision to go forward with the NCR design meant that the officials at the code breaking compound in Washington were tasked with coordinating the bombe

construction project, and was the reason that Joe and Dorothy had such a flow of visitors from Washington. The Naval Annex at the former Mount Vernon Seminary was the new home for OP-20-G-M, a top secret “research” group of engineers and mathematicians to work with Desch. LtCmdr Howard Engstrom, a mathematics professor from Yale took over the Enigma Project, aided by a formidable group of intellectuals from MIT, Harvard, and Yale.

This team included women as well. A number of the “research” department’s mathematicians were women. Like everyone else, the Navy was eager to find women capable of doing higher math; a field that they had long been discouraged from entering. The Naval Annex put out the word to boot camp evaluators to flag enlisted women with high aptitude in math skills.

One such woman was Louise Pearsall, a twenty two year old from Elgin IL. Louise wanted to become an actuary and was accepted to the University of Iowa where she was the only woman in many of her classes. After two years her family could no longer afford the tuition, so she enlisted in the Navy expecting to become an officer. The Women Accepted for Volunteer Emergency Service (WAVES) used Smith College in Northampton, MA as a training facility for its officer candidates and Louise looked forward to being accepted. She wanted to be back on a campus. The positions filled very quickly and Louise, along with other educated women,

went into the Navy as ordinary seamen. She was given specialized training in communications, but due to having a hearing dyslexia, she was diverted to the Enigma Project at the Naval Annex. There, she was assigned to work for John Howard of MIT. As the design for the NCR bombe was refined, it was Louise's job to sit at a desk and do what the bombe would ultimately do much faster: test 4 rotor Enigma settings. The work was intense, but for her it was utterly absorbing.

A side note here: Louise Pearsall was considered too valuable to continue as an enlisted person handling the sensitive information she routinely did. So, in late 1943, she got her wish and was finally sent to Smith College for officer candidate school.

WAVES with technical aptitude and good dexterity were also being sought out by evaluators to work in manufacturing the bombes being built in Building 26.

Specifically, the rotor wheels on each bombe had to be built and wired with hundreds of solder joints in each one. These women were destined to be a critical part of the task of breaking the German Enigma codes.

In April, 1943, 600 WAVES boarded a train at midnight in Washington's Union Station under sealed orders. The women knew only that they were headed west. Some were entertaining visions of the California sun and beaches, but when they reached their destination it was another Union Station; in Dayton, Ohio. The

women left the train, formed up, and boarded buses for the short trip to their new home at a place called Sugar Camp, at the south edge of Dayton not far from the sprawling NCR complex. Sugar Camp began life as an actual maple sugar camp but was now owned by NCR as a training facility for its sales force. Cabins, dining facilities, recreation facilities and meeting spaces were all there. The presence of the WAVES billeted on the property was no secret to the people of Dayton, but the reason they were there was certainly nobody's business. Several times per day groups of smartly uniformed women marched to and from Sugar Camp and Building 26. The public was told they were there to "take courses in the operation of special accounting machines." Some of the women thought the people of Dayton must think they were remarkably stupid to spend a whole summer learning how to use an accounting machine.

Now Joe had all of the elements needed to begin production of the 4 rotor code breaker, except time.

At the beginning of 1943, two prototype machines were built and named Adam and Eve. These machines were not elegant. They weighed over 2 tons, had 64 rotors spinning at 2000 rpm, and each rotor had hundreds of solder joints that had to be precisely done. These rotors failed frequently due to oil leaking into the rotor, metal dust shorting out a circuit, or just plain fatigue on the rotor body. The

pressure on Joe and the team was enormous. LtCmdr. Meader constantly reminded Joe that the U-boats were sinking our ships and killing our sailors and soldiers. After one especially tense meeting with Meader and top-ranking Navy officials Joe reportedly came out of the room and got up on a table and began shouting that everybody had to start working harder and faster to get the machine out. The pressure was practically killing him. Meader had found an effective, and ultimately devastating tool to motivate Desch; GUILT. And to make matters worse, Lt.Cmdr. Meader was not only present all day with Joe in Building 26, but he slept in Joe's two bedroom house every night. He could not get rid of the guy, and he just about lost his mind.

Joe told his daughter long after the war that he had felt so much anguish over the sailors who were drowning in the Atlantic while he was trying to build his machine, that he believed his very soul was in jeopardy. "This was the Catholic in him; he felt like he was in a constant state of mortal sin, so he stopped going to church." she said.

On May 24, 1943 the first breakthrough occurred.

In a secure room in Bldg.26, Phil Bochicchio, one of the project engineers, was conducting a test of Adam with a recent German intercepted message when its high pitched whine suddenly died and the machine shut off. At first the engineer

thought it was another short in the tempermental machine. Then, as it was designed to do, the Bombe came back to life and slowly began to rewind to the “hit” position and printed out the rotor settings for the “hit”. The message was then fed into “Eve” and got the same result.

The decoded settings were sent through Louise Pearsall’s group at Naval Intelligence in Washington where the code breakers could hardly believe their good fortune. The rotor settings enabled them to unscramble a series of intercepted German radio messages over the next two weeks revealing that the Germans were moving 17 submarines to attack a west bound Allied convoy, code named GUS-7A. Messages went out alerting the convoy command to take defensive measures.

On June 5, 1943, planes from the carrier USS Bogue escorting the GUS-7A convoy took off with reliable intelligence in locating a line of 17 U-boats lying in ambush for the west bound convoy. Lt “Goose” McAuslun flying his TBF Avenger and Lt Richard S. Rogers in his F4F Wildcat were patrolling 70 miles away from the convoy when McAuslun spotted the U-217 cruising on the surface 7 miles distant. McAuslun signaled Rogers who instantly banked and went in for the attack strafing the sub’s deck. McAuslun following behind dropped 4 depth bombs from a height of 75 feet lifting the sub out of the water splitting the hull. It sank in 33 seconds. This marked the first time the Navy had sunk a submarine in a purely

offensive action. The previous day pilots from the Bogue using the same intelligence from Building 26 damaged and scattered three other U-boats. Naval historians say those two days marked a turning point in the Battle of the Atlantic. A message was sent back to Building 26 from Nebraska Ave. congratulating the team and stating that if the machine does nothing more, it has more than paid for itself. But there was no time to celebrate.

Even in this late stage of development, the NCR engineers were struggling with the machine's most basic part. The large rotors seemed destined to overheat, lose their shape and create faulty signals. As quick fixes were made to those parts, the metal sensing brushes were shedding small metal particles causing short circuits, and oil leaks were also causing problems with reliability. Those problems raised such fears about the production model's design that assembly was halted. And the news was so grave that all message processing at Dayton was suspended. And, the news would get worse for Joe Desch and his team before it got better.

On June 18, 1943 an order came from Naval Intelligence that seemed unreal. The Navy wanted a whole new Bombe design, with an automatic method of switching rotors and a greater machine speeds; and with no delays in production! I am sure something like the phrase "The impossible we do immediately; miracles take a little longer." went through Joe's mind. The Navy wanted a machine approaching

the complexity of a modern computer. Joe knew that electronic digital processing was the future for computers, but he knew the limits of industrial production, and he realized it would take years to get such a machine into operation.

He protested to Meader, who usually went along with what his naval superiors wanted. This time Meader supported Desch. The Navy had little choice but to continue with the program. But it was Desch's darkest hour. Joe, being the practical engineer that he was, made a discovery that running the bakelite wheels at high speed caused invisible distortions leading to false electrical contacts. Desch predicted that careful storage, handling and refurbishing would solve the problem. Again, the Navy trusted his judgement and the project was spared.

Certainly it wasn't too late for the NCR bombe to help pave the way for the D-Day invasion that would shorten the war. According to Naval Historian Colin Burke, "The alternative methods that the British were using had failed against the four rotor Enigma. The only thing that could keep things moving as far as Enigma intelligence was concerned was the NCR bombe.

In the fall of 1943, although no one knew for certain that the NCR bombes would work in the long run, Lt.Cmdr. Meader decided to ship the first of the 120 machines to Washington before testing was complete. A covered access ramp was built from Building 26 to the nearby B&O rail spur behind the building through

which the machines would be moved to waiting flat cars for shipment to Washington. The first load was moved in the dead of night under the watchful eyes of the Marine guards and sent on its way. Staff members were being transferred to Washington from Dayton. Certain Navy officers, including Engstrom, were the first to move, in order to set up the first machines to be shipped to be ready for productive code breaking. They were followed by a squad of WAVES who could be released from the manufacturing process and transferred to the operations side of code breaking. Some officers and staff remained in Dayton to turn their attention to new problems, including the possibility of changes to the bombe design, or changes to the German encryption systems.

By the end of 1943, the Washington installation was on a par with Bletchly Park and able to decrypt messages faster than the British. The US bombes were contributing to ULTRA, and the longtime “operatives” in England could no longer ignore the contributions of their “colonial cousins”. By October, 1943, 7 U-boats were sunk for every Allied merchant vessel lost. All hands were needed for the run-up to the long anticipated opening of the second front in Europe.

With the decrease in U-boat activities in the Atlantic, the Nebraska Ave. group turned their attention to German Air Force messages. The Luftwaffe was still using

three rotor Enigmas and there was so much traffic from this source that the British were thankful for the help from the US.

Still, hundreds of WAVES continued working in Building 26 producing the critical parts of the NCR bombs still being built and shipped under the Navy contract to Nebraska Ave in Washington. Without the women in Building 26, it is doubtful that the schedule of manufacture, could have been met.

But, it was not all work and no play for the WAVES. They did get liberty and would take the bus into downtown Dayton to have lunch at Rike's Department Store Tea Room, or dinner at the Van Cleve Hotel and a relaxing evening. Airmen from the Army Air Corps stationed at Wright Patterson Air Base in Dayton took note of the WAVES presence making downtown Dayton a lively place. Many made the trip to Beverly Hills Supper Club in Southgate, KY, where the dollar shrimp cocktails were the big hit. The women had a softball team, played the piano, sang, and the Sugar Camp swimming pool was well used. Betty Bemis, a champion swimmer, worked out at the pool, sometimes with spectators that once included Orville Wright.

Following the successful completion of the bombs, Desch turned his attention to applying the technology gained in building the machines to breaking the Japanese codes. Re-visiting the concept of MIT's Bush Comparator, an early attempt to

build an electronic computer that Joe had worked on before the war, Desch's group built an all electronic code breaking machine known as Copperhead and a series of electronic analogs of the Japanese encryption machines. These machines named Viper and Python were steps on the road to building the electronic versions of the bombes that had been proposed in 1942 and resulted in a machine named Rattler which was a significant engineering achievement.

In November 1944, Desch knew as he handed the decoded message to the WAVE in charge of sending secret dispatches to Washington, that its contents would mean the deaths of thousands of defenseless men. The message requested air escort for two convoys transporting the Japanese 23rd Infantry Division from Manchuria to Luzon. It gave their precise location. US Navy submarines would be lying in wait to destroy the convoys before they could land reinforcements to continue the fight in the Philippines. This upset Joe so much that he walked out of Building 26 vowing never to come back. He somehow felt responsible for all those deaths.

He drove out to a friend's farm near Xenia, followed by his security detail, and set himself to work doing the Zen-like task of splitting wood. For six weeks he drove out to the farm almost every day to split wood, suffering from the emotional collapse he was going through. Finally, a Navy officer from Washington went to the farm and pleaded with him to come back to work. His country needed him.

Only he had the expertise to solve some problems that had arisen in cracking the Japanese codes. He just had to come back.

He agreed to come back on the condition that his hours would be limited, and that Lt.Cmdr. Meader be moved out of his house. The Navy agreed to the hours, but Meader would stay.

The NCR group also continued to work on the German codes in response to special requests to build modifications to the bombs by adding electronics and very sophisticated logic to produce advanced electronic machines known as Duenna and Bulldog. While the initial problem was the Battle of the Atlantic, the later support of the D-Day activities and the Pacific Theater of operations certainly helped shorten the war. The NCR team was at the top of their game.

As the war ended, three years of intense war work left Desch drained. At the completion of the Navy contract, the president of NCR, Stanley Allyn, no longer wished to pursue government work, leaving the Naval Computing Machine Laboratory team without a home. The Navy decided that the team was too valuable to allow it to disband, so Meader and Engstrom founded Engineering Research Associates and set up shop in Minneapolis. Desch and Bob Mumma remained with NCR in Dayton.

A source of pride for Joe was being given the Medal of Merit in 1947 by President Harry Truman, despite the fact that he could not discuss it. It recognized “Such civilians of the nations prosecuting the war... as having distinguished themselves by exceptionally meritorious conduct in the performance of outstanding services in the furtherance and prosecution of the war.”

In 1952, NCR promoted Joe to vice president for electrical engineering, and Bob Mumma became director of the research lab. Over the next 20 years their work developed new technologies that brought NCR’s lines of business machines into the digital age.

Joe’s wife Dorothy died in 1971, and he retired from NCR in January 1972.

Joe died at the age of 80 on August 3, 1987.

Unfortunately, the efforts of OP-20-G were not publically recognized in the years immediately following the end of the war. Even after the 1968 revelation of the work at Bletchley Park, and the publication of *The Ultra Secret* in 1974, no mention of the work done at NCR was published. Reports from the Signal Intelligence Service left the impression that the code breaking efforts of World War II were almost totally in the hands of the British. Even NCR made no mention of their work listing only rocket motors, analog computer bombsights, and the Chandler-Evans bombsight used on the B-29 bombers as some of the contributions

by the company to the war effort. It wasn't until the NCR Bombe story was declassified in 1992, and a reunion of the WAVES and NCR engineers was held in Dayton in 1995 that their contribution became public.

During the war 120 NCR bombe machines were installed at Nebraska Ave. and the U.S. took responsibility for decoding the majority of the German Enigma messages according to the Crypto Museum website. All but one of the bombes were destroyed after the war. The last one is on display at the National Cryptologic Museum at Fort Meade, Md.

By the end of 1946, any traces of the bombe were removed from Building 26 and taken to some vacant property across Stewart St.... and buried in a ditch.

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SOURCE MATERIAL

The US Bombes, NCR, Joseph Desch, and 600 WAVES: The First Reunion of the US Naval Computing Machine Laboratory.

John A. N. Lee , Colin Burke, Deborah Anderson

IEEE Annals of the History of Computing July-September, 2000

The Code Girls By Liza Mundy Hachett Books October, 2017

Dayton's Code Breakers Jim DeBrosse Dayton Daily News Feb. 25, 2001

Bletchley Park Remembers the Polish Code Breakers BBC News July 14, 2011

United States Naval Computing Machine Laboratory Wikipedia