Volume 18, No. 1

October 2005

ANTENNA

Newsletter of the Mercurians

Special Interest Group
Society for the History of Technology

Publication costs met in part by support of the Shiers Memorial Fund

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"Plus ça change, plus c'est la même chose? The Peculiar French Telegraph"

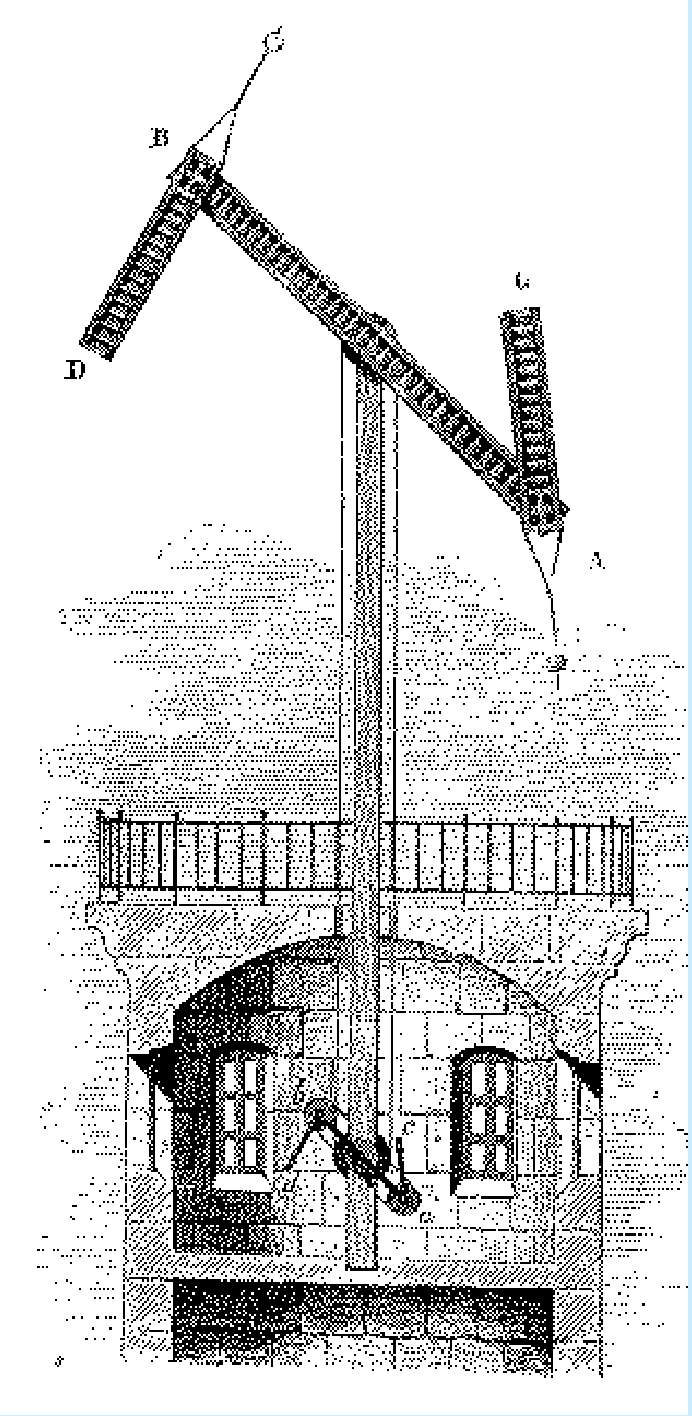
by Heidi Gautschi

This article is based on my dissertation, which is a comparative study of the telegraph systems in France and the United States between 1844 and 1900. My aim is to demonstrate how political decisions and cultural structures influence the development of technology and in turn how technology influences those institutions. Rather than summarizing my dissertation, I discuss here only the evolution of the French telegraph system.

Before they attain a certain degree of technical or functional stability, technological systems go through many iterations. Stable systems are the result of technological innovation, but that technology does not develop in isolation. A number of different communities and systems are involved in the adoption of a new technological system. A number of other systems are developed to maintain the system's stability. Laws are passed regulating various aspects of the system, best practices are adopted, uses are codified, industry is developed around the system, and the general population incorporates the system into their daily lives. All of this takes time. By the time a technological system achieves stability, another system most likely has come along to take its place. What generally ensues is a clash between maintaining the status quo and change. Such a clash occurred in France when the electric telegraph confronted the entrenched system of semaphores.

Neither the telegraph administration (l'administration des lignes télégraphiques") nor the science establishment showed a lack of interest in the electric telegraph. Indeed, Alphonse Foy, the administrator of France's semaphore telegraph network, having heard about the invention of an electrical telegraph by Charles Wheatstone traveled to England to see it in action. Wheatstone already had demonstrated his telegraph system in France, as had Samuel F. B. Morse shortly thereafter. Morse had received a warm welcome from François Arago, a leading French scientist and member of the Chambre des députés, yet the political community was uninterested in using the American's invention, a cumbersome electromechanical system that bore no resemblance to what later would bear the American's name.

France's apparent initial rejection of the telegraph did not stem from that country's isolation from the European scientific community. In fact, a number of French scientists, such as André-Marie Ampère, had played vital roles in the development of electrical theory. However, France already had a very functional system of long-distance communication—the mechanical or optical telegraph—that had been introduced shortly after the revolution of 1789.



Mechanical telegraph initially invented by Claude Chappe and popularized in Dumas' novel, *Le Comte de Monte Cristo*. The *stationnaire,* by working the inside apparatus, moved the arms and cross-support to form figures representing coded signs.

"Plus ça change, plus c'est la même chose? The Peculiar French Telegraph" by Heidi Gautschi (continued)

The Chappe telegraph

Although a number of individuals had proposed various systems of mechanical or optical telegraphs simultaneously, the French government adopted that of Claude Chappe. According to certain French historians, the most convincing argument for adopting the Chappe semaphore was that it would enable the state to govern and control a fractured, post-revolutionary society. By enabling rapid communication across France, the new revolutionary government could maintain the upper hand. Patrice Flichy, however, had argued that Chappe's telegraph met the government's ideological goals.

The telegraph network based on Chappe's invention was built exclusively for the government and by the government. It met the communication needs of the military and civilian branches of government exclusively. Telegraph lines radiated from Paris to the country's major administrative centers, carrying official news to the local prefects who, in turn, further disseminated information regarding discontent or trouble in their region. This was a highly centralized, tightly controlled communication system.

The Chappe network did not spring forth fully formed in one leap, but took decades to complete. In order to manage the system, the government established the *administration des lignes télégraphiques*, whose first *administrateur* was Claude Chappe himself. The telegraph administration was a hierarchical bureaucracy based loosely on that of the military. Over a period of some four decades, the telegraph administration codified and regulated its functional, managerial, and labor procedures and practices.

By the time Wheatstone invented the electrical telegraph, France's mechanical telegraph already was an entrenched institution. The general population accepted the government-imposed limited access to the telegraph. Attempts to make the system also serve commercial interests, such as those trading in stocks and commodities, failed. Proponents of the electric telegraph had to win over the government in order to reshape the *administration des lignes télégraphiques* to the new technology.

Moreover, the electric telegraph remained unproven as a practical means of communication anywhere in the world. In France, where leading scientists and prominent citizens wrote lengthy tracts both opposing and embracing the new invention, one can distinguish three main factors underlying the resistance to the electric telegraph.

The French Resistance

1. The Semaphore Lobby

The inventor Ennemond Gonon made improvements to the existing telegraph so that one could send messages at night. Gonon was lobbying the government for funds to build and test a prototype of his invention when the Chambre des députés began to discuss the electric telegraph.

In two articles that appeared a few years apart in the magazine *Variété*, Gonon outlined his main objections to the electric telegraph. In his first article, actually a letter to the editor published 25 November 1845, Gonon's diatribe focused on the fact that the electric telegraph yet remained to be proven as a practical replacement.

> He wrote:
>
> "Reprenant une théorie, déjà vingt fois éprouvé, sans succès, par leur devanciers, dans l'espace d'un siècle, ces messieurs [Wheatstone, Morse, Arago] se sont flattés qu'ils atteindraient leur but, moyennant de légers perfectionnemens (sic) à des appareils déjà connus (…) Qu'est il résulté de ces expériences? Rien de positif, si ce n'est la démonstration évidente de difficultés invincibles."
>
> "[Wheatstone, Morse, Arago] think they will attain their goal by means of small improvements to these already known apparatus. . . What has resulted from these experiments? Nothing definite, other than the clear demonstration of invincible difficulties."

L. Benoît, a fellow supporter of Gonon, also wrote a letter to the editor that appeared in the same issue of *Variété*. His brief letter has two important items worth noting. One is his description of Gonon's system: "sa forme est gracieuse, bien proportionné et tous ses mouvements s'exécutent avec la plus grande précision." ["its form is graceful, well proportioned, and all its movements are executed with utmost precision."] The aesthetics of technology is a reoccurring theme in the history of French telegraphy and technology in general. The second is Benoît's proposal that the government adopt Gonon's system because it could be found nowhere, not because it was fully functional.

"Plus ça change, plus c'est la même chose? The Peculiar French Telegraph" by Heidi Gautschi (continued)

2. Fear of the Masses

No one had ever seen anything like the electric telegraph. The French—accustomed to the well constructed and protected Chappe towers—were not convinced that the telegraph's thin wires would remain unharmed by the populace. The argument reflected a deep-seated mistrust of the general population. Because of the impossibility of protecting the telegraph wires, the state's entire communication network would be at the mercy of vandals and political activists.

Underlying this fear was the assumption that the electric telegraph would serve the same purposes as the mechanical network. The state's monopoly, however, was unofficial. It was only in 1837, when the threat of the electric telegraph made itself known, that the Minister of the Interior proposed a law that would lay the groundwork for all future French communication networks.

The law stated:

> "Quiconque transmettra sans autorisation des signaux d'un lieu à un autre soit à l'aide de machines télégraphiques, soit par tout autre moyen, sera puni d'un emprisonnement de un mois à un an et d'une amende de 1 000 à 10 000 F. Le tribunal en outre fera démolir la machine et les moyens de transmission." [Whoever will transmit signals without authorization from one place to another using telegraph machines, or by any other means, will be punished with one month to a year of imprisonment and a 1,000 to 10,000 Franc fine. Moreover, the court will demolish the machine and the means of transmission.]

Ultimately, the 1837 monopoly law secured any and all future means of communication for the sole use of the government, effectively creating a hierarchy of long distance communications—those for everyone and those for official state business. Furthermore, the law implied that any network built on French territory would fall under government control.

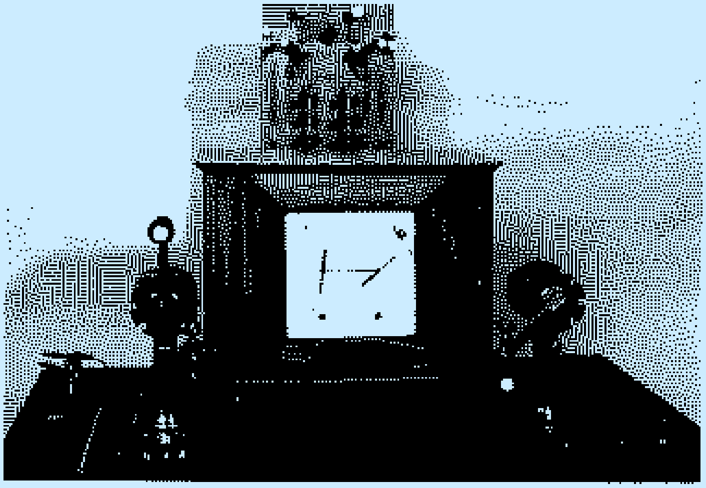
3. Cost

The government and the *administration des lignes télégraphiques* were reluctant to gamble on a new technology until it was shown to be more practical and more efficient than the optical telegraph. Additionally, the Chappe network employed a large number of people from the lowly *stationnaires*, who operated the machinery that sent and received messages, to the director of the telegraph administration. Hiring and training a whole new body of employees would be extremely costly and time consuming, especially given that the state had no guarantee of a healthy return on investment.

Alphonse Foy, the telegraph administrator, was not disinterested in the electric telegraph. His main concern was making sure that the existing network ran smoothly. It is very possible that he—or anyone else for that matter—could not conjure up a viable vision of an electric telegraph network in 1845. French Resistance to the electric telegraph is understandable. Nonetheless, when the report on electric telegraphy that King Louis Philippe had requested came back positive, the government allocated funds for the construction of an experimental line. Now a major decision needed to be made: what kind of instruments would the line utilize?

The Foy-Breguet Telegraph

Administrator Foy knew that the electric and mechanical telegraphs would have to coexist, whether or not the electrical technology replaced the Chappe system. The logical solution therefore was to make the two systems compatible. The electrical telegraph also



Foy-Breguet Telegraph. The needles on the its face (center) and cranks to either side imitated the operation and signal code of the Chappe network into which it was to be integrated. The Foy-Breguet and Chappe devices, however, never operated on the same telegraph line.

"Plus ça change, plus c'est la même chose? The Peculiar French Telegraph" by Heidi Gautschi (continued)

used the same Chappe code, so that the *stationnaires* could operate the new apparatus. This solution also had the financial advantage of not requiring the telegraph administration to hire new workers to operate the electrical instruments. These parameters determined the nature of France's first electric telegraph instrument. But they also ruled out the possibility of using any existing telegraph instruments.

The electric apparatus chosen resulted from a collaboration between Alphonse Foy and Louis Breguet, the celebrated manufacturer of clocks and scientific instruments. The so-called Foy-Breguet replicated the signals of the Chappe towers. For the sake of simplification, they reduced the number of possible signal configurations from 92 to 64, which required a concomitant modification of the code books in use. In order to replicate the sending and receiving functions of the Chappe semaphores, the Foy-Breguet—unlike all other telegraph instruments—operated over two wires.

The Foy-Breguet—officially retired in 1854—was a short-lived experiment. Nonetheless, despite such inherent technical drawbacks as the use of two wires instead of one, it was quite ingenious and highlighted Breguet's technical know-how and artistry. The Foy-Breguet also was a beautiful object made of polished wood and copper. High quality workmanship and careful attention to detail was a constant in the French telegraph network. Not only were the apparatus themselves well made, but the poles, wires, and even the telegram forms reflected the care and perfectionism that went into the development of this communication network.

In contrast, Louis Figuier, France's leading science author, described the U.S. telegraph network as not having been built "avec le soin qu'on y apporte en Europe" [with the care shown in Europe]. This theme carries throughout the literature on French telegraphy. This attention to aesthetic detail shows that the French government's priority was not offering the telegraph to as many people as possible as quickly as possible, but rather the construction of a stable, reliable, well-crafted, and smoothly functioning network.

When the state allocated funds for the construction of the experimental line between Paris and Rouen in 1845, France was not behind other countries in adopting this new form of communication. Both Morse and Wheatstone had patented telegraph instruments in 1837, but neither system was adopted quickly in their respective countries. Following the construction of a second experimental line between Paris and Lille, state investment in electrical telegraphy languished until 1850, as the *administration des lignes télégraphiques* continued to maintain the reliable mechanical system throughout the rest of the country.

Elected *Prince-Président* of the Second Republic in 1848, Louis Napoleon Bonaparte, pictured here after he overthrew himself and crowned himself Napoleon III, ruling until 1870. He, more than anyone else, was responsible for the rapid expansion of the telegraph throughout France and for opening it up to use by business and the general public. The income generated helped to underwrite the network's expansion. He also promoted the speedy growth of the railways and the Cobden-Chevalier free-trade treaty.

"Plus ça change, plus c'est la même chose? The Peculiar French Telegraph" by Heidi Gautschi (continued)

Turning Point

The turning point for the rapid adoption of the electric telegraph throughout France came after the popular revolution of 1848, which overthrew the incompetent King Charles X and established the Second Republic with Louis Napoleon Bonaparte, the reputed nephew of Napoleon I, as its president. In 1850, the *prince-président* opened the telegraph network to the general public, a radical departure from past practice. The increase in the number of messages sent was almost immediate and highlighted the need to build more lines. The Chappe mechanical system was now on the way out.

The opening of the network to the public had an underlying fiscal rationale. The proceeds collected for sending messages helped to underwrite partially the cost of building new lines. As a result, the geography of the network reflected administrative as well as commercial needs.

Nonetheless, the network reflected the fact that first and foremost the telegraph was a vital tool for official communication. By 1855, every prefect was linked telegraphically to Paris. The next logical step was to add the cantons to the Paris-centered network through the prefects. This step proved to be a costly undertaking. Accordingly, the state developed a financial scheme that allowed for the continuing growth of the network without straining state coffers and without raising telegram tariffs. Each canton contributed to the funding of the new construction, and the cantons decided how best to raise the money.

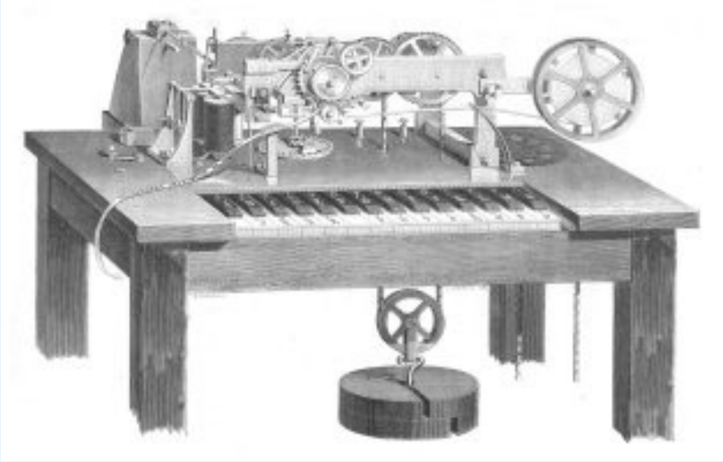
Because of the logic behind the development of the network, apparent inefficiencies in message transmission were inevitable. By 1877, the country had 4,587 telegraph offices, and on average a message had to be retransmitted four times before reaching its destination. The multilayered bureaucratic structure of the telegraphs likely was inspired by the need to eliminate human errors as much as possible and the creation of a paper trail that allowed the retracing of errors.

The creation of a written record was of the highest importance. Public officials, journalists, and authors decried the Foy-Breguet instruments, for example, because they could not print messages. The written word had an exalted place in nineteenth-century French society, and it continues to be venerated in contemporary society. The payoff for requiring a paper trail was higher message accuracy and system stability and reliability, but at the cost of a system that was slower than that allowed by the technology's full potential.

Telegraph Instruments

The telegraph administration replaced the Foy-Breguet instruments with variations on what was known as the Morse telegraph, a device entirely different from the one Morse had patented in that country in 1837. This Morse, moreover, had been perfected initially in order to emboss marks on a long strip of paper and later to record those marks in ink. The demand for a paper trail prohibited the use of the so-called sounders that were so prevalent in the United States, where telegraph companies were less insistent upon message accuracy.

One of the drawbacks of this so-called Morse system was its lack of speed, a result mainly of the number of messages that it printed per hour. Because eliminating the printing function was not an option, the state sought other solutions. One such solution was the instrument devised by the American David Hughes.



The Hughes Telegraph. Born in England, Hughes taught music at New York University, so it is not surprising that the main feature of his telegraph is a piano keyboard. Each key corresponded to a letter of the alphabet, so that the operator did not need any knowledge of code. Its average tansmission speed was 45 words per minute. The Paris manufacturer of scientific instruments Gustave Froment improved the Hughes system, patented in the United States in 1954, and deployed on the French telegraph network in 1860.

"Plus ça change, plus c'est la même chose? The Peculiar French Telegraph" by Heidi Gautschi (continued)

After significant modifications introduced by French scientific instrument makers, the French telegraph administration adopted it for its busiest lines. The Hughes had definite advantages over the Morse. For one, it printed letters, not signs, so there was no need to encode and decode messages. Also, its operation relied less on the electric fluctuations of the telegraph wires. The Hughes' printing power instead came from a falling weight that operated it continuously and consistently like a grandfather clock. ["la force motrice est empruntée, non au courant électrique, mais à un poids de 50 à 60 kilogrammes, qui fait marcher tout l'appareil d'une manière continue et régulière, comme une ancienne horologe."]

The speed of the Hughes, however, created a new problem within the community of telegraph operators. It required a new level of stamina, concentration, and physical strength in order to operate it properly. Just raising a 50 kilogram weight on a regular basis was difficult. In addition to these stress issues, the Hughes also was delicate and prone to breakdowns.

By the 1870s, the French network was becoming saturated. Inventors were turning their attention to ways in which the number of messages sent could be increased without increasing manpower needs or adding more wires to the network. Duplexing and quadruplexing were some of the solutions investigated. Other solutions involved multiplexing, an early form of the type of time sharing commonly found in today's computers. The first such system was created by Bernard Meyer, a telegraph employee. But Meyer's system demanded a high level of coordination and concentration from its operators. Given the work environment, it is understandable why this actually functioned so well in France.

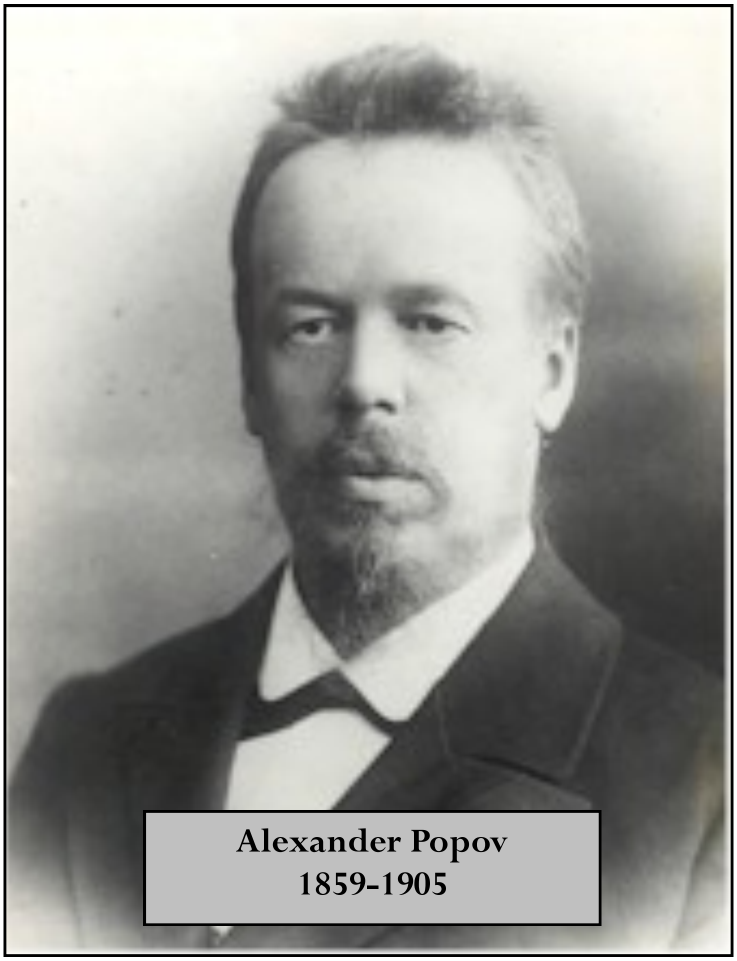
The Meyer system, however, did not provide a printed copy of messages, a major drawback. Its replacement was the invention of another ingenious telegraph employee, Emile Baudot. His system not only printed messages, but also responded to a number of telegraphy problems. At the time, telegraph lines fell into one of three categories depending on the density of traffic, and lines in each category used instruments peculiar to its traffic needs. The diversity of instruments in use was seriously problematic. The instruments were cumbersome, time was lost as operators moved from one instrument to another, and training personnel was difficult. ["[la] diversité des appareils présente de graves inconvénients. Les appareils sont encombrants, il y a une perte de place, une perte de temps au passage d'un appareil à un autre, la formation du personnel est difficile."]

Emile Baudot (1845-1903). The son of farmers, Baudot joined the telegraph service and became an *inspecteur-ingénieur*. In addition to devising several telegraphs and improving others, Baudot patented a 5-character code in 1874 that quickly supplanted the Morse. Installations of his synchronous time-division multiplexing telegraphs included international lines between Paris and Rome, Berlin, Vienna, and London. Because Baudot's name became synonymous with fast transmission speeds, a shortened version of it, "baud," subsequently became the standard unit for data transmission rates, one bit per second.

Baudot's telegraph, quickly adopted by the telegraph administration, streamlined the network's structure and resolved these troublesome issues. As a result, the press and French officials described the Baudot in glowing terms: France's crowning achievement in telegraph technology.

New IEEE Milestone
Alexander Popov and Early Radio Pioneer

In 1895, Alexander S. Popov first demonstrated the principle that a wireless device can detect an electromagnetic signal flowing through the air and ring a bell. The IEEE Board of Directors, in recognition of that experiment, has named Popov's demonstration an IEEE Milestone in Electrical and Computer Engineering. In addition, the St. Petersburg Section of the IEEE celebrated the anniversary of Popov's demonstration at the International Scientific Conference on the 110th Anniversary of Radio Invention held 18-21 May 2005 in St. Petersburg. The conference examined Russian scientists' roles in electrotechnology, as well as new advances in telecommunications.



Alexander Popov
1859-1905

In Russia, Popov already is regarded as the inventor of radio communication, despite the claims made for Gugliemo Marconi (and others) for being the first to demonstrate the practical use of electromagnetic waves. Nonetheless, evidence shows that Popov actually *was* first, but his contribution went largely unrecognized because he signed a mandatory nondisclosure statement when he taught at the Russian Navy's Marine Engineering School. Marconi gained credit for the invention of radio because he applied for a patent in 1896. The creation of the milestone thus restores Popov's claim of priority.

Aleksandr Popov (also spelled Popoff) was born on 16 March 1859 in Krasnoturinsk, Russia, a mining village in the Ural Mountains. One of seven children, he attended a Russian Orthodox seminary to encourage him to follow in his father's profession, the priesthood. But while in the seminary, Popov became interested in physics, and he later was admitted to the University of St. Petersburg. He graduated with distinction, and stayed on one additional year as a laboratory assistant.

Upon graduation in 1883, Popov joined the Russian Navy's Torpedo School as an instructor. The post gave him access to the school's extensive library to continue his research. In 1890, he started teaching at the Russian Navy's Marine Engineering School. It was there that he was required to sign the nondisclosure statement that later would prove detrimental to his claim as an inventor of radio.

During his tenure at the Marine Engineering School, Popov taught electrical engineering, mathematics, and physics. He studied the works of Heinrich Hertz, Oliver Lodge, and others. His initial intention was to invent an instrument capable of detecting lightning. On 7 May 1895 he demonstrated his apparatus to the members of the Russian Physical and Chemical Society.

Popov's receiver consisted of a metal filings "coherer"—a device for detecting electromagnetic waves—an antenna, a relay, and a bell to signal the presence of the electromagnetic waves. Popov discovered that he could send and detect waves up to 64 meters away. Although not initially meant as a means to transmit "intelligence," his apparatus demonstrated the feasibility of radio communication.

Over the next several years, Popov continued his research as a director (appointed in 1901) of the St. Petersburg Electrotechnical Institute. He died on 13 January 1906 in St. Petersburg.

Russians annually celebrate Popov's successful demonstration of wireless transmission on the seventh of May, known since 1945 as Radio Day, when the annual commemoration was established. On that day, all radio workers get the day off from work.

Book reviews from IEEE History Center Newsletter July 2005

David L. Morton, Jr., and Joseph Gabriel, Electronics: The Life Story of a Technology. Greenwood Press, Westport and London, 2004. $45.00, hardcover, ISBN 0-313-33247-9. xiii + 216 pages, 25 illus., index.

Former IEEE History Researcher (and MERCURIAN), David L. Morton Jr., and Joseph Gabriel, a doctoral candidate of History at Rutgers University, offer a concise history of the important electronic devices of the 20th century. The authors begin their introduction by explaining that their study is aimed at an audience with little knowledge of physics and electrical circuits, and that their work will reveal little new information to scholars with advance knowledge in these fields.

Divided into six tightly-presented chapters, Morton and Gabriel cover their subject chronologically and topically, and include a helpful glossary. They present many pictures and diagrams, which complement the text and offer useful visuals for the lay reader. It is also worth noting that the authors constantly place inventions within a broader historical context. They do a fine job emphasizing the crucial links between companies, the military, and the consumer market while never losing sight of changes in the international arena that directly or indirectly shaped the invention and development of electronic devices.

Roughly speaking, each chapter covers individual decades, highlighting the key inventions of the period. Chapter one traces the history of electron devices, especially vacuum tubes, up to 1948, the year when the transistor was announced by Bell Laboratories. In chapter two, the authors focus mainly on the different kinds of transistors that were produced during the 1950s, reminding the readers of the progress and transformations of vacuum tubes such as the 'shadow mask' tube, which remained in use for many decades to come. Integrated circuits and lasers in the 1960s are the focus of chapter three. Chapter four highlights the politically and economically challenging 1970s, a time marked by a series of geopolitical crises to which electrical engineers were not immune. This was a time, the authors remind us, of high rates of unemployment, caused in part by the globalization of manufacturing. During this period, the IEEE-USA was created. In the 1970s, engineers invented the microprocessor and oversaw the commercialization of personal computers. Chapter five demonstrates how inventors helped create different electronic devices for products and services that many of us take for granted today: ATMs, cash registers, microwaves, cell phones, CD players, and the internet.

Throughout most of the book, the authors concentrate overwhelmingly on inventions and innovations that took place in the US. They devote only a few pages to Japanese and European technological achievements. This geographical imbalance leaves readers wondering. In what ways did Asian and European inventors and governments contribute to electronic innovations? Additionally, some may be disappointed by the lack of bibliographical references, although the authors do provide a list of further reading. These shortcomings are nevertheless minor in light of Morton and Gabriel's remarkable ability to clearly synthesize a century of electronic inventions.

Kenneth Silverman, Lightning Man: The Accursed Life of Samuel FB. Morse, Alfred A. Knopf, New York, 2003. $35.00 cloth, ISBN 0-375-40128-8, vi + 503 pp., index.

Kenneth Silverman, professor emeritus of English at New York University and a Pulitzer-Prize winning author, has written in the course of his career a number of histories and biographies that reach both scholarly and general audiences. This account of the life of Samuel F. B. Morse covers all aspects of the inventor's life.

After Morse graduated from Yale University in 1810, he studied painting, gained some success as an artist, helped found the National Academy of Design, and became professor at New York University. Natural philosophy was a strong interest of his, and in the early 1830s he began working on a magnetic telegraph. After a decade of effort and after receiving important help from Alfred Vail, Morse convinced Congress to fund the famous 1844 trial of his telegraph. His system was rapidly adopted in the United States and abroad, and, at a rather advanced age, Morse felt he had at last achieved some success.

Silverman describes Morse's family background, his youth, his education, and his social and intellectual environment. His artistic career is sympathetically described before the telegraph becomes the main interest. Especially detailed is Silverman's account of the struggle to make the telegraph a practical success. Finally, Silverman describes the changes in commerce, journalism, diplomacy, and other aspects of life that the telegraph caused.

The book contains several dozen illustrations, many of them reproductions of portrait photos. Besides an index and photo credits, there is an 8-page listing of documentary and secondary sources on the life of Morse. This is followed by 28 pages of reference notes, each keyed to the associated paragraph in the text.

Swedes Give Bletchley Park Some Competition
by Ernie Teagarden

C. G. McKay and Bengt Beckman. *Swedish Signal Intelligence, 1900-1945*. London: Frank Cass Publishers, 2003. xvii + 310 pp. Illustrations, bibliography, appendices, glossary of technical terms, indexes. $114.95. (cloth), ISBN 0-7146-5211-3.

Reviewed for H-Diplo by Ernie Teagarden, Emeritus, College of Business and Information Systems, Dakota State University.

C. G. McKay, a military intelligence specialist, and Benet Beckman, a former official with the Swedish National Defence Radio Establishment, have written a fine account of the development of Swedish signals intelligence from 1900 to the conclusion of the Second World War. Now commonly referred to by the acronym SIGINT, signals intelligence covers such areas as radio direction finding and monitoring, enciphering and deciphering of messages originally in plain text, techniques of wired and wireless message transmission, and the usages and management of diplomatic and military information gained through electronic interception.

This book could easily serve as the textbook for any Swedish signals intelligence course taught in English. Such courses are hard to find so it may have a better future as a supplemental text or as a primer for the reading public. Some historians do not feel friendly toward subjects which include mathematics and logic in their content and this feeling might deter their use of this book as a supplemental text for a modern history course. On the other hand, faculty who teach electronic signals and/or cryptanalysis courses, or interested laymen who believe Bruce Schneider's *Applied Cryptography* is the crypto-bible, or who read *Cryptologia* may prefer a more technical emphasis. So, this said, what do McKay and Beckman have to say?

They write in a straightforward manner. They start their narrative with basic material like the invention of electronic devices such as telegraph, telephone, and radio, and the practicality of each for civilian and military use. The Swedish industrial structure, which gave some attention to research and development, accepted electronic innovations more readily than did most of its European neighbors. In the years preceding World War I, the Swedish Royal Navy pioneered radio signals intelligence and had successes in monitoring Russian fleet communications. Unfortunately, naval efforts and successes did not yet carry over to other areas of the Swedish establishment.

During the First World War Sweden was a "pro-German neutral." There was little pro-British sentiment in Sweden when the war began, and the imposition of the Allied blockade did nothing to encourage it. Germany received the benefit from Swedish interception of Russian communication traffic throughout the war and even during the early months of the Bolshevik Revolution. The Swedish Ministry of Foreign Affairs provided its facilities to the German Foreign Office for the transmission of its transoceanic dispatches, thus avoiding British interference and censorship. German telegrams to Washington, D.C., alone were said to have reached as many as twenty-two per day before the end of 1914. Called the "Swedish round-about" by the Allies, this operation was discovered by the efficient British "Room 40" cryptanalysts. Anglo-British complaints about the effect of this practice on Swedish neutrality were met by Swedish promises that it would be terminated. The "round-about" never really ceased during the war; instead, Swedish procrastination prevailed. Also, the British could gain some information by reading the German dispatches.

During the interwar period, Swedish signals research led to improvements in organization and technology. In 1927, Swedish intelligence concluded that Soviet fleet headquarters had intensified its interest in Swedish naval matters. Monitoring of Soviet signals traffic was resumed. By 1931 the Swedes had added several more countries to its reading list. During this same period, the Swedes took an interest in the new cryptomachines. Featured was the work of a Russian-born Swede named Boris Hagelin. His first major accomplishment was the construction in 1925 of a cipher machine (B-21) for the Swedish General Staff. Hagelin also supplied the French with an improved version (B-211) of the machine and delivered five hundred units before 1939. Much of what was accomplished in signals intelligence between wars can be attributed to the drive and energy of Capt. Erik Anderberg of the Royal Navy. He supported and encouraged work leading to technical improvement in signals, including machine encryption. Anderberg was appointed head of the Signals Communications Section when the Swedish Defence Staff was organized in 1937. Regardless of Swedish successes, its cryptology staff remained small, about 22 trained people, most of whom were so poorly paid that they had to "moonlight" to maintain a decent living standard.

Swedes Give Bletchley Park Some Competition
by Ernie Teagarden (continued)

At least two incidents stirred neutral Sweden after 1939 to increase its efforts in the area of signals interception. Both must have been frightening. The Soviet Union annexed the three Baltic republics and ultimately defeated Finland in the 1939-40 Winter War. More surprising was the ease with which Germany occupied Denmark and Norway and defeated France in 1940. The authors stress these events in making the Swedes recognize that forewarned is forearmed when it comes to learning what might be Soviet and, especially, German moves on Swedish national territory and its people.

It was given to mathematics professor Arne Beurling to decipher the German messages passing over leased lines in Sweden. These messages originated from Siemens-produced cryptomachines, which the Germans called the *Geheimschreiber* ("secret writer") T52AB. Beurling decoded the operation of the T52AB in relatively short order and, likewise, the improved models which followed. Once Beurling understood how the T52AB functioned, he and his associates were able to construct special decryption machines.

Lines and airwaves between Germany and Norway, Sweden and Finland were intercepted. Diplomatic messages were favored, since the Swedes wanted to know German intentions. In order to better coordinate radio encryption and decryption efforts, the National Defence Radio Establishment was created in 1942 under Commander Torgil Thoren. Placed directly under the Defence Department, its duties were set forth in a royal decree dated June 30, 1942. Swedish signal intelligence accomplishments may have added mightily in keeping the country out of the war.

The authors have accomplished much with this book. They describe the impressive Swedish contributions in the field of wired and wireless communications and interceptions. In both world conflicts the British were dominant in the science of cryptanalysis. Their successes in Room 40 and at Bletchley Park are well known. The reading public, during the past 25 years, has read much about the unraveling of the German Enigma machine, but little has been published about Swedish developments in cryptanalysis, machine driven or otherwise.

The reading public knows of Alan Turing and his decryption efforts at Bletchley Park as well as the construction of his Universal Turing Machine, a precursor to the modern computer. Now the English reading public can know something of the efforts and achievements of Arne Buerling. Had the authors compared and contrasted the work of Turing and Buerling the results might have been interesting. Both spent time at Princeton's Institute of Advanced Study. Beurling received Einstein's old office, a signal honor. Certainly Beurling's hard work did much to keep Sweden neutral and unoccupied.

Antenna is published for the Mercurians, a Special Interest Group of the Society for the History of Technology. Two-year subscriptions are US$5 for delivery in the United States and US$10 elsewhere. Single issues are $1.50 per copy. Please make all checks payable to SHOT in U.S. dollars, write "Mercurians" on the memo line, and mail to ANTENNA, P.O. Box 534, College Park, MD 20741-0534

National Cryptologic Museum
by Pete Sypher

An interesting place to spend a half day on a hot Saturday this summer is the National Cryptologic Museum on a corner of Fort George G. Meade near Laurel, Maryland. The museum is in Building 9900 of Fort Meade, but there are no guards or checkpoints to pass when visiting the museum. Anyone with an interest in radio communications, cryptography, code breaking, or the picket flights we made during the Cold War will enjoy this museum.

Many of the displays, and the special aircraft at the adjacent National Vigilance Park, involve the reception of radio signals. Interception and radio direction finding go back to World War I days, as shown by the then state-of-the-art receiver in the "direction-finding tractor." There is a wall display on the Zimmermann Telegram, in which the Imperial German Foreign Minister proposed an alliance with Japan and Mexico during World War I. The promised reward for Mexico was the return of part of the American Southwest.

There is a lot of electronic equipment for code-breaking intercepted signals, dating from World War II days. The German Enigma and the Japanese Purple encryption/decryption devices are on display with explanatory materials. Our actions in both the European and Pacific theaters of World War II were greatly aided by our interception and code breaking of radio and cable traffic. The outcome of the naval Battle of Midway depended on our code-breaking efforts. You can see a movie about this battle and the role of code breaking in a small theater in the museum.

The museum opened in December 1993. It is one result of an attempt to "demythologize" the National Security Agency (NSA). In the past, NSA was shrouded in almost complete secrecy. In the post-Cold War era, some revelation of NSA's activities was thought to be in the best interests of the agency, particularly with congressional appropriations in mind.

The museum is a creation of the NSA with some assistance from the Smithsonian. The display quality and interpretation of the museum's holdings equal or exceed the Smithsonian's. The museum has a good audio tour available. By stopping at the gift shop and surrendering your driver's license, you get a "portaphone" that has over 60 topics, selectable by a keypad.

Exhibits include a Cray supercomputer, mass-storage devices, and many encryption-decryption devices. These include the venerable KY-3 and the KW-7, and more recent crypto boxes, such as the KG-27, KG-81, KG-84, KG-85, KY-57, KY-65/75, KY-99, KY-100, the HY-2 vocoder and the currently used STU-III. I would venture to say that there are many current and former workers in communication security in our membership who could show their families the crypto boxes they used or installed.

Other displays feature espionage and aerial reconnaissance, and honor those who lost their lives flying in the vicinity of the totalitarian countries during the Cold War. The museum has a library, and you are free to wander through the stacks. Near the entrance are free pamphlets on cryptography, the KGB, aerial reconnaissance and the role of women in cryptography.

Near the old motel building housing the museum is National Vigilance Park. A footpath winds through a wooded area between the museum and the park. Three aircraft are on display, a RU-8D, a C-130 Hercules, and an EA-3B. The Army RU-4D is a modified Beechcraft L-23D tin-engine piston plane with a vertical dipole antenna on each wing, and the C-130A had an extensive suite of radio interception equipment aboard. The Navy EA-3B Skywarrior played a role in the Navy's secret reconnaissance war against the U.S.S.R. and the Warsaw Pact countries.

The museum's hours are 9:00 am to 4:00 pm Monday Through Friday, and 10:00 am to 2:00 pm on the first and third Saturdays of each month. The museum is closed on all federal holidays. It is behind the Shell station at the northeastern corner of the intersection of Maryland Route 32 and the Baltimore-Washington Parkway (Route 295). Admission is free.

The museum's website can be viewed at www.nsa.gov/museum.