Breaking Enigmas

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Introduction

Warfare has always been fought not just with guns and armies but also, crucially, with information—and its denial. The invisible world of codebreakers, cryptanalysts, and signals intelligence has played a silent yet pivotal role in shaping the destinies of nations. In the shadowy corridors of power, in crowded workshops filled with clacking machines, and in isolated interception stations, brilliant minds wrestled with the secrets of enemy communication. Their struggles, victories, and even failures reverberated across battlefields and diplomatic tables, often turning the tide of history.

Yet much of this story has remained in the shadows. The work of codebreakers was, by necessity, secret. Many of the individuals whose dedication made decisive breakthroughs possible went unrecognized for decades, their achievements hidden behind official silence or lost to the passage of time. Only recently have historians and declassified documents begun to piece together the full picture, revealing just how critically signals intelligence operations shaped major twentieth-century conflicts—and, by extension, the modern world.

This book, *Breaking Enigmas: The Untold Story of Codebreakers, Cryptanalysis, and Signals Intelligence*, aims to shed light on this clandestine history. It traces the origins of signals intelligence from its early roots—when coded messages moved by messenger, wire, and wireless—through the two World Wars, the fraught standoffs of the Cold War, and into the era of digital surveillance. Here you will meet the mathematicians, linguists, engineers, and unlikely recruits who became the backbone of secret intelligence efforts. Their personal stories—both celebrated and unsung—are essential threads in the fabric of history.

In addition to rich historical narrative, this book explains the methods and machines that made codebreaking possible. From the ingenious simplicity of the Caesar cipher to the labyrinthine complexity of the Enigma and Lorenz machines, readers will gain a clear, accessible understanding of how cryptographic puzzles were constructed—and ultimately unravelled. Key case studies reveal how signals intelligence not only provided information for military strategy but also influenced momentous diplomatic decisions, as in the case of the Zimmermann Telegram or the high-stakes brinkmanship of the Cuban Missile Crisis.

The pursuit of secret knowledge has always walked a thin line between national security and ethical risk. As you will discover, the rise of SIGINT brought with it uncomfortable questions about privacy, legality, and the potential for abuse—questions that are as relevant today as ever. In exploring both the triumphs

and dilemmas of past operations, this book invites readers to reflect on the enduring relevance and complexity of keeping, stealing, and breaking secrets in a connected world.

Ultimately, *Breaking Enigmas* celebrates the ingenuity—and humanity—of codebreakers on all sides during moments of global crisis. Behind the diagrams and algorithms are real people: men and women whose intellect, perseverance, and teamwork changed the course of history. By bringing their stories, techniques, and machines to light, this book seeks not only to document a remarkable legacy but also to inspire a new generation in the ever-evolving art of breaking enigmas.

CHAPTER ONE: The Origins of Secret Writing: Early Cryptography and Espionage

Long before radio waves crackled with coded messages and complex machines whirred to break ciphers, the desire to communicate secretly was a fundamental aspect of human interaction, particularly in the realms of power, warfare, and intrigue. The origins of secret writing are as old as writing itself, driven by the unchanging need to convey information to an intended recipient while keeping it hidden from all others. From the earliest forms of steganography to the more sophisticated substitution ciphers, the art of cryptography developed hand-in-hand with the equally ancient practice of espionage, each seeking to outwit the other in a perpetual intellectual contest.

One of the earliest and most rudimentary forms of secret communication relied not on transforming the message, but on concealing its very existence—a practice known as steganography. The word itself, derived from Greek, means "covered writing." Herodotus, the ancient Greek historian, recounts a clever example from the 5th century BC. Histiaeus, a tyrant of Miletus, needed to send a secret message to Aristagoras, inciting a revolt against the Persian king. To achieve this, he shaved the head of his most trusted slave, tattooed the message onto his scalp, and then waited for the hair to grow back. Once the hair had regrown, the slave was dispatched to Aristagoras, who, upon receiving instructions to shave the slave's head, uncovered the hidden communiqué. It was a slow but, one must admit, remarkably secure method for its time.

Another classic example from antiquity involved wax tablets. In ancient Greece, messages were sometimes written on the wooden tablet itself, then covered with a layer of wax to make it appear blank, or to allow a mundane, innocent message to be written over the secret one. The recipient would simply scrape away the wax to reveal the true content. These methods, while ingenious, were inherently limited. They required physical proximity or a trusted courier, and the risk of discovery was ever-present if the disguise was penetrated. The true revolution in secret communication would come with cryptography, the art of transforming a message to make it unintelligible to unauthorized readers.

The earliest forms of cryptography primarily involved transposition and substitution. Transposition ciphers rearrange the order of letters in a message according to a specific rule, while substitution ciphers replace letters or groups of letters with others. One of the most famous and enduring examples of early substitution is the Caesar cipher, attributed to Julius Caesar, who used it for his private correspondence. In a

Caesar cipher, each letter in the plaintext is shifted a certain number of places down or up the alphabet. For instance, with a shift of three, 'A' would become 'D', 'B' would become 'E', and so on. The simplicity of this cipher made it easy to implement, but also relatively easy to break, especially with the aid of frequency analysis.

Frequency analysis, a cornerstone of cryptanalysis, relies on the fact that certain letters and letter combinations appear with predictable frequencies in any given language. In English, for example, 'E' is the most common letter, followed by 'T', 'A', 'O', 'I', 'N', 'S', 'H', and 'R'. If a cryptanalyst can identify the most frequent letter in a ciphertext and deduce it represents 'E', they can then work backward to determine the shift value in a Caesar cipher and unlock the entire message. This technique, while seemingly obvious to us now, was a groundbreaking development, often attributed to Arab scholars in the 9th century. Al-Kindi, an Arab polymath, wrote a treatise on cryptanalysis that included a detailed description of frequency analysis, showcasing a level of sophistication in codebreaking far ahead of its European counterparts for several centuries.

The development of more complex substitution ciphers followed, attempting to thwart frequency analysis. Polyalphabetic ciphers, where different substitution alphabets are used for different parts of the message, were a significant leap forward. The Vigenère cipher, though often misattributed to Blaise de Vigenère in the 16th century, was actually developed earlier by Giovan Battista Bellaso. This cipher used a keyword to determine which Caesar cipher to apply to each letter of the message. For example, if the keyword was "ROME," and the first letter of the plaintext was 'A', the 'R' in "ROME" would dictate the shift. For the second letter, the 'O' would dictate the shift, and so on, cycling through the keyword.

The Vigenère cipher was long considered unbreakable, even earning the moniker "le chiffre indéchiffrable" (the indecipherable cipher). Its strength lay in obscuring letter frequencies, as a single plaintext letter could be represented by multiple ciphertext letters, and vice versa. However, it was eventually cracked by methods that looked for repeating sequences in the ciphertext, suggesting repetitions in the keyword, a technique refined by Friedrich Kasiski in the mid-19th century. The Kasiski examination, coupled with statistical analysis, could eventually reveal the length of the keyword, after which the cryptanalyst could treat the cipher as a series of simple Caesar ciphers.

Beyond substitution and transposition, early espionage also employed various forms of codes. Unlike ciphers, which manipulate letters, codes replace entire words, phrases, or even sentences with other words, numbers, or symbols. Codebooks were essential for both encoding and decoding, acting as dictionaries of secret meaning. These could range from simple agreed-upon substitutions—such as "apple" meaning "attack at dawn"—to elaborate books containing thousands of entries. The security of a code depended entirely on the secrecy of the codebook. If the codebook fell into enemy

hands, the entire system was compromised.

One fascinating historical example of code use comes from the Renaissance. Mary, Queen of Scots, famously used ciphers and codes in her correspondence while imprisoned, attempting to plot her escape and overthrow of Elizabeth I. Her use of a complex substitution cipher, combined with a rudimentary code for common phrases, was ultimately her undoing. The diligent efforts of Thomas Phelippes, a master cryptanalyst working for Sir Francis Walsingham, revealed her incriminating messages, leading to her trial and execution. This incident vividly illustrates the life-and-death stakes involved in the world of secret communications and their decryption.

Walsingham himself was a pioneer in early signals intelligence, operating a sophisticated postal interception bureau during Elizabeth I's reign. This bureau, while primarily focused on diplomatic and political intelligence, possessed rudimentary cryptanalytic capabilities, hinting at the future institutionalization of codebreaking. By intercepting and analyzing mail, Walsingham was able to gain crucial insights into the intentions of England's rivals and internal threats, effectively laying some of the foundational groundwork for what would become organized intelligence gathering.

The advent of gunpowder and the printing press further escalated the importance of secret communication. The printing press allowed for the widespread dissemination of information, but also for more standardized and sophisticated cryptographic texts to be produced. The increasing complexity of warfare and diplomacy in the early modern period meant that leaders needed to convey orders and information securely over greater distances and to more people, without fear of interception and compromise.

Leonardo da Vinci, for example, designed a number of cryptographic systems, including one that used a rotating disc for polyalphabetic substitution. While many of his designs were theoretical, they showcased the growing intellectual interest in creating unbreakable codes. The intellectual challenge of cryptography attracted some of the brightest minds, laying the groundwork for the more systematic and scientific approaches that would emerge centuries later.

The early evolution of cryptography and cryptanalysis was largely a cat-and-mouse game, with each advancement in secret writing eventually met by a counter-advancement in breaking those secrets. It was a battle of wits, where the most clever and diligent minds could gain a decisive advantage. The methods were often manual, painstaking, and required immense patience and ingenuity, yet their impact could be profound, influencing the fate of individuals, armies, and even nations.

From invisible inks to elaborate codebooks, the fundamental principles of secret communication were established in these early centuries. The desire to conceal and reveal information remained constant, even as the methods grew more complex. These rudimentary beginnings, rooted in the very human need for secrecy and

advantage, set the stage for the dramatic transformations that would occur with the advent of electrical communication, ushering in an entirely new era of signals intelligence and codebreaking. The stage was set for the "untold story" of those who would break enigmas, not with ink and parchment, but with wires, radio waves, and eventually, the very first machines designed to decipher the deepest secrets.

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