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L'ART DE DESCHIFFRER. A SEVENTEENTH-CENTURY TREATISE ON THE ART OF DECIPHERING USED BY THE SPANISH SECRETARIAT OF STATE AND WAR IN THE SOUTHERN NETHERLANDS

Abstract. Between 1668 and 1714, a handbook on cryptography was written in Brussels. It was used by the Spanish authorities (the Secretariat of State and War) in the Southern Netherlands. In 1967, the Belgian historian Jérôme P. Devos published the manuscript. In this article, we present the contents of this publication, highlighting the most important principles of encryption and decryption used in European cryptography.

Keywords: Spanish cryptography; encryption manuals; Southern Netherlands; 17th century

L'ART DE DESCHIFFRER. SIEDEMNASTOWIECZNY TRAKTAT DOTYCZĄCY SZTUKI DEKODOWANIA STOSOWANY PRZEZ HISZPAŃSKI SEKRETARIAT STANU I WOJNY W POŁUDNIOWYCH NIDERLANDACH

Abstrakt. Pomiędzy 1668 a 1714 rokiem został napisany w Brukseli podręcznik z zakresu kryptografii. Był on stosowany przez hiszpańskie władze (Sekretariat Stanu i Wojny) w Południowych Niderlandach. W 1967 roku, rękopis został wydany przez belgijskiego historyka Jérôme P. Devos'a. W niniejszym artykule przedstawiamy treść tego traktatu, podkreślając najważniejsze zasady kodowania i dekodowania stosowane w europejskiej kryptografii.

Słowa kluczowe: kryptografia hiszpańska; podręczniki kodowania i dekodowania; Południowe Niderlandy; XVII wiek

The second half of the 20th century saw a surge in interest among historians in modern cryptography. Noteworthy works from this period include

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those by David Kahn,[1] Charles J. Mendelsohn,[2] Peter Pesic,[3] Claude Dulong,[4] Laurence Dwight Smith,[5] Helen Fouché Gaines,[6] John Laffin,[7] James Westfal Thompson and Saul K. Padover,[8] George Beal,[9] Peter Way,[10] Martin Gardner,[11] Simon Singh,[12] Fred Wrixon,[13] Robert Churchhouse,[14] and many others. As regards the Polish historiography of the late twentieth and early twenty-first centuries, I deal with modern Spanish cryptography.[15]

In 1967, the Belgian historian of cryptography Jérome P. Devos[16] published a seventeenth-century treatise on deciphering secret information.[17]

[1] David Kahn's *The Codebreakers: The Story of Secret Writing* (New York: Macmillan, 1967) and "On the Origin of Polyalphabetic Substitution," *Isis* 71 (1980): 122–27.

[2] Charles J. Mendelsohn's "Blaise de Vignère and the 'Chiffre Carré'," *Procedings of the American Philosophical Society* 82 (1940): 103–29; and "Bibliographical Note on the 'De cifris' of Leone Battista Alberti," *Isis* 32 (1947): 48–51.

[3] Peter Pesic, "Secrets, Symbols, and Systems. Parallels between Cryptanalysis and Algebra, 1580–1700," *Isis* 88 (1997): 674–92.

[4] Claude Dulong, "Les signes cryptiques dans la correspondence d'Anne d'Autriche avec Mazarin. Contribution a l'emblématique du XVIIe siècle," *Bibliotheque* 140 (1982): 61–83.

[5] Laurence D. Smith, *Cryptography: The Science of Secret Writing* (Dover: Dover Publications, 1955.)

[6] Helen Fouché Gaines, *Cryptanalysis: A Study of Ciphers and Their Solution* (Dover: Dover Publications, 1956).

[7] John Laffin, *Codes and Ciphers: Secret Writings through the Ages* (London: Abelard-Schuman, 1964).

[8] James W. Thompson and Saul K. Padover, *Secret Diplomacy. Espionage and Cryptography 1500-1815* (New York: Frederick Ungar Publishing Company, 1965): 253–63.

[9] George Beal, *Codes, Ciphers and Secret Writing* (London: Hamlyn, 1973).

[10] Peter Way, *Codes and Ciphers* (New York: Crescent Books, 1977).

[11] Martin Gardner, *Codes, Ciphers and Secret Writing* (Dover: Dover Publications, 1984).

[12] Simon Singh, *The Code Book: The Science of Secrecy from Ancient Egypt to Quantum Cryptography* (New York: Doubleday, 1999).

[13] Fred Wrixon, *Langages Secrets. Codes, Chiffres et Autres Cryptosystèmes* (Köln: Könemann, 2000).

[14] Robert Churchhouse, *Codes and Cyphers* (Cambridge: Cambridge University Press, 2001).

[15] Cezary Taracha, "Cómo descubrir el secreto de una cifra diplomática," *Investigaciones Históricas* 18 (1998): 109–22; Taracha, "Sekrety hiszpańskiej ambasady w Rosji. Matryca szyfrowa księcia de Liria z 1727 roku," *Studia Rossica Gedanensia* 2 (2015): 360–70; Taracha, "Szyfr Felipe Rodrigueza z 1726 roku," in *Ojczyzna i wolność. Prace ofiarowane Profesorowi Janowi Ziółkowi w siedemdziesiątą rocznicę urodzin*, ed. Anna Barańska, Witold Matwiejczyk, and Ewa M. Ziółek (Lublin: Towarzystwo Naukowe KUL, 2000), 725–44.

[16] Jérôme P. Devos was a honorary professor of the Royal Athenaeum in Louvain. He wrote on early modern cryptography, diplomacy and politics, e.g. in *Les chiffres de Phelippe II, 1555-1598, et du Despacho Universal durant le XVII siècle* (Brussels: Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1950). He edited *Description de l'Espagne par Jehan Lhermite et Henri Cook, humanistes belges. Extrait du Passe-temps, manuscrit II, 1028 de la Bibliothèque Royale de Bruxelles* (Paris: SEVPEN, 1969).

Featured on the title page as the co-publisher is the Belgian Army General Henri Séligman, who died in 1955. Thus Devos wanted to honour a scholar who had been the first to study the text and in 1908 published an article on it in the journal *Revue des Bibliothèques et Archives de Belgique*.[18] The publication, which was financed by the Ministry of National Education and Culture of the Kingdom of Belgium and the University of Louvain Foundation, was issued "in the memory of brothers in arms in the 7th and 34th Artillery Corps of the French Army (1917–1918)".

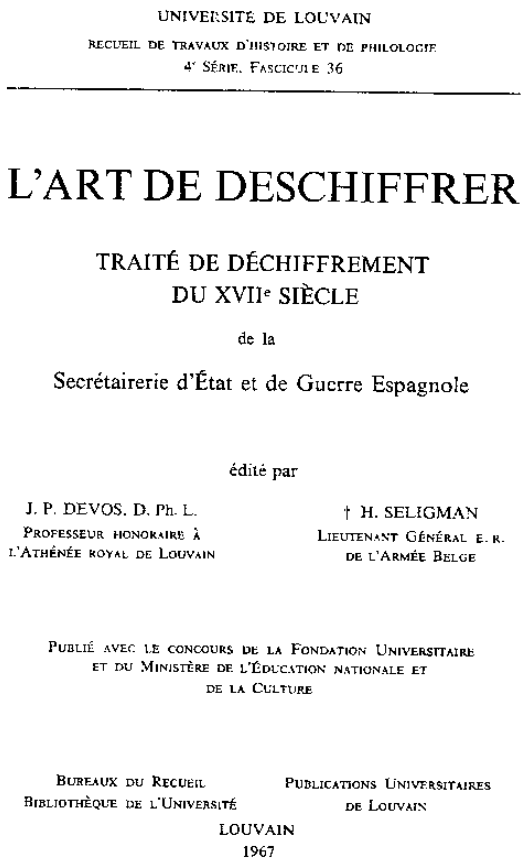
Figure 1. Map of the Netherlands by Johannes Janssonius, https://es.wikipedia.org/wiki/Guerra_de_los_Ochenta_Años#/media/File:Seven_United_Netherlands_Janssonius_1658.jp

[17] Jérôme P. Devos and Herbert Seligman, eds., *L'art de deschiffrer. Traité de déchiffrement du XVIIe siècle de la Secrétairerie d'Etat et de Guerre Espagnole* (Louvain: Université de Louvain, 1967).

[18] Henri Séligman, "Un traité de déchiffrement du XVIIe siècle," *Revue des Bibliothèques et Archives de Belgique* 6 (1908): 1–19.

According to the publishers, the *Traité de l'Art de deschiffrer* manuscript, now at the Archive Générale de Royaume, was written in Brussels between 1668 and 1714.[19] It was used at the Spanish Secretariat of State and War in the southern Netherlands by special cells that deciphered correspondence.

Who wrote this thesis? Devos does not say; instead, he writes that it was person devoted to Spain ("dévouée a la Couronne d'Espagne"), in the service of that state, fluent in French and Spanish, and connected with the cipher bureau at the Madrid Court.[20]



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L'ART DE DESCHIFFRER

TRAITÉ DE DÉCHIFFREMENT
DU XVIIe SIÈCLE
de la
Secrétairerie d'État et de Guerre Espagnole

édité par

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PUBLIÉ AVEC LE CONCOURS DE LA FONDATION UNIVERSITAIRE
ET DU MINISTÈRE DE L'ÉDUCATION NATIONALE ET
DE LA CULTURE

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PUBLICATIONS UNIVERSITAIRES
DE LOUVAIN

LOUVAIN
1967

Figure 2. Title page of the treatise *L'art de deschiffrer*

[19] In the 17th century, Brussels was one of the most important centres in the Spanish monarchy for publishing works on matters concerning the military, diplomacy and cryptography.

[20] The author of the treatise frequently refers to his own experiences, concrete facts, events and people, including letters from the king of France to his ambassador in Nijmegen, which were intercepted in the southern Netherlands, cf. *Traitté de l'art de deschiffrer*, 72: "De déchiffrer en langue francoise un chiffre composé au mois de juin de l'an 1676. L'on intercepta aux Pays-Bas un courrier de France, qui portait des lettres en chiffre au Roy très chrétien par ses ambassadeurs a Nimègue, dont l'original Est entre les mains del autheur du présent ouvrage."

This anonymous treatise (the author would naturally shun publicity) comprises a prologue and ten chapters.[21] For the sake of greater clarity, the publishers have added to the source a contents page listing the titles of successive chapters.

The treatise is in a way a summary of contemporary theoretical knowledge and practical experience of deciphering. It reflects a mentality that was very characteristic of the second half of the seventeenth century, especially with regard to science, art, politics and secrecy. The author argues that "the art of deciphering" clearly differed from other arts and sciences. What else, in his opinion, could include astrology, medicine, jurisprudence, geometry and arithmetic?[22] Therefore all arts and sciences that are based on clear, concrete and generally known principles from which one may draw conclusions. And yet:

> Il n'est que l'art de déchiffrer qui semble n'avoir rien de certain, ny d'assuré qui nous propose une chore inconnue pour venir à la connoissance d'une autre qui l'est encore plus, qui fait chanceller d'abord parmy des doutes et de simpleks conjectures et qui pourtant nous conduit à une connoissance claire et évidente de ce qu'elle cherche, mais avec tant de détours et par une voye si peu attendue que bien des gens ont soulu dire que le hazard avoit mutant de part que le raisonnement dans les succès de ceux qui s'y sont appliquez et qui ont réussy.[23]

Deciphering (decoding) encrypted information, discovering secret messages is for the author of the treatise an "art" (*l'art*). What is more, it is one of the most difficult arts to master. It is therefore a very exclusive art, the preserve of a narrow elite of people endowed with special predispositions and abilities. This was because in the process of encryption and decryption in addition to knowledge of certain sciences (especially arithmetic) of particular importance was the gift imagination and fantasy: "le chiffre dépend de la fantaisie d'un particulier" and later: "tout dépend de l'imagination de celuy qui compose le chiffre."[24] To emphasise the difference between the

[21] Chapter 1: General rules of the art of encryption; chapter 2: Specific rules of the art of encryption; chapter 3: Methods of deciphering simple encryptions, e.g. in Spanish and French; chapter 4: Application of maxims and rules; chapter 5: (untitled); chapter 6: Specific recommendations to facilitate the art of decryption; chapter 7: Application of rules concerning a complex cipher; chapter 8: Methods of decrypting exceptional ciphers; chapter 9: Methods of decrypting another type of extraordinary cipher; chapter 10: On ciphers that are impossible to decrypt.

[22] *Traitté de l'art de deschiffrer*, 1: "Touttes les sciences et tous les Arts ont des principes évidents desquels on forme les conclusions qui s'y rapportent."

[23] *Traitté de l'art de deschiffrer*, 3.

[24] *Traitté de l'art de deschiffrer*, 3.

possibilities of contemporary science and the art of deciphering, our cryptologist makes the following comparison. Even an educated person is unable to alter the meaning of the signs of nature, neither the astrologist nor the physicist is able to start or stop the rain. Yet in the art of ciphering everything is possible. As in Baroque painting, sculpture and poetry, the meaning of signs can be altered at the creator's or artist's whim, and so one day the number 24 may mean the sky, whereas tomorrow it might mean the earth. Here there is freedom to use randomness and apply various other tricks which confront the opponent, armed with knowledge and a desire to crack to the code, with what seems to be chaos and eventually make him doubt his own abilities or even any certainties. He becomes the proverbial Archimedes seeking the fulcrum. Does the art of encryption therefore condemn us to failure? According to the author of the treatise the art of deciphering is the answer to this problem. Let us therefore with pleasure discover its secrets by analysing the successive chapters of *l'art de déschiffrer*.

The first of these presents the general principles of the art of deciphering. Our specialist tries to establish the definition of a cipher as a way of expressing thoughts and communication between people. In his opinion there exist three basic methods of communication: (1) by means of spoken words (conversation), (2) by means of an open written text, (3) by means of coded messages. Thus a cipher is "une troisième signification médiatte des pensées des hommes, réglées et concertée entre deux ou plusieurs personnes pour se faire connoistre leurs sentiments par escrit et les déguiser à tous ceux qui ne sont pas du ministère".[25]

To prove his thesis, the author resorts to linguistic and theological speculation. The first sign (expression) of human thought is the word, thanks to which we pass on our knowledge. The second sign is writing, whereas the third is the cipher in the form of written text which expresses words and thoughts indirectly. Therefore a cipher is in essence the concealing of the content of a text expressing certain intentions and thoughts, i.e. the concealment of the truth about a certain reality. Hence, he argues, it is out of the question that God or the angels would communicate using ciphers. God alone knows the thoughts of all creatures capable of thinking, whereas celestial beings, rooted in the same truth, have no need for secrets.

Further on the author's arguments refer to contemporary philosophy, "psychology", linguistics, music and painting. He maintains that by being produced though the work of organs of the physical body, words are to a far

[25] *Traitté de l'art de deschiffrer*, 5.

greater extent constricted than thought emanating from the soul. Words expressing specific concepts are in turn a combination of specific syllables or other constituents. Out of a limited number of syllables comes an unlimited number of words, as unlimited as in the number of possible sounds in music or colours in painting, where there exist thousands of shades of green. The sheer richness of words rests on just 24 letters of the alphabet. And among them a very special role is played by just five vowels, which are the very "essence of language", serving as bridges to connect and construct.

It is indeed the vowels, which, according to the author of the treatise, define the character and structure of individual languages. Hence in French the most frequently used vowel is *e*, in Italian it is *i*, in Spanish *o* and in Latin *i*. The author also believes that the predominance of particular vowels is related with the nature of particular nations. Thus the vowel *e* is related with the French *doucer*, the cheerful disposition of Italians with the *i*, whereas the *o* with the Spanish *gravedad*. This interesting reflection on the connection between language and the characteristics of nations ends with an important conclusion for cryptologists concerning the particular significance of vowels in the deciphering of texts.

In the second chapter we find some basic guidelines (rules) for decoding and the correct terminology. The author proposes the following preliminary stages of proceeding with ciphered material, leading to the reconstruction of the key (grille cipher).

1. **Identifying the structure and construction of a cipher**. The cryptologist of the Brussels *Secretaría de Guerra y Estado* divided ciphers into simple and complex, regular and irregular. The first division concerns structure. Simple ciphers are ones that only use letters of the alphabet, whereas complex ones comprise letters, syllables, half words and full words. The division into regular and irregular ciphers refers to the relation between encrypted elements and encrypting elements. In regular ciphers the relationship is always the same, the same encryption key always refers to the same encryption element. On the other hand, in irregular ciphers the encryption key refers to more than one encryption element or the same encryption element has various meanings depending on its position in the text.

2. **Identifying the language of the original text (before ciphering).** Indications can be found in unencrypted elements, such as dates, honorifics, use of titles, etc. Of course, not all "black cabinet" specialists received such clues. In European guidelines there are many entirely encrypted texts.

3. **Determining the degree of care in preparing a ciphered text**. For various reasons the person ciphering could make mistakes, unknowingly leaving clues that might facilitate decryption. Conducive to this was routine, a sense of superiority, fatigue, or simple carelessness.

Once the structure and language are identified, one may proceed with the actual reconstruction. Here the author sets out a procedure of five steps:

a) prepare a sheet of paper to write down all the encryption elements (separately: the numbers in natural order as well as the syllables and words in alphabetical order);

b) determine the strength of every encryption element (*la puissance*) by calculating how many times a given element is repeated in the ciphered text;

c) list the encryption elements according to how often they appear;

d) review the 5–6 strongest elements and the proportions between them;

e) try to identify the "blank" signs (*chiffres nuls*), i.e. ones which have no corresponding encryption elements. Based on his own experience in the Secretariat of State for War, the author of the treatise states that the cipher clerks usually (out of convenience) include such characters at the start and end of the encrypted text.

The next chapter is devoted to detailed (theoretical) methods of decoding simple ciphers with regard to the Spanish and French languages. The recommendations are presented in the form of maxims and rules, which were then popular in literature. The maxims have theoretical value and include comments on the strength and meaning of vowels and syllables in both languages. They show the letters of the alphabet in the following order of frequency (strength).

Table 1. The "strength" of vowels and consonants in the Romance languages

Language	**Vowels**	**Consonants**
Spanish	a, e, o, i, u	s, r, n, l
French	e, a, u, i, o	s, n, r, f

Of great significance are also observations concerning the most frequently encountered Spanish and French two-letter combinations (syllables and other structures) as well as the successions of vowels and consonants.

Table 2. Syllables and consonant/vowel combinations

Language	**Syllable**	**vowel/consonant**
Spanish	la, lo, de	on, as, ar, er, en, et
French	re	et, es

Next the author draws attention to the different ways in which phrases and expressions are constructed in each language.

In French expressions there may be as many as seven consecutive vowels (e.g. "Il fait beau savoir"), which does not happen in Spanish.[26] It is moreover rare for there to be more than five consecutive consonants ("fort grand"). But how are we to distinguish between a "strong" vowel and a "strong" consonant when the number of corresponding encryption elements is similar? What does it mean when the same encryption element is immediately repeated two or three times? Answers to these questions are found in the following rules:

1) The same consonant can never be repeated three times in succession, whereas this is possible in the case of vowels:

Iba a Alcala

2) If in one expression or series of expressions the same encryption element is repeated, then it must be a vowel:

conocido, Málaga

3) If we have identified encryption elements for the letters *a* and *s*, then in the Spanish language they most frequently appear in the order *as*:

muchas gracias

4) In both languages the consonant *r* is often preceded by another consonant (br, cr, dr, fr, gr, pr, tr) or in the order r-vowel-r in the case of infinitives:

briller, admirar

5) A characteristic element in encryption is the *que* particle.

6) Two identical encryption characters following in immediate succession may mean double consonants (ff, ll, pp, ss, tt) or double vowels in French:

guerra llamar armée

[26] In encrypted texts the vowel *u* often replaces the consonant *v*.

In our review of the Devos's treatise we shall omit chapter four. This is because it concerns two simple cipher texts (in Spanish and French).

The next two chapters concern decrypting a complex cipher text. Chapter five presents the general rules.

1) In the case of complex ciphers not only the "strength" of individual letters, but also the "strength" of syllables and other elements is important.

2) In Spanish these include: co, de, do, la, lo, me, mo, no, que, re, ro; and in French: ce, de, la, le, me, ne, que, re, se, te.

3) The most common syllable-letter sequences in Spanish are: con-n, como, la-s, mo-s, ne-s; and in French: n-s, n-t, r-t, r-s, de-s, le-s.

4) The letters and syllables that are most frequently doubled in complex ciphers include aa, ff, tt, cc, dd and lele in French and (less frequently) ff, no no, se and se in Spanish.

5) The most frequent x-y-x sequences in French are me-s-me, que-l-que and te-s-te, re-p-re, and in Spanish de-s-de and ta-n-ta.

6) In a structure where the same element is repeated in close proximity two or three times, we may assume that it is a syllable and try and determine the meaning of the word, for instance, as follows:

65.24.65.18.12.65, we assume 65 to be the syllable re,
re.24.re.18.12.re >>> re-p-re-n-d-re >>> reprendre

7) By associating a specific encryption element with a specific consonant, one may speculate on the subsequent syllables. Thus in the case of the consonant *b* the following syllables are possible: la, le, li, lo, lu; ra, re, ri, ro, ru; sa, se, si, so, su; ta, te, ti, to, tu; bla, ble, bli, blo, blu, etc.

8) In the case of the x-y-x-y sequence the most likely expressions in French are che-r-che-r or me-s-me-s

9) Discovering a word (noun) facilitates accompanying articles and/or pronouns

ville > la ville, conde > el conde de

10) In the case of blank signs the same methods of observation are applied as in the case of simple ciphers.

In the sixth chapter of the treatise the author adds a few more detailed guidelines that might facilitate decryption.

First, the cipher bureaus of European ministries of state try to secure in grille ciphers letters that are particularly susceptible to decryption, vowels and "strong" consonants.

Second, in every correspondence particular words appear more frequently, depending on the interests of the author. Capturing the relationship between a particular concept and certain structures in an encrypted text may ease the recreation of a grille cipher. To illustrate this, the author provides the following example:

Hypothesis 1: In the analysed encrypted correspondence there should frequently appear the word *operaciones*. In the text we observe the following structures:

4.46.55.37.4.26.2
9.46.55.37.9.26.6
4.46.55.37.9.26.6
9.46.55.37.4.26.8

Let us note that each structure includes the number sequence, 46.55.37, and the penultimate number is always 26.

Hypothesis 2: 46 = pe, 55 = ra, 37 = ci, 26 = ne.

Hypothesis 3: the vowel *o*, as a "strong" vowel, corresponds to digits in the 4–9 range, whereas the consonant *s* corresponds to 2, 6, 8.

Thus we are able to reconstruct a fragment of the grille cipher:

Letters, syllables	o	pe	ra	ci	ne	s
Digital and numerical equivalents	4,5,6,7, 8,9	46	55	37	26	2,6,8

Third, you can order encryption elements (e.g. syllables) alphabetically, and try to match them with various combinations of digits rising numerically:

ba, be, bi, bo, bu ba, be, bi, bo, bu
25, 26, 27, 28, 29 42, 53, 64, 75, 86

Fourth and final, the basis of success in the art of deciphering are accurate suppositions, assumptions concerning the relationship between the encrypted and encrypting elements. We apply both positive and negative suppositions,

and all assumptions as well as the verification should be accompanied by considerable patience.

In chapter eight the author of the treatise demonstrates the application of the above described rules to complex cipher texts. The final two chapters concern two extraordinary ciphers to which the standard solutions do not apply.

There can be no doubt that the anonymous manuscript found in the Brussels office of the Secretariat of State played a very important role in the work of cryptologists working for Spain towards the end of the 17th century. Finally, we should ask whether the treatise published by Jérome P. Devos has any practical significance for scholars today? The answer seems to be yes. Research carried out over the years in Spanish archives has shown that a significant part of diplomatic and intelligence correspondence has (for various reasons) remained encrypted. If we succeed in discovering the grille ciphers, we will be able to decode texts with ease. In many cases, however, the grilles are lost. In this situation, the only solution is to try and reconstruct the key on the basis of ciphered texts. We may therefore agree with Devos when he writes: "C'est une vraie aubaine de découvrir un traité de déchiffrement. Des cryptologues renommés, tels Alois Meister, le commandant Bazieres, A. Lange et E. A. Soudart, affirment unanimement que ce genre de document est très rare."[27]

Diego Navarro Bonilla, a Spanish historian specializing in research on Spanish intelligence services and modern cryptography, published in 2007 a book entitled *Derrotado, pero no sorprendido: reflexiones sobre la información secreta en tiempo de guerra* (Defeated, but not surprised: Reflections on secret information in times of war).[28] The title perfectly reflects the situation of the Spanish monarchy under the rule of the last Habsburg, Charles II. Spain was losing the battle for world domination in its confrontation with the powerful France of Louis XIV. It was defeated militarily and its political significance was waning, but the country was still able to maintain efficient diplomacy and intelligence structures. They provided Madrid with important information, thanks to which the state government was not surprised by the moves of its external enemies.[29]

[27] Devos, introduction to *L'art de deschiffrer*, v.

[28] Diego Navarro Bonilla, *Derrotado, pero no sorprendido: reflexiones sobre la información secreta en tiempo de guerra* (Madrid: Plaza y Valdés, 2007).

[29] Cezary Taracha, "Unas reflexiones sobre el servicio de información español en la época de los Reyes Católicos y los Austrias," *Roczniki Humanistyczne* 67, no. 2 (2019): 79–110.

According to Mariano Alcocer, the encryption matrices used by the Spanish intelligence services were among the most complex in Europe.[30] The cryptography manual used by the Secretariat of State and War in the Southern Netherlands, discussed in this article, is an excellent example of the reliability of information security, a basic condition for the success of secret diplomatic and intelligence operations.

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