The History of Cryptology: The Dialect of Deceit

Kristof Marsolais

San Jose State University

Abstract

This is a paper about the history of the art of codebreaking, those who helped in that endeavor, and how they were rewarded for their efforts. Their accomplishments signify an important impact upon society whether it was unlocking languages and writings that were thought to be dead, developing the fundamentals of science and technology or sometimes saving the civilization that relied on their services. If these individuals had not done their work, we would have lost a language, delayed the progress of civilization and lost vast empires due to massive amount of spoliation that would have occurred without their deeds. Their work and their stories are one of complex coding.

The history of Cryptology is a fascinating one. It is a clever game of deception often using repeating patterns and puzzles that are not obvious at first glance. I wanted to talk about the history of the art because it is a fascinating subject that has always been interesting to me, but I was always impatient with the actual process of decoding secret messages. The best way for me to start the analysis of the history of cryptology and codebreaking is with one of the earliest known sources of a language we considered dead: The Egyptian Hieroglyphics on the Rosetta Stone. I will also talk about the individuals who went out of their way to analyze the meanings behind the material on those old pieces of evidence. The profession itself did not start in that time, and following that subject I will briefly talk about the origin of the codebreaking behavior that started in the Golden Age of Islam. I will also mention the individuals who started the entire cycle of the code-breaking methods and analogies. When it comes to preserving the British Empire against a supposedly intimidating German army, there were a few codebreakers who helped remove the illusion of that threat to the Admiralty that I will have to discuss. Their methods and mindsets lead to the invention of one of the most significant technologies of our time, the computer. I will discuss how some of these codebreakers were rewarded for their efforts in their profession. I will then conclude the paper with some final assessments and opinions of the profession itself. While the codebreakers of our time period made extraordinary discoveries and improved the knowledge of the profession greatly, their renown was often posthumous due to their eccentric behavior that was not understood by the societies that they lived in at that time.

The earliest known source of Cryptology goes as far as Ancient Egypt. “Egyptian scribes often used nonstandard hieroglyphs while inscribing clay tablets; this is the first documented use

of written cryptography" (Whitman & Mattord, 2017, p. 451). The writing of the hieroglyphics was not used in a phonetic sense that we use in the English language today. It was more a visual depiction of characters such as you would see in Mandarin Chinese whether it is simplified or traditional. How did we know about this? Ironically, the discovery was processed in the way of all imperialists during the industrial era: construction in other people's territory. "According to one account it was found lying on the ground, and according to another it was built into a very old wall, which a company of French soldiers had been ordered to remove in order to make way for the foundations of an addition to the fort, afterwards known as "Fort St. Julien." (Wallace Budge, 2015). Let that settle in for a second – they discovered one of the oldest pieces of history by accident and almost destroyed it. It is a small miracle that they recovered it and it gave us a significant source of information. The stone contained both Greek and Egyptian characters. "The EGYPTIAN portion of it is cut upon it in: I. the HIEROGLYPHIC CHARACTER, that is to say, in the old picture writing which was employed from the earliest dynasties in making copies of the Book of the Dead, and in nearly all state and ceremonial documents that were intended to be seen by the public; and II. the DEMOTIC CHARACTER, that is to say, the conventional, abbreviated and modified form of the HIERATIC character, or cursive form of hieroglyphic writing, which was in use in the Ptolemaïc Period" (Wallace Budge, 2015). That is a significant amount of information to store on a stone and I have not even mentioned the content that was recovered on the Greek side of it yet. "The GREEK portion of the inscription is cut in ordinary uncials. The hieroglyphic text consists of 14 lines only, and these correspond to the last 28 lines of the Greek text. The Demotic text consists of 32 lines, the first 14 being imperfect at the beginnings, and the Greek text consists of 54 lines, the last 26 being imperfect at the ends" (Wallace Budge, 2015). Keep in mind this stone is approximately the size of a Sunfish. The

actual size of the Rosetta stone is created out of a slab-shaped black basalt which is shaped irregularly and is 3 feet 9 inches in length, 2 feet 4-1/2 inches in width, and 11 inches in thickness (Wallace Budge, 2015). The process of decryption without the Greek characters for reference would have taken a significant amount of time to solve or would have left them with just mere interpretation rather than actual knowledge of what the text aims to convey. Even with this source available the process took years and many debates were had on what the material of the Rosetta stone initially said or meant. The initial translation took a significant amount of time and three individual scholars outshone others when it came to knowledge about the black basalt stone. The first one was Dr Thomas Young, who had discovered a phonetic connection with the Egyptian characters and was able to create an alphabet with those given characters (Wallace Budge, 2015). His work paved the way where others could not; he was successful in deciphering the names of both Ptolmeny on the slab and Berenice on another monument (Wallace Budge, 2015). What should also be noted is that the Rosetta Stone was not the only object used for deciphering the hieroglyphics and Greek translation. In 1815, the Philae obelisk was obtained by Mr William John Banks who also did some deciphering of his own specifically discovering the name “Cleopatra” on the granite structure. It was in the year of 1822 that both the work of W. J. Banks and Thomas Young would be improved and finalized by the Egyptologist Jean-François Champollion who used their work and “correctly deciphered the hieroglyphic forms of the names and titles of most of the Roman Emperors, and drew up a classified list of Egyptian hieroglyphs, and formulated a system of grammar and general decipherment which is the foundation whereon all later Egyptologists have worked.” (Wallace Budge, 2015). This was a significant improvement as he was able to connect the Greek names that Egyptians used and also came to the conclusion that the translation of the entire language required the knowledge of current

variant of Egyptian still alive during that time: Coptic. “Now Coptic is only a name meaning “Egyptian.” The Egyptians who embraced Christianity after the preaching of Saint Mark at Alexandria are called “Copts,” and the translations of the Holy Scriptures, Liturgies, etc., which they made from Greek into their native Egyptian language soon after their conversion to Christianity, are said to be written in “Coptic.” The knowledge of Coptic has never been lost, and a comparatively large sacred literature has always been available in manuscripts for study by scholars” (Wallace Budge, 2015). This knowledge helped Champollion greatly as he used his knowledge of Coptic writing to fill in the gaps he noticed with Young’s and W. J. Banks work earlier. With all of these sources available, Champollion was able to find a pattern within both of the given sources and developed a pattern and resurrected a writing style that was thought to have been lost.

The credit for the profession of Cryptology and codebreaking has been debated with many scientists and scholars, but there is a significant amount of evidence to support a that it started with two individuals from the Arab culture. “The following cryptologists are known to have used statistics and probability in one form or the other. Among the first is al-Khalil (718-786) who wrote the Book of Cryptographic Messages (the book is considered lost) which contains many "firsts," including the use of permutations and combinations to list all possible Arabic words with and without vowels”. (Broemeling, 2011). If that book were ever to be recovered, it might contain the first formulas and patterns that every cryptologist and codebreaker would have developed and improved upon. Fortunately, there was some merit to his ideas as the most successful cryptologist probably learned something from this individual. His name was al-Kindi and he was most likely the father of Cryptology. He was born in 801 C.E. and his childhood years were spent in Baghdad. He had a significant amount of academic merits and

mastered the concepts of “philosophy, astronomy, medicine, linguistics, mathematics, statistics, and music” (Broemeling, 2011). As if that was not enough to impress individuals during that time period, he left a significant amount of literature and written works behind in all of those fields. What he contributed to the codebreaker field was cryptanalysis techniques, cipher types, phonetics, syntax, and computational linguistics (Broemeling, 2011). His methods and strategies were probably used by the Egyptologists who discovered the language and meaning of the Rosetta Stone and the Philae obelisk. One of his most commonly referenced methods of ciphering is substitution ciphering. “Thus, the frequency analysis of al-Kindi is based on a relative frequency table of the 28 letters of Arabic, and the cryptanalysis of the encrypted message is accomplished by matching the letters with the same relative frequencies between those determined by a sample from the source language and the relative frequencies of the letters of the cryptogram” (Broemeling, 2011).

If we were to apply this to the discovery of the ancient Egyptian language on the Rosetta Stone and Philae obelisk, the method they would use is to look for the similar pictographic characters on the stones themselves. They would decipher what the most common characters on the samples were and then look for the second most common characters on the stones. Once they did that they would look for the third most common character on the stones and the process would continue for a significant time. There is a flaw with this method when it comes to decrypting a message or language using this method because the practice requires a significant sample size. In the words of al Kindi, he stated: “It could happen sometimes that the cryptogram is too short to have all different letters. The high and low counts will not be correct, for high and low counts are only correct in long enough messages to correspond to all places of frequent and rare occurrences so that if some letters are (too) few in one segment of the message, they will be

(too) many in some others. But if the cryptogram is too short, equivalence does not apply, letter ranks are not correct, and a second trick should be used to recover letters" (Broemeling, 2011). The good news with the stones that the Egyptologists had studied was the fact that all the characters were available on the sample size. They also had two alphabets to work with which helped the decoding process because they were able to use the ancient Greek dialogue as a reference to the Egyptian pictograms. Champollion's knowledge of Coptic also confirmed what the Rosetta Stone was: A declaration. More specifically, this was a declaration to commemorate Ptolemy V, Epiphanes, the King of Egypt at the time in 196 B.C.E. It is highly plausible that the Egyptian Language and knowledge of the Hieroglyphics were combined with the use of some of al-Kindi's methods if not all of them. Even the author Lyle D. Bromeling who wrote about al-Kindi stated that was likely the case. "One of the earliest references to statistical inference is found in the Pascal and Fermât (1654) correspondence. It is interesting, however, to observe that the standard texts on the history of statistics do not mention Arab contributions" (Broemeling, 2011). It is unfortunate that we seem to have forgotten about the accomplishments that the Golden Age of Islam brought to the field of codebreaking. The 21st century began with controversy attached to the 9/11 attacks and the media erupted with Islamophobic remarks. I remember when I went to school that day that kids were fighting during lunch hour over religious beliefs. When I went on my computer, I tried to avoid surfing the web to avoid any of the negative media attached. Speaking of computers, there is another individual that we should talk about.

Another Englishman made groundbreaking achievements in Cryptology. Alan Turing only recently acquired renown and credibility in his profession after being posthumously pardoned for his act of homosexuality during a time when it was still illegal. His accomplishment

to the field is extraordinary because the work he produced not only generated a new thinking pattern, but also led to the invention of mankind's most popular technology: the computer. He stated: 'We have said that the computable numbers are those whose decimals are calculable by finite means. This requires rather more explicit definition. No real attempt will be made to justify the definitions given until we reach 9 pounds. For the present I shall only say that the justification lies in the fact that the human memory is necessarily limited' (Newman 1955). To counter with the lack of human memory required for such tedious tasks such as finding the complete number of π or to generate relative frequency characters in a code much like al-Kindi did manually, this device would take care of those given tedious tasks if instructed to (Newman 1955). This was the concept that would help Alan Turing break the code of the Enigma Naval Codes, but there was a machine that he would need to use in order do so. With his blueprints in mind, an engineer named Harold Keen installed the bombe machine with the specifications that Alan Turing requested, and the process to break the Enigma code began. The need for this machine stemmed from the Enigma Machine's ability to reset the code pattern every 24 hours. Despite Alan's brilliant method for the design and intricacies of the machine, there was a significant improvement that even his expanded database of information could not calculate. This was where a renowned cryptanalyst equivalent to Alan Turing known as Gordon Welchman came in with a significant discovery: "A bombe did not magically tell BO's cryptanalysts how Enigma operators on a German communication network were setting up their machines before they encrypted a message. It simply eliminated enough of the 158.9 million, million, million possible ways they could have done it to allow the actual settings to be worked out using hand methods" (Greenberg, 2014). He realized that there was a way that he could have fixed it and in his stroke of genius he wrote the following: "When this new method of interconnecting the

scramblers came to me, I couldn't believe it. But I sat down with a few colored pencils, drew a simple wiring diagram, and convinced myself that the idea would indeed work. Armed with this diagram I hurried once again to the Cottage, this time to talk to Turing. On this occasion I had a better reception than I had received from Dilly. Turing was incredulous at first, as I had been, but when he had studied my diagram he agreed that the idea would work and became as excited about it as I was. He agreed that the improvement over the type of the Bombe that he had been considering was spectacular" (Greenberg, 2014). Even though this improvement had significant benefits to the machine and the way the process worked, there was still a significant amount of information and probabilities that had to be considered. A significant issue came with the 'stops' that the Bombe machine had. The idea behind the Bombe stops is that certain German letters would be revealed in the probability cipher process. Each stop had to be checked because the Bombe machine still stopped occasionally by chance (Hodges, 2014, p. 299). This could a take a significant amount to prove if the German letter was correct. Keep in mind the daily reset meant that they would have to reprogram the Bombe to adjust to the changes. Assuming that they were able to generate words, there was also the issue of repeating words which could throw the code breakers of the trail. They did have repeating words in the messages and sometimes mixed up structures which could make deciphering the message incredibly difficult. It did not matter though if they had managed to successfully decode an entire sentence in the machine. What was needed was the entire message or statement that could be found inside the Naval Enigma codes. Not having that information was damning to the crew until a significant piece had entered the playing field: perforated sheets from France. They had received information that perforated sheets from French cryptanalysts at Vinolles would provide answers for an Enigma code that was brought to Bletchley park with more to follow (Hodges, 2014, p. 301). This would lead to having

to split up the codebreaking teams into different sections to focus on the different enigmas. Gordon Welchman ;as placed in charge in Hut 6 and was responsible for the Airforce and Army Enigma machines, Dillwyn Nox who was also a cryptanalyst was in charge of the Italian Enigma signals and the German Intelligence one, and Alan Turing was given charge of the Naval Enigma inside of hut 8 (Hodges, 2014, p. 303). By reading the previous sentence alone it sounds like Alan Turing had less work and some would guess that meant less pressure to figure out the code; unfortunately this was not the case. The German Navy consisted mostly of U-Boats which were underwater and difficult to trace and despite the knowledge and existence of their deployment in battle, there was significant pressure to figure out the naval patterns of the U-Boats. One of the reasons for this pressure came directly from the Admiralty. The British for the longest time held naval supremacy in the world and brute force and numbers was a tactic that worked for them for a very long period of time. Unfortunately, in the post-industrial era that was not the only method that they could rely upon and they needed to add intelligence into their tactics because of the technology of U-Boats. The second element of pressure came in the form of Britain itself. Because the Country was an island, knowing where the enemy was impacted the trade and travel of goods that went to the people of Britain. Not being able to leave your country or provide resources because you were risking an attack from the underwater German Navy had severe consequences on morale. Alan Turing was not just cracking the Naval Enigma codes, he was opening the gates to bring calm and relief to the heartland of the British people. The morale of the British people were also in dire straits because of the bluff tactics that Germany employed when using their U-Boat scare tactics: “One factor alone weighted against the probability of German victory in the naval war. The U-boat force, so phenomenally successful in 1917, had not been built up in time for 1939. The Bluffin over Danzig had meant that Hitler blundered into a

war while Donitz commanded less than sixty submarines. Short sighted strategy would keep the numbers at this level until late 1941" (Hodges, 2014, p. 313). In June 1940, there was a significant addition to the Hut 8 team who is renowned for her work on the Enigma machine. Joan Clarke was recruited by Gordon Welchman and was sent to work with Alan Turing in Hut 8 to work with the Naval Enigma Code. This was a significant occurrence because women were not commonly hired in the cryptology profession.

Before I continue to talk about Joan Clarke, I should mention the first female cryptologist in history or more specifically in the United States of America. Her name is Elizabeth Smith Friedman. She with her husband William F Friedman were cryptologists who were assigned to figure out the mystery of Mrs. Gallup's Bacon cipher theory (Grimes, 2017). The scenario was laid out in an article on the New York Times: "Mr. Fabyan subscribed to the popular theory that Francis Bacon had written the works attributed to Shakespeare and had embedded coded clues to that effect in the First Folio and other texts" (Grimes, 2017). The couple debunked that theory and wrote an entire book about it called *The Shakespearean Ciphers Examined*. They indicated that Mrs. Gallup's theory was impossible not only because of the method of the cipher but also because the technology and writing style of the time period would not support that method of communication (Kahn, 1996, p. 888). She has done a variety of other work including deciphering messages from Rum runners for various departments including the Bureau of Prohibition and Customs (Kahn, 1967, p. 806).

Moving back to Joan Clarke in the Enigma codebreaking team, her work with Alan Turing was a unique experience that often is misunderstood. Her work was exemplary and on many different occasions she helped Alan Turing generate ideas for deciphering the Naval Enigma codes. When they were not working on the Enigma, they often saw each in a platonic

way, at least until Alan Turing decided to propose to her (Hodges, 2014, p. 333). She was of course thrilled and was excited for the notion since she like Turing was an intellectual individual rather than a physical one. Their relationship was a difficult one and his doubts started showing when he had to tell her about his homosexuality. Surprisingly she did not care about that and was willingly okay with his sexual preferences. They would eventually call it of and they would continue to remain friends even after the war.

Hugh Alexander, another cryptanalyst, thought that Alan's Work was essential and critical to the entire operation at Bletchley Park. He stated: "It is always difficult to say that anyone is absolutely indispensable but if anyone was indispensable to Hut 8 it was Turing. The pioneer work always tends to be forgotten when experience and routine later make everything seem easy and many of us in Hut 8 felt that the magnitude of Turing's contribution was never fully realized by the outside world" (Alexander, 1945). In 1952 Alan Turing was charged with "Gross Indecency contrary to Section 11 of the Criminal Law Amendment Act of 1885" (Hodges, 2014, p. 715). He was given two options by the court of England: Hormonal therapy which reduced libido, or jail time. He chose the former and the results of the chemical castration had a significant impact on his thinking pattern. He died on June 7 1954 by supposedly killing himself. There were no common indicators or warnings to support that theory. It seemed that the death of Turing was unexplained in the psychological format because of his behavior patterns prior to the years after his trial (Hodges, 2014, p. 736). His hormonal treatment had ended a year before and he seemed to have gotten through with it with little to no side effects. He was not the type of individual who would attempt suicide.

Alan Turing was not the only individual who committed an act of "Gross Indecency" that led to his credibility being lost and almost forgotten. William John Banks, who I mentioned

earlier was one of the Egyptologists who helped decipher the hieroglyphics on the Philae obelisk, also committed an act of "Gross Indecency". According to Norton, this was how they handled it: "In 1833 Bankes was arrested for engaging in indecent behavior with a soldier in a urinal outside the Houses of Parliament. He said his actions had been misconstrued and he denied the charges. Many noblemen, including the Duke of Wellington, testified to his good character. When the principal witness set sail for America and failed to appear, Bankes was acquitted. Bankes retired from public life, and concentrated on renovating Kingston Lacy" (Norton, 2015). In 1833 as long, you had a significant amount of money, friends in high places, and a great amount of luck, you could get out of a crime, including one that had the death penalty attached to it. Alan Turing did not enjoy this level of privilege even though he saved the country from falling into Nazi hands. Instead of giving him probation like they did with his lover Alan Murray, the British Government gave him a choice of hormonal therapy over jail time which is not much of a choice. William John Bankes committed additional acts of indecency: "Everything went well until 1841, when Bankes was again arrested for indecent behavior with a guardsman, this time in Green Park, near Wellington Barracks. On this occasion Bankes forfeited a £5,000 bond of recognizance and fled the country" (Norton, 2015). He was at risk of losing his properties to the kingdom after pulling two stunts like that, but somehow, he was smart enough to make a clever decision. "Bankes was officially declared an outlaw, but before that officially came into effect he signed over all his property to his relatives, mainly to his younger brother, so his estate could not be forfeited to the crown" (Norton, 2015). Finding two Englishmen that have committed acts of indecency and being judged by their country as criminals was not something I was expecting to find in the history of this field.

There was another Englishman who also was disowned by his country, but on a different level than the former two candidates. Gordon Welchman wrote a book about his experiences in Bletchley Park in 1982, a long time after the Engima Codes were cracked. The book was called *The Hut Six Story: Breaking the Enigma Codes*. It would be a year later that *Alan Turing: The Enigma*, had been published discussing his former colleague's life and accomplishments. He did not worry about his publication because technically he was an American citizen at the time he published his book (Greenberg, 2014). He also did not think that publishing what he did at Bletchley Park in the United States would be considered an act of treason or make any negative relationships with the public. His assumptions were wrong, and the following event took place: "On 20 April, Welchman was visited at his home by two USAD special agents and an NSA representative. Much to his surprise, he was told that the ideas that had occurred to him in the first three months of the Second World War were still regarded as classified in the USA" (Greenberg, 2014). He did not think the consequences would be too severe because of his reputation despite the fact that the Corporate Security Officer of MITRE (who he had met the following day) had received news about a letter from the top security man at the US Department of Defense that had been sent to his MITRE President about the severe controversy of his publication (Greenberg, 2014). There was even an interview that Gordon Welchman had on April 22, 1982 where he gave a testimony along with his lawyer present, about how he felt about his publishing and how strongly he felt about submitting his work to the public eye. The interviewers were so sympathetic with his account and how he felt about the entire situation they genuinely believed by the end of his interview that he had acted "with good reason, to be in the best in the interests of US national security" (Greenberg, 2014) and even autographed one of the interviewer's copies of his book. He was told that a decision about the charges being made by the

United States government would be made by May 6 1982, but was caught off guard when his security clearance was rescinded on April 29, 1982 and that if he wanted to continue his work at MITRE, he would have to do so with a security escort which made work excruciatingly difficult (Greenberg, 2014). He was never able to receive trust from the government agencies again and died on October 8, 1985 at the age of 79. Something that I read in the Greenberg text that stood out to me was the story about how Gordon Welchman had supposedly almost lost credit for his diagonal board due to a bureaucratic discrepancy between a superior named “Willy” who did not want him to have the credit for some reason. Apparently after the war, he did not receive credit for his invention but rather Harold Keen (the engineer who constructed the machine) had received the award that was intended for Welchman (Greenberg, 2014). I am not sure about the authenticity of this story, but I surely know that he was the individual who designed it because Andrew Hodges also gave credit to Welchman for the design in his autobiography of Alan Turing. I mentioned it earlier when talking about it in the section about the Bombe mechanics. Even Hugh Alexander mentioned that Welchman had a part to play as he stated: “There should be no question in anyone's mind that Turing's work was the biggest factor in Hut 8's success. In the early days he was the only cryptographer who thought the problem worth tackling and not only was he primarily responsible for the main theoretical work within the Hut (particularly the developing of a satisfactory scoring technique for dealing with Banburismus) but he also shared with Welchman and Keen the chief credit for the invention of the Bombe” (Alexander, 1945).

If there is anything that I took from this entire lesson of the history of codebreakers, it’s that they often do not receive the credit for their actions until much later in their life or posthumously. There are a few exceptions with that being Joan Clarke (or Murray if using her married name) and Elizabeth Smith Friedman with her work with her husband. Otherwise the

rest of the key individuals were either punished as criminals for personal matters, accused of plagiarism, or fell out of their profession due to being losing their funding by the most recent ruler in the kingdom, as al-Kindi was (Broemeling, 2011). These codebreakers worked in societies where their more personal behaviors were frowned upon and their determination to pursue and advance our civilization despite the odds against deserve credit. We can only hope that in the future the next time we see a codebreaker or intellectual that chooses to use their time improve the security of our societies and our homes, we do what we can for them because they are likely being judged for their behaviors of a personal matter. If we decide to discredit these individuals because of what they on their personal time, then maybe we deserve to have our security and livelihoods compromised.

References

Alexander, H. C. (c. 1945). "Cryptographic History of Work on the German Naval Enigma". The National Archives, Kew, Reference HW 25/1.

Broemeling, L. (2011). An Account of Early Statistical Inference in Arab Cryptology. *The American Statistician, 65*(4), 255-257. Retrieved from http://www.jstor.org.libaccess.sjlibrary.org/stable/23339552

Grimes, W. (2017, December 21). 'Decoding the Renaissance,? at the Folger Shakespeare. Retrieved from https://www.nytimes.com/2015/02/04/arts/decoding-the-renaissance-at-the-folger-shakespeare.html?login=email&auth=login-email

Greenberg, Joel. “Gordon Welchman: Bletchley Park's Architect of Ultra Intelligence.” Amazon, Frontline Books, 2014, read.amazon.com/.

Hodges, A. (2014). *Alan Turing: The Enigma: The Book That Inspired the Film The Imitation Game - Updated Edition*. Princeton, NJ: Princeton University Press.

Kahn, D. (1967). *The Codebreakers: The Story of Secret Writing* (1st ed.). New York: The Macmillan Company.

Kahn, D. (1996). *The Codebreakers: The Comprehensive History of Secret Communication from Ancient Times to the Internet*. New York, NY: Simon & Schuster.

Newman, M. (1955). Alan Mathison Turing. 1912-1954. Biographical Memoirs of Fellows of the Royal Society, 1, 253-263. Retrieved from http://www.jstor.org.libaccess.sjlibrary.org/stable/769256

Norton, R. (2015, March 1). Homosexuality in 18th-cent. England: William Bankes. Retrieved from http://rictornorton.co.uk/eighteen/bankes1.htm

Wallace Budge, E. A. (2015, April 6). The Project Gutenberg eBook of The Rosetta Stone, by E. A. Wallis Budge. Retrieved from https://www.gutenberg.org/files/48649/48649-h/48649-h.htm

Whitman, M. E., & Mattord, H. J. (2017). Principles of Information Security. Boston, MA: Cengage Learning.