"[T]he deprofundity of multimathematical immaterialities": *Finnegans Wake* II.4 as a Parody of Mechanical Encryption

Pingta Ku

ABSTRACT

In *The French Joyce*, Geert Lernout claims that Philippe Sollers mistook *Finnegans Wake* for a Nazi-annihilating bomb. Lernout's sarcasm is remotely evocative of Alan Turing's "Bombe," a deciphering machine that accelerated the Allies' victory over the Axis. However, the connection between Joyce's and Turing's endeavors could be more than tangential: the former wrote the enigmatic *Wake* to gesture resistance to the fascist encryption of language as well as to the Nazi persecution of his allegedly schizophrenic daughter, whereas the latter constructed a *singular* machine capable of simulating any other machines and carrying out any algorithms. More explicitly speaking, the duo of contemporaries' attempts to fight against fascism resulted in two extreme solutions: Joyce celebrated the opacity of schizophrenic language and saw mental illness as uniquely human, whereas Turing invented a prototypical artificial intelligence whose digital computation pitted the material infrastructure of mathematical algorithms against the assumed immateriality of human consciousness. Therefore, this article aims to reread *Finnegans Wake* II.4 as Joyce's response to the advent of computational devices. By turning "memostinmust egotum sabcunsciously senses" of Isolde/Issy/Lucia into an ocean of encrypted free indirect speech, Joyce wards off the imminent threat of mechanical encryption.

KEYWORDS James Joyce, *Finnegans Wake*, fascism, cryptography, QWERTY, *Die Schlüsselmaschine Enigma*

Introduction

Stephen's brooding rumination in response to Mr Deasy's antisemitism—"History . . . is a nightmare from which I am trying to awake" (*U* 2.377)—resounds in our COVID-stricken world, where Poldy's anachronistic reflection on the "influenza epidemics" of 1918 strikes a sympathetic chord (*U* 6.124). While Stephen remains trapped in the eternity of Bloomsday, James Joyce ventured into another round of the vicious circle named history and semi-prophetically incorporated into Humphrey Chimpden Earwicker's whisky-induced slumber kaleidoscopic fragments of catastrophic events: "Here endeth chinchinatibus" (*FW* 367.04); "One bully son growing the goff and his twinger read out by the Nazi Priers" (*FW* 375.17-18); "*Attabom, attabom, attabombomboom!*" (*FW* 103.02). It is true that *Finnegans Wake* resembles oracle bones from the Shang dynasty and that willful readers may decrypt any desired information out of its immense ocean of data and noise. However, it is also true that Joyce's idiosyncratic encoding strategy of portmanteaux uncannily anticipates such viral hashtags on social media as "#Chinazi" and "#Xitler," which seem to blend seamlessly with his polyglottic Wakese that fuses heterogeneous languages through homophonous associations. *Finnegans Wake* often conjures up a sense of déjà vu, as if it were a textual machine relentlessly assembling, disassembling, and reassembling a colossal volume of verbal information to register past, present, and future events.

Having powered through his seventeen-year struggle with *Finnegans Wake* against the triple threat of economic depression, the aftermath of the Spanish flu, and rising fascism across the globe, Joyce died in Zürich after fleeing the Nazi occupation of Paris. Gone too soon to witness the Allies' victory over the Axis with the aid of the British "bombe" designed by Alan Turing and the Government Code and Cypher School (GC&CS) at Bletchley Park, Joyce had nonetheless inhabited a technologized world that midwifed the advent of digital computers. Both formally and content-wise, Joyce's oeuvre experiments with the triumvirate of gramophone, film, and typewriter, whose capacity for "storing and . . . separating sounds, sights, and writing," according to German media theorist Friedrich A. Kittler, "ushered in a technologizing of information that . . . paved the way for today's self-recursive stream of numbers" (*Gramophone* xl). Joyce's creation of a whimsical verbal chaosmos in response to his contemporary world plagued by misery and brutality had been criticized as self-indulgent, yet the *Wake*'s oxymoronic duality of morbid playfulness

foreruns Kittler's shrewd observation that online entertainment initially burgeoned as a by-product of the Pentagon's contingency plan for electronic and nuclear warfare:

> People will be hooked to an information channel that can be used for any medium—for the first time in history, or for its end. Once movies and music, phone calls and texts reach households via optical fiber cables, the formerly distinct media of television, radio, telephone, and mail converge, standardized by transmission frequencies and bit format. The optoelectronic channel in particular will be immune to disturbances that might randomize the pretty bit patterns behind the images and sounds. Immune, that is, to the bomb. As is well known, nuclear blasts send an electromagnetic pulse (EMP) through the usual copper cables, which would infect all connected computers. (*Gramophone* 1)

What Kittler might have failed to foresee when publishing *Gramophone, Film, Typewriter* back in 1986, however, is that social media like Facebook would evolve into effective weaponry in the virtual battlefield of information warfare where faceless cyberwarriors and algorithms could sabotage a distant state's stability by circulating fake news. The Pentagon might as well be surprised that its preemptive deployment of fiber-optic networks would be exploited by Russian hackers for "an espionage operation inside the system of the American bureaucracy" or even a "more sinister" plot to "[insert] 'backdoor' access into government agencies, major corporations, the electric grid and laboratories developing and transporting new generations of nuclear weapons" (Sanger, Perlroth, and Barnes).

Worse still, Jeffrey Herf's thesis that Nazi propaganda championed a "reactionary modernism"—which boasted "a beautiful new order replacing the formless chaos due to capitalism in a united, technologically advanced nation" (2)—finds an echo in Xi Jinping's ambition for a New Sino-centric World Order wherein "the values and norms . . . reflect . . . Chinese preferences, such as elevating the right to development over individual political and civil rights and establishing technical standards that enable state control over the flow of information" (Economy 64). When processing dire realities foreshadowing ours in *Finnegans Wake*, Joyce astoundingly forecasts a weird digitized world where actual wars and virtual games become indistinguishable, where prosthetic memories simultaneously enhance and diminish *intelligence*, where "memostinmust egotism sabcunsciously senses upers the deprofundity of multimathematical immaterialities" (*FW* 394.31-33).[1]

---

[1] The narratives of Joyce and his fellow modernists, as Sara Darius elegantly puts it, "describe a general transition from technological *prosthesis* to technological *aisthesis*" (3).

To demonstrate how *Finnegans Wake* registers the technocultural transition from the modernity of gramophone, film, and typewriter to the postmodernity of digital computers, this article will scrutinize the *Wake* with a focus on II.4, namely, the "Tristan and Isolde"-cum-"Mamalujo" episode. II.4 culminates Book II's "Viconian multi-media-mini-drama" (Theall 74), which evolves from "*The Mime of Mick, Nick and the Maggies*" (*FW* 219.18-19) to Richard Wagner's *Gesamtkunstwerk* and the cinematic version of Dion Boucicault's "Arrah-na-Poghue" (*FW* 384.34). More intriguingly, II.4 cinematographs HCE-becoming-Mark's unconscious spectacle wherein the not-so-*intelligent* quartet of Mamalujo spy and intercept the private erotica of "the big kuss of Trustan with Usolde" (*FW* 383.18).

Unlike Nazi reactionary modernists or "Chinazi" reactionary postmodernists, Joyce neither fetishizes media technology nor equates it with progress. II.4 impugns the popular belief in linear technological progress by pitting modern military *intelligence*'s machine-encrypted cipher texts against Mamalujo's senility-related anagrams, palindromes, and mumbo-jumbo. With a jocoserious touch, Joyce reduces state-of-the-art Enigma encryption to demented patients' nonsensical blather, which finds an echo in Kittler's assertion that "it was precisely at the site of madness that machines originated" (*Gramophone* 255). If we take Kittler's hint, then *Finnegans Wake*'s textual spectacle of overwhelming noises mimics how modern media technology has exposed human consciousness to nonlinguistic data that language-based communication of yore used to filter out.[2] However, Joyce's simulation of machine-encrypted cipher texts remains radically different from the Enigma code: vivaciously human, the former yearns for communication and counteracts the latter's lethal deception. The following sections will first revisit the war-devastated era where Joyce struggled through his *Work in Progress* and where the Nazis' Enigma ushered in Turing's Universal Machine, and then analyze how *Finnegans Wake*, especially II.4, simultaneously emulates and resists its contemporary techno-cultural logic of mechanical encryption.

Rejewski, Turing and Bombes that Reduce Shannon's Entropy

In his 1977 article entitled "Joyce & Co," Philippe Sollers polemicized against the then-popular depoliticized reading of Joyce, arguing that his reluctance to touch "on the subject *in a dead language*" doesn't mean he "had no political concern" (108). Apparently, by *dead language* Sollers didn't refer to such extinct languages

---

[2] Kittler contends that Sigmund Freud's "discovery" of the unconscious is inseparable from his contemporary media gadgets capable of storing visual and audio data and that the term "psychic apparatus" (*der psychischer Apparat*) per se is "already technified by its name" (*Gramophone* 38).

as British Vulgar Latin or Galwegian Gaelic. Instead, his rather idiosyncratic no-menclature here indicates any explicit references to politics with *deadly* serious-ness. Sollers puts forth a paradoxical thesis, asserting that "Joyce's refusal to in-dulge in the slightest dead pronouncement is exactly *itself* the political act, and act which explodes at the heart of the rhetorical *polis*" (108). In other words, Joyce's decision to disinvest from straightforward political discourse in the *Wake* embod-ies a dignified gesture of resistance to all ideological factions, because his opaque dream logic—wherein "*nothing remains but difference*" (108)—impugns and dis-solves both *identity* and *community*, which are the basic ingredients for fascism and communism. Sollers goes on to elaborate upon Joyce's political resistance by demonstrating how he, not unlike Sigmund Freud, pits libidinal levity against thanatopolitical gravity:

> Joyce's persistent determination to probe the religious phenomenon is proba-bly his most important political gesture. . . . Joyce represents the same ambition as Freud: to analyze two thousand years of manwomankind, and not ten or a hundred years of politics. What is monotheism? What is Christianity? What is reason? *Finnegans Wake* teems with "answers," but these answers are not of a scientific order; they come from a knowledge that will never present itself as systematic, any more than as definitively centered or serious. This is why it is a matter of the most forceful act ever accomplished against political paranoia and the overhanging weight of its deadening discourse, outside of all humor. Let me stress then that *Finnegans Wake* is the most formidably anti-fascist book produced between the two wars. (108-09)

Sollers's anti-fascist reading of Joyce was dismissed by Geert Lernout as a boastful statement almost suggesting that "copies of *Finnegans Wake* dropped over Nazi Germany would have effectively finished the National Socialist Party" (173). De-spite all the ridicule, Lernout's whimsical analogy between *Finnegans Wake* and bombs somehow redirects our attention to Joyce's contemporary cryptographic "bombe" that accelerated the Allies' victory over the Axis in reality.[3]

Now famously associated with Alan Turing and his code-breaking team at Bletchley Park, the first Bombe machine was in fact the brainchild of a group of mathematicians working for the Polish Cipher Bureau under the supervision of Marian Rejewski. As Rejewski recalls,

---

[3] Joyce's works have been associated with and mistaken for cryptography. For instance, Ezra Pound reveals in a letter to Joyce: "News item or rather phrase of conversation from ex-govt. official: 'The censorship was very much troubled by it (*Ulysses*) during the war. Thought it was all code'" (182).

When the first machine-enciphered messages appeared on the air on July 15, 1928, transmitted by a German military station, Polish radio telegraphers working at monitoring stations began to pick up the transmissions. Polish cryptologists in the German section of the Cipher Bureau received orders to undertake an attempt to decipher them. . . . To do this, knowledge of the German language was very helpful. But, as I will try to make clear later, knowledge of the *language* was not as useful as familiarities with *mathematics*.[4] (213-14; emphasis added)

Rejewski and his colleagues called their mathematical machine capable of deciphering the Enigma-encrypted German *bomba* "[f]or lack of a better name" (Rejewski 226). The naming of the Polish cryptological machine has long been an object of speculation. Patrick Mahon—who headed Hut 8 at Bletchley Park from 1944 to the end of World War II—believed that "[t]he bombe was so called because of the ticking noise it made, supposedly similar to that made by an infernal machine regulated by a clock" (291). However, rumor has it that Jerzy Różycki, Rejewski's fellow cryptologist at the Polish Cipher Bureau, named the machine after *Bombe glacée*, a French ice-cream dessert shaped like a cannonball. Indeed, the oxymoronic quirkiness of a frozen bomb may have delighted James Joyce. Better yet, the analogy between reducing temperature and decoding ciphers would point to the concept of *information entropy*, also known as *Shannon's entropy*. From this primitive Polish *bomba*, "Turing made a machine that the head of Bletchley Park not coincidentally named the Oriental Goddess: a fully automatized oracle to interpret fully automatized secret radio communication" (Kittler, *Gramophone* 256).[5]

Often unfairly overlooked by historians, Rejewski's mathematical approach to linguistic structures and encrypted communication during the 1920s is a conceptual precursor to Claude Elwood Shannon's conception of information theory

---

[4] Andrew Hodges illustrates how radio messages might be encoded into numerically encrypted numbers in aerial, naval, and mobile land warfare as follows:

In practice, the words of the message would first be encoded into numerals by means of a standard code-book. The job of the cipher clerk would then be to take this "plain-text," say 6728 5630 8923 and to take the "key" say 9620 6745 2397, and form the cipher-text 5348 1375 0210 by modular addition. For this to be of any use, however, the legitimate receiver had to know what the key was, so that it could be subtracted and the "plain-text" retrieved. There had to be some *system*, by which the "key" was agreed in advance between sender and receiver. (205)

[5] Catherine Flynn offers a detailed account of Joyce's resistance to Nazi Germany's radio propaganda in "*Finnegans Wake*'s Radio Montage: Man-Made Static, the Avant-Garde, and Collective Reading." As for how Joyce incorporated the sounds and technical aspects of the radio into the *Wake*, see Hayman, "Male Maturity" (258-64).

during the 1940s. In his seminal 1948 paper "A Mathematical Theory of Communication," Shannon (with whom Turing discussed his concept of Universal Machine at Bell Labs in 1943) introduces the measurable thermodynamic property of *entropy* to the statistical analysis of Printed English. Shannon defines entropy by the following probability function "with no dimensions, no materiality, and no necessary connection with meaning" (Hayles 52):

$$\mathrm{H}(X) = -\sum_{i=1}^{n} \mathrm{P}(x_i) \log \mathrm{P}(x_i)$$

Shannon's entropy function would later be modified by Norbert Wiener to define information (I) in the following formula: $I = -\Sigma\, p(s_i)\, [\log p(s_i)]$, "where $p(s_i)$ is the probability that the message element s_i will be selected from a message set with n elements (Σ indicates the sum of terms as i varies from 1 to n)" (Hayles 53). Shannon's and Wiener's functions both imply that information is theorized as the sum of a series of *binary choices*: $C = \log n$, where all logarithms could be considered taken to base 2 ($\log_2$). In other words, "[o]nly the probabilities of message elements enter into the equations," so that information, now taken out of context, could be treated as an entity "flow[ing] unchanged between different material substrates," be they "a brain" or "a computer" (Hayles 53-54).

It is a "strategic choice" for Shannon to define information entropy as a probability function because he "did not want to get involved in having to consider the receiver's mindset as part of the communication system" (Hayles 54). Shannon's strategy to mathematize language is clearly shown in his exposition of "entropy" and "redundancy" within English:

> The ratio of the entropy of a source to the maximum value it could have while still restricted to the same symbols will be called its *relative entropy*. This is the maximum compression possible when we encode into the same alphabet. One minus the relative entropy is the *redundancy*. The redundancy of ordinary English . . . is roughly 50%. This means that when we write English half of what we write is determined by the structure of the language and half is chosen freely. (398-99)

Simply put, lower redundancy and higher relative entropy imply a higher degree of freedom and information in vocabulary-based communication. Intriguingly enough, Shannon chooses "Basic English" and "Finigans [sic] Wake"—an opaque communication system whose semantic values highly depend on the receiver's

non-sequiturial free associations—to demonstrate two "extremes of redundancy in English prose":

> The Basic English vocabulary is limited to 850 words and the redundancy is very high. This is reflected in the expansion that occurs when a passage is translated into Basic English. Joyce on the other hand enlarges the vocabulary and is alleged to achieve a compression of semantic content. (399)

Shannon's categorizing the *Wake* under "English prose" may cause disagreement. Sam Slote, for example, contends that "*Finnegans Wake* is certainly not written *in* English. . . . Perhaps it would be safer to say that it is written *from* English as it includes many different languages" (78). Although Basic English seems much less sophisticated than *Finnegans Wake*, it is nonetheless an artificial language created by linguist and philosopher Charles Kay Ogden of the University of Cambridge in 1925. The term Basic is actually an acronym that stands for **B**ritish **A**merican **Sc**ientific **I**nternational and **C**ommercial. According to Sam Slote, "While it might seem that Ogden's aims for Basic English are the inverse of Joyce's post-Babelian *Wake*, both aim towards a universalizing ambit that begins from English. Joyce complicates English, whereas Ogden refines and simplifies it" (84). As a matter of fact, Joyce and Ogden collaborated to translate "Anna Livia" into Basic English:

Finnegans Wake	Well, you know or don't you kennet or haven't I told you every telling has a taling and that's the he and the she of it. (*FW* 213.11-12)
Basic English	Well are you conscious, or haven't you knowledge, or haven't I said it, that every story has an ending and that's the he and the she of it. (Joyce and Ogden 259)

As can been seen in the brief excerpts above, the Basic English translation irons out the polysemous pair of "kennet"—which evokes the Scottish phrase "ken it" and Kennett River in Australia (McHugh 213)—and "taling"—which resonates with the phrase "tailing out," the Dutch word for language, *taal*, and River Taling in Thailand (Slote 85). To a certain extent, when the *Wake* is translated into Basic English, its human complexity becomes reduced to mechanistic monotone. In Slote's words, "[t]ranslation into Basic English . . . proceeds as a decoding, an attenuation of language down to information, a *reductio ad intellectum*" (85).

It is not difficult to see the shared tendency to reduce *information entropy* in

both Turing's Bombe and Ogden's Basic English. Both projects—one mathematical and the other linguistic—were conceived as measures to combat the threat of fascism and enthusiastically endorsed by Winston Churchill. In order to gain the upper hand over Nazi Germany's cipher device, Turing conceived a *singular* machine capable of simulating any other machines and carrying out any algorithms, and his project culminated in a prototypical artificial intelligence whose digital computation produced a simulacrum of human reasoning and thus pitted the assumed immateriality of human consciousness against the material infrastructure of mathematical algorithms. Following a similar logic, Ogden's Basic English cleanses language of polysemy and ambiguity, so as to fend off the propagandistic rhetoric that exploits the opacity of language. Ironically, the Turing machine has greatly contributed to the "end of privacy" and "ubiquity of sinister panoptical technology" (Sheehan 106), whereas Basic English's authoritarian potential has been revealed by George Orwell's Newspeak in *1984*.

If both Turing's Bombe and Ogden's Basic English anticipated the advent of post-war cybernetics that would automatically control the mechanical and the organic, how and why could *Finnegans Wake*'s entropy-increasing textual spectacle be read as a precautionary resistance to the imminent digital regime that morphs humankind into "information-processing entities who are essentially similar to intelligent machines" (Hayles 7)? If Joyce hints at a will to resist cybernetic disembodiment at all, doesn't the *Wake* rather adopt quasi-homeopathy by uploading Tristan and Isolde to "the deprofundity of multimathematical immaterialities" (*FW* 394.30-32)? Such pressing questions transport us back to the Wakean parody of Wagnerian *Liebestod* in II.4, wherein Joyce transposes the Celtic tragedy from the Arthurian era to a proto-cyberpunk dystopia and exposes the star-crossed lovers—now refashioned as a "rockbysuckerassousyoceanl" "quartebuck" and a jazzy flapper "in her ensemble of maidenna blue, with an overdress of net" (*FW* 384.3-4, 384.1, 384.30-31)—to the ubiquitous "waveslength" (*FW* 394.17) that "is a pattern rather than a presence, defined by the probability distribution of the coding elements composing the message" (Hayles 25).

"[T]he parkside pranks of quality queens"

First conceived in 1924 as two separate sketches and later fused into one in 1938,[6] II.4 parodies the Wagnerian motif of *Liebestod* from his 1859 opera *Tristan und*

---

6   See Joyce: "Finally, in 1938, [Joyce] returned to the early sketches . . . fusing the Tristan piece and the 'Mamalujo' to make II, iv. . . . According to a letter by Paul Léon, Joyce was assembling both II, iv, and IV in or about July 1938" (*First-Draft Version* 8).

Isolde by incorporating the four myopic, self-absorbed barons from Joseph Bédier's reconstructed French version of *Tristan et Iseult* as well as the secret-transmitting kiss from Dion Boucicault's Irish play *Arrah na Pogue* (Deppman 318). In Earwicker's oneiric slumber, he transforms into the cuckold King Mark of Cornwall, whose fiancée Iseult of Ireland is to elope with his nephew Tristan. Joyce integrates the love-death tragedy with the themes of surveillance and interception: Mamalujo, "the four maaster waves of Erin . . . listening to the oceans of kissening, with their eyes glistening" (*FW* 384.6-20), embody the omnipresence of radio waves and spy on the two lovers, whereas *Arrah-na-Pogue*'s kiss becomes superimposed on "the big kuss of Trustan with Usolde" (*FW* 383.18).

It is easily traceable that II.4 riffs on the entangled double helix of eros and thanatos—*la petite mort*—by juxtaposing Brangäne-turned-Prankquean's *Liebestrank*-swap with "a queeleetlecree of joysis crisis" from *Liebestod* (*FW* 395.32). What has been less addressed is how Joyce extracts the motif of military cryptography from Tristan's anagrammatic pseudonym Tantris and experiments with modern communication apparatuses' impact on Mamalujo's half-cryptographic, half-aphasiac mumbo jumbo. In a famous 1926 letter to his benefactress Harriet Shaw Weaver, Joyce presents a cheat sheet in a clipped telegraphese:

> Dear Madam: Above please find prosepiece ordered in sample form. Also *key* to same. Hoping said sample meets with your approval
> <div align="center">yrs trly</div>
> <div align="center">Jeems Joker</div>
> Howth (pron Hoaeth) = Dan Hoved (head)
> Sir Amory Tristram 1st earl of Howth changed his name to Saint
>   Lawrence, b in Brittany (North Armorica)
> *Tristan et Iseult, passim*
> viola in all moods and senses (*Letters I* 247; emphasis added)

As per Joyce himself, the legend of Tristan and Isolde functions as a key—that is, "[a] word or other device for encrypting or decrypting a code or cipher" ("key, *n.1*")—to decipher the enigmatic Wakese. However, the intriguing question that he has left unaddressed—Jed Deppman reminds us—is "why a literary text would require a key" (Deppman 305)? Presumably, Joyce doesn't see the necessity of addressing it at all because he is too steeped in "an aesthetics of encryption that can be gleaned from modernism's poetics of elusiveness" (Sheehan 108). We tend to differentiate "real cryptography" from its literary counterparts after "the rise of professional cryptography and its subsequent mathematical systematization," but

Shawn Rosenheim contends that literary and technical cryptographies share the "common task of hiding meaning from some while revealing it to others—an imperative shared by texts as different as the Talmud and a digitally encrypted electronic bank transaction" (20). Rosenheim's observation is applicable to the *Wake*'s compositional process, which ceaselessly encrypts "the lingo . . . however basically English" (*FW* 116.25-26) into an idiosyncratic, quasi-mathematical "Pythagorean sesquipedalia . . . however apically Volapucky" (i.e., Volapük, an artificial language constructed by a Roman Catholic priest yclept Johann Martin Schleyer between 1879 and 1880) (*FW* 116.30-31).

The *decryption key* Joyce confided in Weaver is authentic, as the Celtic legend's pivotal role in the conception and evolution of *Finnegans Wake* has been proven by the *Notebooks at Buffalo* VI.B.3, which not only contains various entries regarding the original love triangle between Tristan, Is(olde), and Mark, but also records the embryogenesis of Is's Pop and Mop, two characters of Joyce's own invention. David Hayman speculates that "Joyce seems to assimilate Pop with the indulgent father of Isolde/Lucia" and that "Joyce was already on track" to transform Pop into HCE even though "Chapelizod is never named" (*The "Wake"* 108). Hayman's Pop-as-ur-HEC hypothesis is convincing because a note from VI.B.3 has already associated Pop with HCE's alleged indiscretion in the park in I.2 (*FW* 33.14-34.29): "ᴦIt is not true that / Pop was homosexual / he had been arrested / at the request of some / nursemaids to whom / he had temporarily / exposed himself / in the Temple gardens" (VI.B.3 153). This note alludes to Frank Harris's appendix to his 1918 biography of Oscar Wilde, where he disproves the rumored homosexuality of Wilde's father-in-law: "The charge against Horatio Lloyd was of a normal kind. It was for exposing himself to nursemaids in the gardens of the Temple" (608). Joyce soon connects the nursemaids in Lloyd's case with Isolde's handmaid Brangäne, who would ultimately integrate into the Prankquean pulling "the *park*side pranks of *q*uality *q*ueens . . . for Earl Hoovedsoon's choosing" (*FW* 394.27-29; emphasis added). The Wakean motif of the Prankquean urinating— "she rain, rain, rain" (*FW* 21.22)—at Jarl van Hoother's mirrors another note from VI.B.3: "Earwicker's bath / ᴦIs[olde]'s piss liquid sunshine" (38). Such textual trace fossils represent Joyce's encryption process by integrating multiple layers of meanings into a singular Wakese word or phrase. For instance, "**E**arl **H**oovedsoon's **c**hoosing" may simultaneously evoke Jarl van Hoother, an anagram of the trigram HCE, Hoved (Danish name of Howth), and a *Hobson's choice* that allows one to choose between something or nothing at all. In a nutshell, Joyce encrypts messages by condensing and compressing textual data to a high degree of semantic opacity.

In addition to compressing data, a coded phrase from the opening passages of II.4—"the big k*u*ss of Tr*u*stan with *U*solde" (*FW* 383.18; emphasis added)—demonstrates the straightforward encryption method of mono-alphabetic substitution through replacing *i* with *u*. By so doing, this Wakean phrase not only injects into *kiss* its German equivalent *Kuss* but dissolves the boundary between *I* and *you*. Joyce's quirky substitutions of *i's* with *u's* also simulate a series of typos, as the two letters are adjacent on the QWERTY keyboard devised by Christopher Latham Sholes and Carlos Glidden in 1868 (see Figure 1). Genetic critics indicate that Joyce scarcely composed the Wake on typewriters, but he was nonetheless aware of textual production's fallibility to mechanical mis-reproduction as he constantly proofread typescripts and fair copies. More intriguingly, the QWERTY keyboard sheds new light on the *Wake*'s ubiquitous exploitations of the L/R and P/Q splits in the evolution of the Celtic languages—as is best exemplified in "*L*owman *Cat*-*l*ick's patrician," from which "*R*oman (Catholic) *Pat*rick's patrician" emerges if *l* is swapped for *r*, *c* for *p* (*FW* 485.01; emphasis added).[7]
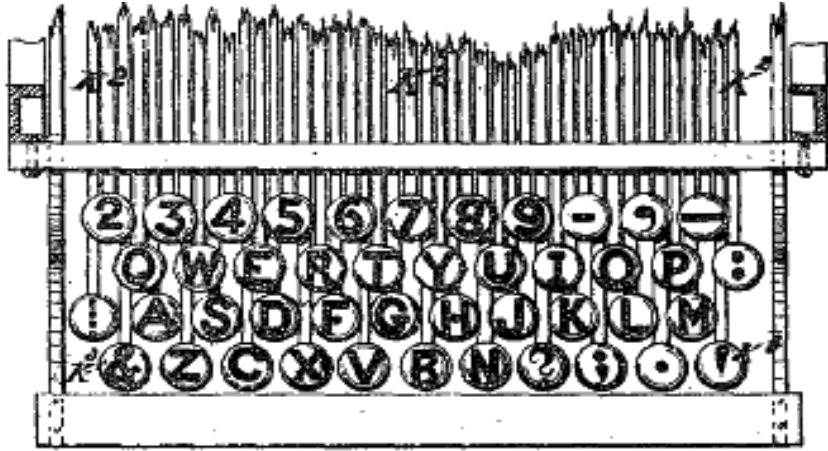

Figure 1. Christopher Latham Sholes's QWERTY typewriter key layout depicted in U.S. Patent No. 207, 559, issued August 27, 1878. Public Domain.

---

[7] The generally accepted view, in Barry Cunliffe's words, is that "the Celtic spoken in Ireland was an early form of Celtic—Goidelic or Q-Celtic—whereas in the British Isles and France the later Brythonic or P-Celtic was dominant" (155). According to his hypothesis, the significant differences between Q-Celtic and P-Celtic and their chronological implications indicate that "Ireland received its Celtic language roughly at the same time as the rest of Atlantic zone but did not share in the development or spread of the later form of P-Celtic which replace the linguistic form in France and the British Isles" (155).

The L/R interchange in the *Wake* is not only phonetic but also typographical, as has been demonstrated by Laurent Milesi when he attempts to unlock the Wakean diptych illustrating how "Roman Catholic" became "Rumnant Patholic" (*FW* 611.24) with the pair of keys "Tunc" (*FW* 611.04) and "Punc" (*FW* 612.16):

> The signature keys to this diptych . . . relate the mock-erudite dialogue to the descriptions of the formal, though obscene, embellishments on the "Tunc" page of the Book of Kells and brings us back to Kate's lewdness; after "Tip," the reverse of "pit," had become "Tik": now "Tunc," the reverse of "cunt" (*t* and *c* are inverted; *n* and *u* are mirror-images), becomes "Punc." (Milesi 110)

In this regard, the seemingly trivial fact that *left*-hand Q mirrors *right*-hand P above the home row on the QWERTY keyboard invites us to rethink how Milesi has interpreted the "mirror-dissociated unit" of p|q as a device to express "Joyce's view of a schizophrenic Ireland" (Milesi 105-06). Milesi's interpretation is based on Shaun the Postman's attack on Shem the Penman that "he would far sooner muddle through the hash of lentils in Europe than meddle with Irrland's split little pea" (*FW* 171.04-06). Milesi spots German *irr*—denoting "mad, confused, mistaken"—in *Irr*land and associates *irr* with Richard Pigott's spelling *error* in his forged letter that libels Charles Stewart Parnell, a treacherous act Joyce ridicules by adding an erroneous *g* to Pigott and riffing on the expression "Mind your Ps and Qs": "Mind your pughs and keaoghs, if you piggotts, marsh" (*FW* 349.03)!

The long-winded excursion into the interplay among the P/Q split, L/R interchange, and the QWERTY keyboard as well as how Joyce injects perversion and schizophrenia into his parodic simulation of corrupted mechanized textual production prepares us for rebooting our unfinished discussion about Brangäne-turned-Prankquean and the *Liebestod* of Tristan and Isolde in II.4 through the lens of cryptography. Emulating encrypted telegrams, Joyce encodes characters to corresponding sigla: Tristan to ⊤, Isolde to ⊥, the Prankquean to △, Mark to m, and Mamalujo to ✕. Joyce further increases the entropy of his cryptographic system by shuffling the corresponding relationship between characters and sigla. For instance, Isolde's ⊥ may rotate into ⊣ and multiply into a mirror-dissociated, schizoid ⊣⊢ that evokes the p|q split embodied by the **P**rank**q**uean. Similarly, **M**ark's m—whose rotating variants include Ǝ, ɯ and Ǝ—also stands for **H**umphrey **C**himpden **E**arwicker, Jarl van Hoother, and other historical or fictional father figures, whereas the Prankquean's △ primarily belongs to **A**nna **L**ivia **P**lurabelle the fluid mother figure.

The swapping and rotating mechanisms of such sigla hint at another technological affinity between literary production and mathematical cryptography: *Die*

17

Schlüsselmaschine Enigma (see Figure 2)—the prototypical cipher machine liberating cryptographers from manual labor—was "a secret typewriter" that German electrical engineer Arthur Scherbius first invented in 1918 by connecting Remington's typewriter keyboard to "a distribution system consisting of three (later, four or five) rotors and an inversion rotor, which always selected other substitute letters" (Kittler, *Gramophone* 251). Scherbius's rotor cipher machines and radio-transmitted cryptograms are semi-present in "a doonloop, panementically" (*FW* 394.14) and "windswidths in the waveslength" (*FW* 394.16-17): the sneaky and "tyred" (*FW* 394.16) quartet of Mamalujo ceaselessly intercepts the lovers' private whispers, only to distort information by adding physical/information noises of hiccups and alphabet transpositions: "(*up* one *up* four) to membore her *beaufu* mouldern maiden name" (*FW* 396.36-397.01; emphasis added). The term "beaufu" and its variant appearing on the following page—"beautfour sisters" (*FW* 393.22)—allude to the Beaufort cipher, a Vigenère-type substitution cipher credited to Admiral Sir Francis Beaufort, Royal Navy (Staples 170).
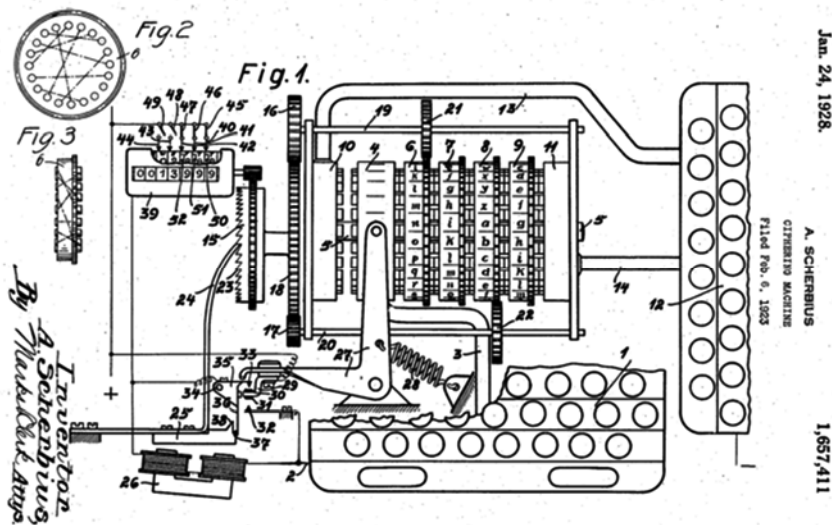

Figure 2. Arthur Scherbius's Enigma patent (U.S. Patent 1,657,411), granted in 1928. Public Domain.

The most famous application of the "self-decrypting" Beaufort cipher was in a rotor-based cipher machine named the Hagelin M-209 (Mollin 108). The classical Vigenère (named after Blaise de Vigenère) and Beaufort ciphers are both processed

by a cipher tableau (see Figure 3), with the defining laws "given in terms of corresponding letter values modulo the length of the alphabet (Franksen 342). "To illustrate" how the Beaufort cipher works, Ole Immanuel Franksen explains, "consider a four-letter alphabet permuted in arbitrary sequence by assigning each letter a positional value beginning with the value zero" (Franksen 342) as follows:

Alphabet:	E A B C	Tableau:	\	EABC	Sum mod 4:	\	0 1 2 3
Values:	0 1 2 3		E	EABC		0	0 1 2 3
Length:	4		A	ABCE		1	1 2 3 0
			B	BCEA		2	2 3 0 1
			C	CEAB		3	3 0 1 2

Figure 3. Vigenère-type Cipher tableau, reproduced from Rosenheim 257.

19

Then the "interpretation of a cipher tableau" could be "derived from the defining Conservation Law": "Key = (Plaintext + Cipher) mod Length" in the Beaufort system. For encipherment, "[r]epeat the key to the length of the plaintext below the latter and encipher the result columnwise, using either the tableau or modular arithmetic to determine the cipher from the derived equation" (Franksen 342) as follows:

Cipher = (Key - Plaintext) mod Length
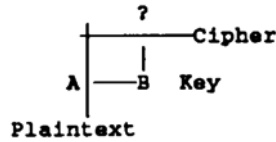
Plaintext:	ABBA	- 1 2 2 1
Key:	BABE	2 1 2 0

Cipher:	A . . .	1 . . . mod 4

When it comes to decipherment, "[r]epeat the key to the length of the cipher below the latter and decipher the result columnwise, using either the tableau or modular arithmetic to determine the plaintext from the derived equation" (Franksen 342) as follows:

Plaintext = (Key - Cipher) mod Length
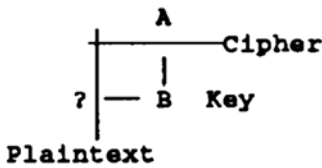
Cipher:	ACEC	- 1 3 0 3
Key:	BABE	2 1 2 0

Plaintext:	A . . .	1 . . . mod 4	(Franksen 342)

Hugh Staples remains reasonably skeptical about Joyce's actual knowledge of Beaufort's "sophisticated . . . transposition cipher," for *Finnegans Wake* betrays "the apparent lack of any long enciphered text" (Staples 171). However, the ubiquitous

trigrams of HCE and ALP as well as their anagrammatic permutations dispersed over the *Wake* indeed generate a sense of vertigo that constantly haunts paranoid cryptanalysts:

HCE HEC CHE

CEH EHC ECH

ALP APL LAP

LPA PAL PLA

The textual traces where Joyce feminizes Beaufort as "beaufu mouldern maiden name" and "beautfour sisters" hint at women's contribution to cryptanalysis. When jump-cut to the catastrophic scene of "armada, all scattered, and all officially drowned" (*FW* 388.11), "*Wreneagle Almighty*" (*FW* 383.14) in the overture to II.4 evokes the "Wrens/WRNS," a tetragram standing for the **W**omen's **R**oyal **N**aval **S**ervice. The WRNS was first formed in 1917 for the First World War and later revived in 1939 at the outbreak of the Second World War as GC&CS's support staff for Enigma codebreaking at Bletchley Park, which Commander Alastair Denniston refers to—rather *Newspeakishly*—as a "peace organisation" (Denniston 48).

Such cryptographic elements redirect our attention back to Mamalujo. By inserting the four senile annalists—or, if you will, prying (psycho)analysts and perverted *anal*ists—into Tristan and Isolde's *Liebestod* tragedy as four covert bugs, Joyce creates a comical theater of surveillance where the quartet of earwiggers' fou**r/l**-play is compromised by their own physical deterioration and semantic redundancy.[8] In other words, Joyce plays with the double meaning of *intelligence* by integrating machine-encrypted anagram and dementia-induced dyslexia. For example, King Mark of Cornwall is inverted as "Kram of Llawnroc" (*FW* 388.1-2), whereas Tristan and Isolde become "Narsty" and "Idoless" (*FW* 395.2). The four senile annalists pry into the private erotica of the two "hunnishmooners" (*FW* 395.13) in the *war*-troubled *Wake*, *passim* and furtively: "Yet is it but an old story, the tale of a Treestone with one Ysold, of a Mons held by tentpegs and his pal whatholoosed on the run, what Cadman could but Badman wouldn't, any Genoaman against any Venis" (*FW* 113.18-22). In the excerpt that conjures "Treestone"

---

[8] According to Hodges, "[t]he essential difficulty of providing speech secrecy lay in the overwhelming redundancy of speech, as compared with writing" (299).

21

and "Ysold," we would find Mamalujo—a mockery of Jesus Christ's four evange-lists **Ma**rk, **Ma**tthew, **Lu**ke, and **Jo**hn—absently present in the image of Samuel Parkes "Cadman," an English-born American *televangelist* who exploited the newly commercialized media of radio to preach liberal theology and condemn Nazi anti-Semitism. In other words, radio enabled "Cadman" to wage an ideological war against the reincarnation of "Badman," an irreligious deadman and the eponymous antihero from John Bunyan's 1680 novel *Life and Death of Mr Badman.* While the military motif—say, Battle of Mons, Battle of Waterloo, and Venetian-Genoese Wars—dominates this particular Wakean scenario, "Genoaman" also alludes to a reclusive *madman* who battled against *Venus*: Friedrich Nietzsche.

An 1882 article in the *Berliner Tageblatt* reported that the allegedly syphilitic Nietzsche, despite failing eyesight, was able to resume writing in Genoa after ac-quiring a Malling-Hansen Writing Ball (qtd. in Kittler, *Gramophone* 203).[9] The fact that the Malling-Hansen Writing Ball's "semicircular arrangement of the keys itself prevented a view of the paper" suspends instantaneous visual feedback in the action of writing, hence tempting Kittler to assert that "people, whether blind or not, acquire a historically new proficiency: *écriture automatique*" (204). Similar to Freudian psychoanalysis's indebtedness to the phonographic recording of random audio data that defy conscious process, psychoanalytically-oriented Surrealism was equally obsessed with the concealing mechanism of typewriters that frees us-ers' moving digits from the censorship of their thinking minds. Modern media technology's paradoxical emancipation of unconscious residues—psychiatry at the turn of the twentieth century deemed schizophrenia/dementia praecox to be a condition of personality atavism—convinces Kittler that "[l]iterature in the dis-course network of 1900 is a simulacrum of madness" (*Discourse Network* 304).

Finnegans Wake's superimposition of Nietzsche the madman and his typewriter (or, in Kittler's words, his "blind machine"[10]) onto the motif of Mamalujo's omni-present surveillance reminds us of Joyce's own failing eyesight and allegedly schiz-ophrenic daughter Lucia, whose life was exposed to Nazism's thanatopolitics in the name of eugenics. Such biographical and historical traces give us some insight into Joyce's modulation of Wagner's *Liebestrank*-induced *Liebestod*: Brangäne's replacing

---

9 While Nietzsche's dementia is widely believed to have been caused by syphilis, Leonard Sax contends that "[t]he syphilis hypothesis is not compatible with most of the evidence available" and that "[o]ther hypoth-eses—such as slowly growing right-sided retro-orbital meningioma—provide a more plausible fir to the ev-idence" (47).

10 According to Kittler, "Nietzsche's decision to buy a typewriter, before greater interest in the new technology arose in Europe around 1890, had a different motivation: his half-blindness. Indeed, the first typewriters (in contrast to the Remington of 1873) were made for those who were blind, and sometimes (as with Foucauld and Pierre) by those who were blind" (*Discourse Network* 193).

poison with philter—"the parkside pranks of quality queens" (*FW* 394.27-28)—forces the Hobson's choice upon Tristan, whose aphrodisiac-swamped brain leaves no room for free will:

> Earl Hoovedsoon's choosing and Huber and Harman orhowwhen theeuponthus (chchch!) eysolt of binnoculises memostinmust egotum sabcunsciously senses upers the deprofundity of multimathematical immaterialities wherebejubers in the pancosmic urge the allimmanence of that which Itself is Itself Alone (hear, O hear. Caller Errin!) exteriorises on this ourherenow plane in disunited solod, likeward and gushious bodies with (science, say!) peril-whitened passionpanting pugnoplangent intuitions of reunited selfdom (murky whey, abstrew adim!) in the higherdimensional selfless Allself, theemeeng Narsty meetheeng Idoless.[11] (*FW* 394.28-395.02)

Tellingly, this climax recycles various elements from the Wagnerian aria of "Liebestod," such as "eye (*Auge*)," "high (*hoch*)," "to drown (*ertrinken*)," and "unconscious (*unbewusst*)." However, Joyce problematizes Wagner's aestheticization of death—which anticipates German fascism's aestheticization of (thanato)politics—and uncannily predicts the ocean of information that is distributed to our eyes via algorithms and penetrating deep into the unconscious through the unthinking digital simulacra of human languages.

Ironically enough, Joyce's *key* to decrypting "the deprofundity of multimathematical immaterialities" has everything to do with what Claude Shannon aspires to purge from his mathematized information system: the unquantifiable, illogical interplay between contextual overtones and readers' mindsets. The "queeleetlecree of joysis crisis" (*FW* 395.32)—a sonic mixture of Isolde's orgasmic queer little cry and Brangäne's "scream whose notation cut straight through the score" (Kittler, *Gramophone* 23)—reminds us that Isolde's ⊥ would rotate and split into the schizoid ⊣⊢/p(rank)|q(uean) in the *Wake*'s dream-logic. Similarly, Mark, Earwicker, and Jarl van Hoother are simultaneously entangled in the (Phoenix) Parkside scandal that hints at Parnell, Lloyd, and Wilde (whose *De Profundis* emerges from abysmal death), while ⊥'s *k*iss p|q-splits into her/△'s "*p*iss liquid sunshine" that shimmers *s*-abc-*un*-sciously in m/Ɛ's naughty, nonsensical, non-

---

[11] David Hayman reconstructs the first version of Tristan's soliloquy as follows: "when ~~thereupon~~ **theeuponthus** I ~~do~~ oculise my most inmost Ego most vaguely senses the ~~profundity~~ **deprofundity**" of multimathematical immaterialities whereby in the pan cosmic urge the Allimmanence of That Which Is Itself exteriorates on this here our plane of disunited solid liquid and gaseous bodies in pearlwhite passionpanting intuitions of reunited ‡ Selfhood in the higherdimensional Selflessness" (Joyce, *First-Draft Version* 209).

stoppingly permuting dream narrative. ⊤'s self-deceiving analogy between life-death cycle and water's three states ("solod, likeward and gushious") also resonates with the Jungian hypothesis of the collective unconscious: "the higherdimensional selfless Allself" where the decomposed lovers ("Narsty" and "Idoless") "theem" to "meeth" again. However, we must not be lured into the *Liebestod* of ⊤ and ⊥—two lovers "deaf with love" (*FW* 395.29)—as biographical and epistolary traces remind us that Joyce abhors Jung, who not only failed to cure Lucia but, more sinisterly, injected Nazi-tinted *völkisch* mythology into his own branch of psychoanalysis.

The exegesis above may seem to have come out of the mouth of a psychotic patient suffering from delusions of grandeur, but it is by resonating with human illogicality and non-sequiturial leaps that Joyce invents an idiosyncratic method of encryption that is decodable to human minds yet unprocessable to digital machines: Joyce's cipher texts in *Finnegans Wake* are teeming with intertextual nexus and semantic overtones that cannot be reduced to the probabilities of alphanumerical combinations.

Finnegans Wake as a "1000th-Generation Computer"?

On 28 July 1934, Joyce wrote Harriet Shaw Weaver an over-optimistic letter: "I'm afraid poor Mr Hitler-Missler will soon have few admirers left in Europe, except for your nieces and my nephews, masters W. Lewis and E. Pound" (*Letters III* 311). Much to his dismay, he soon realized that he would have to power through *Work in Progress* in a time where "[i]ntelligence [would win] the war" (Hodges 455). Meanwhile, *Die Schlüsselmaschine Enigma* urged Marian Rejewski and Alan Turing to invent entropy-reducing bombes in response to Nazi atrocities. History, it seems, is not without a sense of irony: Turing's anti-fascist machine has evolved into the material infrastructure that helps a new generation of "pulpic dictators" (*FW* 185.02) disseminate customized fake news and paralyze our reasoning faculty by white noise in our twenty-first-century *Ewige Wiederkunft* of "the Crimean war" (*FW* 49.05).

Sharing a tangential relation to the Enigma through the QWERTY keyboard, *Finnegans Wake* and Turing's Universal Machine demonstrate two distinct systems of encoding and decoding: the former exploits linguistic quirkiness whereas the latter champions "the precise logic of pure mathematics" (Hodges 138). Despite the two systems' fundamental differences, Jacques Derrida nonetheless analogizes *Finnegans Wake* to a "1000th-generation computer" in his 1982 paper entitled "Two Words for Joyce," because "the current technology of our computers and our micro-computerised archives and our translating machines remains a *bricolage*, a

prehistoric child's toy" (25). Almost four decades later, while computers have become too threateningly powerful to be dismissed as a child's toy, our translating machines remain tactless in the face of *Finnegans Wake*. The two words that Derrida has taken from II.1—namely, "he war" (*FW* 258.12)—epitomizes the *Wake*'s resistance to machine translation and decryption, because the phrase can't be contained within any single set of linguistic rules and therefore defies Shannon & Co.'s mathematical analysis of language.

While Marian Rejewski finds mathematics of more use than linguistics in modern cryptanalysis, Joyce, like a Kabbalist, adheres to an esoteric, almost schizoid approach to encipherment and decipherment. By reading German into "he war," Derrida sees a Babelian scene where Yahweh—namely, he who was (*war*) true (*wahr*)—wars "on language and by language" (23). If the mathematical emulation of human languages is a project of debabelization and thus a "war-to-end-war" (*FW* 178.25), then Joyce has foreseen its threatening potential to translate organic heterogeneity into mechanical homogeneity and reduce language into information entropy and noise. Perhaps Joyce was not waging war on language; he was warring *for* language, so as to protect the heteroglossia of Babelism against mechanical encryptions and dehumanizing algorithms.

WORKS CITED

Cunliffe, Barry. *The Ancient Celts*. Oxford, UK: Oxford UP, 1997.

Darius, Sara. *The Senses of Modernism: Technology, Perception, and Aesthetics*. Ithaca: Cornell UP, 2002.

Denniston, A. G. "The Government Code and Cypher School between the Wars." *Intelligence and National Security* 1.1 (1986): 48-70.

Deppman, Jed. "A Chapter in Composition: *Chapter II.4.*" *How Joyce Wrote* Finnegans Wake*: A Chapter-by-Chapter Genetic Guide*. Ed. Luca Crispi and Sam Slote. Madison: U of Wisconsin P, 2007. 304-46.

Derrida, Jacques. "Two Words for Joyce." Trans. Bennington, Geoffrey. *Derrida and Joyce: Texts and Contexts*. Ed. Andrew J. Mitchell and Sam Slote. Albany: State U of New York P, 2013. 22-40.

Economy, Elizabeth. "Xi Jinping's New World Order: Can China Remake the International System?" *Foreign Affairs* 101.1 (2022): 52-67.

Flynn, Catherine. "*Finnegans Wake*'s Radio Montage: Man-Made Static, the Avant-Garde, and Collective Reading." *James Joyce Quarterly* 52.2 (2015): 287-306.

Franksen, Ole Immanuel. "Babbage and Cryptography. Or, the Mystery of Admiral Beaufort's Cipher." *Mathematics and Computers in Simulation* 35 (1993): 327-67.

Harris, Frank. *Oscar Wilde: His Life and Confessions*. New York: Frank Harris, 1918.

Hayles, N. Katherine. *How We Became Posthuman: Virtual Bodies in Cybernetics*. Chicago: U of Chicago P, 1999.

Hayman, David. "Male Maturity or the *Pub*lic Rise & Private Decline of HC Earwicker: Chapter II.3." *How Joyce Wrote* Finnegans Wake*: A Chapter-by-Chapter Genetic Guide*. Ed. Luca Crispi and Sam Slote. Madison: U of Wisconsin P, 2007. 250-303.

---. *The "Wake" in Transit*. Ithaca: Cornell UP, 1990.

Herf, Jeffrey. *Reactionary Modernism: Technology, Culture, and Politics in Weimar and the Third Reich*. Cambridge, UK: Cambridge UP, 1984.

Hodges, Andrew. *Alan Turing: The Enigma*. Princeton: Princeton UP, 2014.

Joyce, James. *Finnegans Wake*. London: Faber and Faber, 1939.

---. *The* Finnegans Wake *Notebooks at Buffalo* VI.B.3. Ed. Vincent Deane et al. Turnhout: Brepols. 2001.

---. *A First-Draft Version of* Finnegans Wake. Ed. David Hayman. Austin: U of Texas P, 1963.

---. *Letters of James Joyce*, Vol. I (*Letters I*). New York: Viking, 1957.

---. *Letters of James Joyce*, Vol III (*Letters III*). New York: Viking, 1966.

---. *Ulysses*. Ed. Hans Walter Gabler. New York: Random, 1986.

Joyce, James, and C. K. Ogden. "James Joyce's 'Anna Livia Plurabelle' in Basic English." *Transition* 21 (1932): 259-62.

"key, n.1." *OED Online*. Oxford, UK: Oxford UP. Web. Accessed 22 Mar. 2022.

Kittler, Friedrich A. *Discourse Networks 1800 / 1900*. Trans. Michael Metteer and Chris Cullens. Stanford: Stanford UP, 1990.

---. *Gramophone, Film, Typewriter*. Trans. Geoffrey Winthrop-Young and Michael Wutz. Stanford: Stanford UP, 1999.

Lernout, Geert. *The French Joyce*. Ann Arbor: U of Michigan P, 1990.

Mahon, Patrick. "History of Hut 8 to December 1941 (1945), Featuring an Excerpt from Turing's 'Treatise on the Enigma.'" *The Essential Turing*. Ed. Jack Copeland. Oxford, UK: Clarendon, 2004. 265-312.

McHugh, Roland. *Annotations to* Finnegans Wake. 3rd ed. Baltimore: Johns Hopkins UP, 2006.

Milesi, Laurent. "The Perversions of 'Aerse' and the Anglo-Irish Middle Voice in *Finnegans Wake*." *Joyce Studies Annual* 4 (1993): 98-118.

Mollin, Richard A. *An Introduction to Cryptography*, Second Edition. London: Chapman & Hall/CRC, 2007.

Pound, Ezra. *Pound/Joyce: The Letters of Ezra Pound to James Joyce, with Pound's Essays on Joyce*. Ed. Forrest Read. New York: New Directions, 1967.

Rejewski, Marian. "How Polish Mathematicians Deciphered the Enigma." *IEEE Annals*

of the History of Computing 3.3 (1981): 213-34.

Rosenheim, Shawn James. *The Cryptographic Imagination: Secret Writing from Edgar Poe to the Internet*. Baltimore: Johns Hopkins UP, 2019.

Sanger, David E., Nicole Perlroth, and Julian E. Barnes. "As Understanding of Russian Hacking Grows, So Does Alarm." *New York Times* 2 Jan. 2021. Web. Accessed 11 Feb. 2022.

Sax, Leonard. "What Was the Cause of Nietzsche's Dementia?" *Journal of Medical Biography* 11 (2003): 47-54.

Shannon, Claude E. "A Mathematical Theory of Communication." *The Bell System Technical Journal* 27.3 (1948): 379-423.

Sheehan, Paul. "Enigma Variations: Mallarmé, Joyce, and the Aesthetics of Encryption." *Writing, Medium, Machine: Modern Technographies*. Ed. Sean Pryor and David Trotter. London: Open Humanities. 106-19.

Slote, Sam. "*Finnegans Wake*, However Basically Translated." *Translation Studies* 12.1 (2019): 78-88.

Sollers, Philippe. "Joyce & Co." *TriQuarterly* 38 (1977): 107-21.

Staples, Hugh B. "Joyce and Cryptology: Some Speculations." *James Joyce Quarterly* 2.3 (1965): 167-73.

Theall, Donald F. *James Joyce's Techno-Poetics*. Toronto: U of Toronto P, 1997.