Opportunistic use of GNSS Signals to Characterize the Environment by Means of Machine Learning Based Processing

18 DEFENSIVE ARCHITECTURE OF THE MEDITERRANEAN

Ornella ZERLENGA, Vincenzo CIRILLO (Eds.)

DEFENSIVE ARCHITECTURE OF THE MEDITERRANEAN

Vol. XVIII

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Antoine de Ville and the 'supputation' of the regular fortress (1628)

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Abstract

The contribution, part of the research project PRIN2022 INFORTREAT, proposes an updated critical reading of *Les Fortifications du Chevalier Antoine de Ville*, 1628, specifically of the *Livre Premier–Partie I* (regular fortifications). The author, A. de Ville (ca. 1596-1656), enjoyed a successful career as a military engineer, sharing the 'stage' with the more famous B. F. Pagan (1604-65), and succeeding the first generation of French military architecture treatise writers. De Ville proposed a personal methodology for tracing regular fortifications. His design was based on a fixed dimension of the base side of the polygon, 180 or 150 geometric paces. However, what places de Ville among the innovators of fortification practice are the procedures for the 'supputation' (calculation) of the bastioned front, summarised in a table.

Keywords: treatise, fortification design, drawing, geometry.

1. Introduction

The research presented here is part of the two-year PRIN 2022 project entitled "INFORTREAT: Reconstructing the Early Modern Bastioned Front." This project aims to develop information models for the utilization of constructive knowledge in fortified architecture treatises from the 16th to 18th centuries.

The project's overarching objective is to facilitate access to constructive knowledge pertaining to military architecture, as elucidated in early modern treatises, by utilizing three-dimensional digital information models. These models are designed to be consulted and interrogated by scholars, practitioners, and the broader community.

The project's initial phase comprises an exhaustive examination of military treatises from the 16th to 18th centuries in Italy, France, the Netherlands, and Spain. This aims to identify the geometric constructions for profiling the bastion system and the technological, material, and construction indications for the sections of the system itself, as proposed by the different authors. The objective is to identify recurrent methodologies and techniques, explicit or implicit derivation relationships between one treatise and another, and elements of innovation and originality in fortification techniques.

In this context, the present contribution focuses on a critical analysis of the first book of the treatise on military architecture, *Les fortifications du Chevalier Antoine de Ville* (de Ville, 1628).

2. Methodology

The analysis presented here focuses on the connection between geometry and architecture, including the visual aspects, within the context of the history of representation and the visual culture of military architecture, with specific interest in the already recalled design constructive knowledge. Through their books, the treatise writers acted as conduits for disseminating specific manifestations of the same (Pavignano 2023a, Pavignano 2023c, Pavignano 2024). It is,

therefore, fundamental to consider the science of representation through the analysis of architectural treatises between text and image (Spallone, 2004). Furthermore, the seriality of movable type printing, supported by appropriate techniques of engraving and transposition on paper of the images, is of great significance in this context. This enables the elevation and unveiling of the meaning of the texts to a greater extent (Carpo, 1998). In the context of visual culture, we draw upon the theoretical frameworks put forth by Alpers (1983) and P. Pollak and Somaini (2016). Alpers highlights the necessity of contextualizing any visual artifact within the cultural and social *milieu* in which perceptual habits are formed and sedimented; Pinotti and Somaini emphasize that a defining feature of studies in the context of visual culture is the examination of the circulation and reception of images within a specific cultural context. Thus, the contribution also emphasizes the significance of illustrations in the context of *Les fortifications* and the scientific methodology based on the calculation of angles and segments.

3. Antoine de Ville 1596 – 1656

Of noble origins, Antoine de Ville was born in Toulouse circa 1596. He received a humanistic and scientific education at the *Jesuit College* in Toulouse. During this period, he became acquainted with treatises on military art and architecture by J. Errard, who was at the time the most renowned French military engineer (Pernot, 1978; Pernot, 1987; Pollak, 2010). De Ville's works also demonstrate a comprehensive understanding of the principles of drawing and printing, which we will discuss in subsequent sections.

Upon completing his studies, de Ville enlisted in the French army, where he was employed from at least 1620 until 1624 (de Ville, 1628, p. 91; Pernot, 1987, p. 405). In this initial phase of his military career, he participated in operations against the Protestants in 1620 and served in the Netherlands in 1624. In 1625, he served with his brother in the ranks of the Piedmontese army of Prince Tommaso Francesco di Savoia. In recognition of his service, he was bestowed with the title of *Knight of the Order of St. Maurice and St. Lazarus* on 5 May 1626 (Pernot, 1987, p. 405), and from that date, he started to name himself *Chevalier* (knight). Between 1626 and 1627, he undertook a journey through Italy, traversing the territories of Piedmont, the Republic of Venice, and the Kingdom of Naples.

In 1628, he returned to France and published his first treatise on fortified architecture, *Les fortifications du Chevalier Antoine de Ville*. Subsequently, he may have published a description of Italian monuments. Between 1630 and 1635, he served in the Venetian Republic, working in Dalmatia, Istria, and on the defenses of the city of Pula (Augoyat, 1860, p. 36), where he designed the original project of the Castle of Pula. It seems reasonable to posit that de Ville also had the opportunity to travel to Slavic territories, Greece and Turkey during this period, as he himself states (de Ville, 1639, p. 117). In 1635, he returned to France, having been recalled by Cardinal Richelieu. He undertook many military engineering commissions, including constructing fortifications along the Oise River in 1636. He subsequently served as a military engineer at the fortresses of Beauvais, Landrecies, Castelet and Hesdin (Pernot, 1987, p. 406).

In 1639, he published his second treatise, *De la Charge des Gouverneurs des Places*, which had considerable success and was republished on numerous occasions until the 1860s, remaining in use until approximately 1870 (Pernot, 1987, p. 407). No further information about de Ville was forthcoming. He died in Paris in 1656.

4. *Les fortifications de Chevalier de Ville*, 1628

As already recalled, de Ville first published his treatise *Les fortifications du Chevalier Antoine de Ville Tholosain, avec l'ataque & la defense des places,* in 1628. Before undertaking a detailed critical analysis, it is essential to make an initial methodological observation to highlight a significant aspect related to the publication of the treatise. The volume consulted for this research, preserved at the *Biblioteca Reale di Torino* (1), contains a frontispiece that dates its publication in 1628, in Lyon, at Irenée Barlet, and a *colophon* that confirms the year of publication but states another publisher, Scipion Iasserme (2).

Additionally, the volume contains a dedication, and a sonnet addressed to Prince Carlo Emanuele di Savoia-Carignano. Notably, numerous other editions dated 1628 (such as the one digitized by Google Books) feature a frontispiece dated 1629, a *colophon* dated 1628, both listing Irenée Barlet as publisher. However, these editions lack the

dedication and sonnet to Charles Emmanuel. A comparison of the volumes above reveals a total overlap of chapters and similar pagination, excluding the presence or absence of the dedication and sonnet.

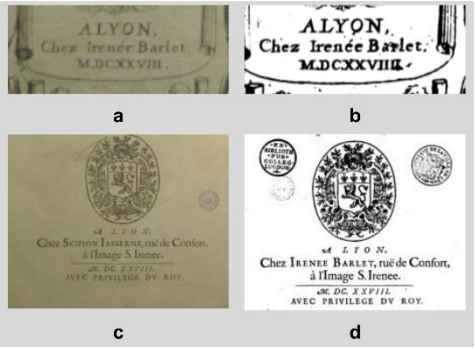

Fig.1- Comparison of editorial data of volumes dated 1628 and/or 1629.

4.1. *Les fortifications*: structure and visuality

The first edition of *Les fortifications* is an *in-folio* volume, with dimensions of approximately 270 × 395 mm. The book comprises nine unnumbered sheets preceding 441 numbered pages, followed by another seven unnumbered sheets containing the *Table des matieres principales* (in alphabetical order). The volume is illustrated by 55 copper engraved plates interspersed with the text; 45 are on a single sheet, and 10 are on a double sheet. Plates include the frontispiece and a portrait of the author. The latter was drawn and engraved by Jérôme David, based on a painting by Artemisia Gentileschi (Pernot, 1978, p. 30). De Ville created all other illustrations through the process of drawing and engraving on copper; in the dedication *Au Lecteurs*, de Ville himself states, «*l'ay taillé les Planches de ma main, afin qu'elles soient plus iustes*» (de Ville, 1628, f. 6r). From the perspective of the science of drawing, this aspect is of significant value, as it demonstrates the author's intention to exercise control over the results of the representation, and consequently, the relationship between text and image. This is evident in the eidetic formalization of visual content and how it is conveyed on paper.

This specific focus on the visual structure of the treatise is not an isolated phenomenon within the broader landscape of military architecture treatises. The most well-known example is that of Albrecht Dürer and his *Etliche unterricht zu befestigung der Stett, Schlosz und flacken* (1527). Indeed, the Nuremberg-born artist oversaw the drawing and engraving of the illustrations in his treatise on military architecture, published in 1527. *Les fortifications* was reprinted both in French (1636, 1641, 1666, 1672, and 1675) and a German (1676) (architectura.fr).

In terms of the topics discussed, de Ville divided the treatise into three books (*livres*), which were divided into parts (*parties*) (Pernot, 1987; Bruand, 1988).

The *Livre Premier, Les fortifications, Attaques, & Defences des Places,* was divided in four *parties*: I) *De la Fortification reguliere*; II) *Des parties extérieures*; III) *De la Fortification irregulieres, & des Pieces qui le sont au dehors del la Place*; IV) *Des Places qui ont moins de six Bastions, & autres indifferents.* The *Livre Second, De l'ataque des places,* was divided in two *parties* I) *Des ataques par surprise*; II) *Des ataques par force.* Il *Livre Troisieme*, *De la defense del places,* è suddiviso in due parti: I) *De la defence contre le surprise*; II) *De la defence contre les sieges par force*.

Livre Premier			
Section	Pages	Plates (x-y)	Plates (n°)
Partie I	1-112	1-16	16
Partie II	113-136	17-20	4
Partie III	139-176	21-28	8
Partie IV	179-208	29-36	8
Tot. Livre I	**208 (47%)**		**36 (65%)**
Livre Second			
Partie I	209-266	37-41	5
Partie II	269-356	42-49	8
Tot. Livre I	**148 (34%)**		**13 (24%)**
Livre Troiesme			
Partie I	357-388	50	1
Partie II	389-441	51-53	3
Tot. Livre I	**85 (19%)**		**4 (7%)**

Tab. 1- Subdivision and percentages of pages and plates for each section of the treatise (by Martino Pavignano, 2024).

The structure of topics reflects the author's practical intentions to provide a comprehensive account of the subject matter, encompassing not only the construction of regular and irregular fortifications but also the external and internal elements of the fortified perimeter, as well as the management of warlike operations, including attack and defence. It is also noteworthy that de Ville dedicated a second treatise to fortresses'

economic and political management (de Ville, 1639). The three books contain a considerable number of pages and illustrations. Table 1 provides further clarification on this matter. A quantitative analysis of the number of pages and plates dedicated to each book reveals that the *Livre Premier* comprises a similar number of written pages as the other two *Livres* combined. However, the illustrations associated with this *Livre* represent two-thirds of the total illustrations in the treatise.

4.2. Plates and illustrations

The 53 illustrative plates have a peculiar graphic structure. They contain a descriptive part of the geometric and constructive characteristics of the elements described in the individual chapters (plans, sections, elevated plans, etc.), summarized by an allegorical and/or descriptive part of war scenes/practical applications related in some way to the topics of the various chapters, as suggested by de Ville: "[…] *i'ay mis la Plante pour coignostre plus facilement le forme & les mesures ; la Prospective, pour s'acoustumer ò prendre le Plan de Places, lesquelles sont le mesme effect que ie les represente veuës de loin : les païsages servent d'ornement*.» (de Ville, 1628, f. 6r).

Fig. 2- Example of visual structure of illustrations, the *planchet 13*.

The threefold function of de Ville's representations is revealed in these few lines: if orthogonal views serve to investigate the geometric aspects of the organisms of the fortified fabric, perspective views allow to verify their spatial, distributive, and altimetric aspects, and 'genre' scenes impose themselves as complements of the visual narrative, sometimes providing valuable elements for understanding military operations (Pernot, 1978; Pavignano, 2023b, p. 232). An illustrative example of this triple function can be found in *Planche 13*, which pertains to *Murailles* (walls) and *Esperons* (buttresses) (Fig. 2). The perspective section that dominates the lower part of the *planche* contains precise indications regarding the design of the scarp of the wall, complete with the graphic scale contained in the picture plane relating to the first type of buttress described. Additionally, the section indicates the presence of a stone *cordone,* a characteristic feature of modern Italian military architecture, and a counter-mines gallery. The title block, held by a *putto* in the lower left corner, contains a geometric scheme for calculating the scarp. The center of the *planche* depicts an 'ancient' fortification situated on a hilltop.

5. de Ville's Sources

De Ville's treatise is situated within the context of the founding fathers of the *alla moderna* fortified architecture of the so-called French School. This group of professionals included C. Flamand (ca. 1570-1626), J. Errard de Bar-Le-Duc (1554-1610), A. de Ville himself, and B. F. Pagan (1604-1665), who was the teacher of both N.-F. Blondel (1618-1686) and S. Le Prestre de Vauban (1633-1707). Upon analysis of de Ville's text, some explicit sources arise. Among them, Errard (1600) is particularly relevant, as it is quoted at the point in de Ville's text (1628, p. 53) where the author is about to define the structures of the rampart, starting at its faces. De Ville's approach differs from that of Errard since he asserts the necessity of starting the defence of the bastion faces from the point where the flanks meet the curtain wall. Additionally, he proposes the inclusion of the second flank, a concept that is notably absent in Errard's work. Still in contrast to Errard's approach, de Ville advocates a system where the flank is always perpendicular to the curtain walls. Another source is the treatise of S. Marolois (1628), referenced in the discussion regarding optimizing the *angle flanqué rectangle*

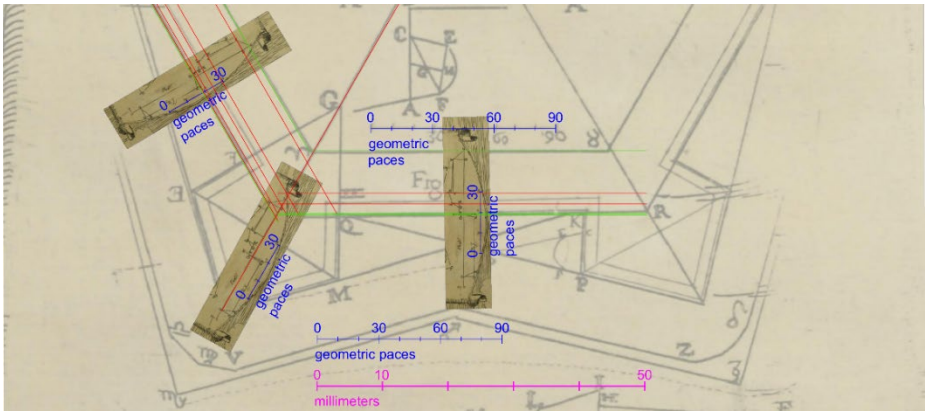

Fig. 3- Correlation between the two projections in *planche 1,* graphic analysis (Martino Pavignano, 2024).

(de Ville, 1628: p. 66). De Ville offers the example as a potential solution for those who mayhave reservations about constructing the acute bastion or rectangle.

He proposed Marolois' solution as a viable alternative (de Ville; 1628: p. 304). de Ville does not neglect to cite the initial published treatise on military architecture, namely Dürer's work (1527), by challenging the efficacy of one of the proposed solutions for the profile of parapets (de Ville, 1628: p. 104). It seems likely that de Ville also refers to Bonaiuto Lorini, citing a certain Laurino whose ditch would be too wide (de Ville, 1628: p. 114).

The sources explicitly cited by de Ville demonstrate the author's attention to the cultural context of reference and situate *Les fortifications* among the main military treatises of that period.

6. *Pour moy i'ay tasché à réduire la Fortification en methode très-facile*

According to the prevailing practice for military treatises of the period, de Ville put forth a personal geometric methodology for the design of the regular bastion system. In contrast to the approach taken by some of his predecessors, he outlines a method starting point from the inner polygon (de Ville, 1628: p. 16), which then passes through the gorge of the ramparts and aligns with the planimetric profile of the curtains. The side of the polygon, referred to as the *costé* or *ligne de defense*, is equal to 180 geometric paces for the Royal fortifications and 150 for the smaller ones. Given that the geometric pace is equal to five *pieds du Roy* (King's feet) (de Ville, 1628: p. 20), it can be concluded that the side of the polygon can be 900 or 750 feet, which is approximately 292.36 and 243.63 meters, respectively, since the King's foot is equal to 0.32484 meters (Martini, 1883: p. 466).

The illustrations on *planche 1* elucidate the procedure associated with a regular hexagon. It presents both a plan and a vertical section of the same fortification, which are supposed to be correlated. Despite the use of two distinct graphic scales, which impede the accurate projective relationship between the two projections (Fig. 3), the relationship between the two is nonetheless evident. Indeed, Figure 2 (the plan) of the table is approximately scaled at 1:5180, while Figure 3 (the vertical section) is approximately scaled at 1:920. In this instance, the author demonstrates an inability to navigate the transition in scale while executing the illustrations independently.

The measurements presented by the author are clearly related to the ballistic aspects of defence conducted using firearms. Indeed, it is the range of the musket – the main defensive weapon in conjunction with the more formidable cannons (de Ville, 1628, p. 5) – that enables the estimation of the plan layout of the bastion-courtyard system. The dimensions of the base side, equal to 180 paces, are derived from the assumption that the range of the musket is superior to this, necessitating the sweeping of the tip of the bastion with flanking fire (de Ville, 1628: pp. 45-46).

De Ville's method was subjected to graphical analysis in Fig. 4. This entailed the following steps: 1) given a circumference, 2) divide its angle at the centre into six equal parts, drawing

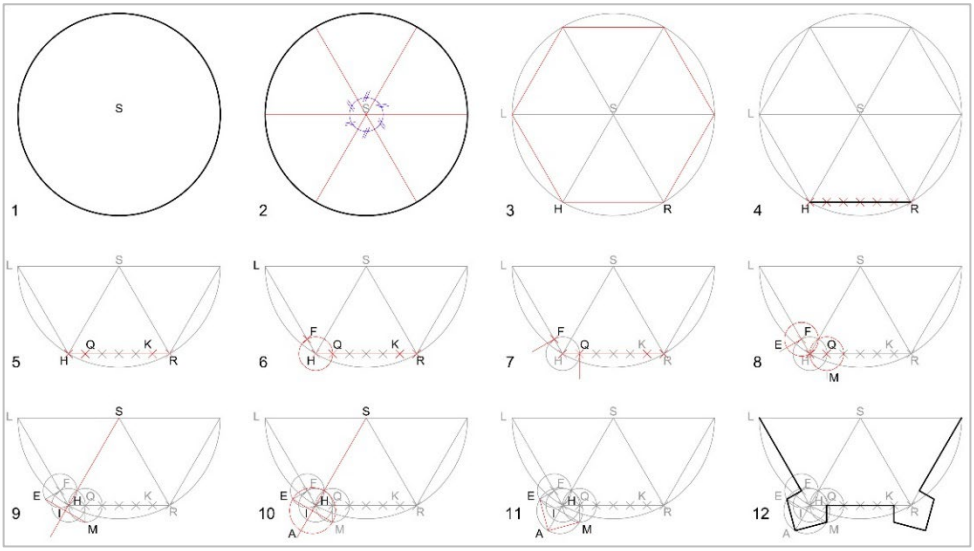

Fig. 4- de Ville's method, graphic analysis (Martino Pavignano, 2024).

the six radii, 3) then define the six sides of the polygon. 4) take the HR side: it should be divided into six equal parts. 6) To draw the rampart on the corner defined by sides LH and HR, defining the second half-gorge HF is necessary. 7) Subsequently, the perpendiculars to the points F and Q are drawn, defining the lay of the flanks EF and MQ. 8) The length of the flanks is equal to that of the half-gorge. 9) Subsequently, the segment ME is drawn, and the radius SH is extended outward from the figure, with the point I located on the segment ME. 10) A circle is centered in point I with an aperture of IE, and an arc of the circle is defined that intersects the extension of ray SH at point A. 11) Segments AE and AM define the faces of the bulwark with an angle between them of 90°. 12) The planimetric profiles of all bastions are obtained by repeating the process for each corner of the defended regular polygon. The author concludes the methodology by delineating three distinct categories of orillons (de Ville, 1658: p. 19).

De Ville's method has an indisputable advantage: it is entirely independent of the unit of measurement employed, thereby ensuring a straightforward and uncomplicated process (3). Nevertheless, the proposed ratio of sizing between half-gorges and curtains, based on the use of the inner polygon and equal to 1-4-1, cannot be considered an absolute novelty for the French School. Flamand, probably inspired by Zanchi, used the inner polygon while establishing a ratio between half-gorges and curtains of 1-4-1 (Flamand, 1597: pp. 86-88). Still, de Ville's work possesses additional strengths. Indeed, the author, arguably the first to write a treatise on military architecture and undoubtedly well-versed in the latest developments in geometry, sought to provide readers of his volume with a practical demonstration of his knowledge on the subject by including a table (Fig. 5) summarizing the calculated sinuses and linear values of the individual segments described in the plans of the bastion curtain system described in *planche 2*, calculated «*par les Sinus, qui sont iusques asteure le plus cognus*» (de Ville, 1628: p. 23).

7. Conclusions

De Ville's design is distinguished not only by the selection of the internal polygon but also by the decision to present the system initially without units of measurement, except for the side of the base of the polygon. Moreover, de Ville innovation was not limited to geometric construction.

The methodology depicted by de Ville is of significant interest for two reasons. First, it represents a clear example of how to trace *alla moderna* fortifications on paper, namely the application of geometry shaping architecture (Fara, 2012); second, it illustrates the author's approach to knowledge transmission, which is mediated and supported by a combination of texts, images, and tables.

Fig. 5- de Ville's table of calculations of each segment of fortifications based on 6 to 12 sided regular polygons.

The *Table pour plus facilment voir le Calcul des figures* distinguishes de Ville's work and, arguably, establishes a seminal precedent in military architectural treatises. The provision of tabular data, previously calculated by the author, assumed a programmatic significance over time for most professionals engaged in fortification studies. However, a notable discrepancy exists between de Ville's table and those of his contemporaries and subsequent authors since de Ville did not provide the calculated values of angles but only their sinuses (maybe because the author referred the *supputation* directly to the calculation of sinuses). For instance, Freitag (1635) incorporated both calculated angular values and the resulting linear values into his tables, whereas Blondel (1683) provided linear values and angular values in two different tables. Nonetheless, de Ville's method might have been a precursor to the system described by Guarini (1676) (Spallone, 2015; 2024). Further investigation of the graphical analysis may reveal additional distinctive features of the *Chevalier*'s method. Still, the illustrations of the treatise define de Ville's visual language and reveal, at times, as much about the fundamental elements of modern fortification construction as they do about the author's own visual culture, which is situated between memory and communicative innovation. Indeed, de Ville's *Les fortifications* fixed a standard for this kind of 'technical' books.

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While the research results from the collaboration between the authors, R. Spallone wrote paragraph 1, M. Pavignano wrote paragraphs 2, 3, 4, 5, 6.

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Notes

(1) The volume belongs to the Saluzzo collection and is identified by the shelf mark F. 171.

(2) It seems probable that the two publishers operated in partnership. Some bibliographical records indicate that they were established together in the following decade (BnF, 2022). The discrepancy between the dates on the frontispieces and those in the *colophons* may indicate a dual production intended for distribution in both Savoyard and non-Savoyard territories. It is therefore possible, similarly to what occurred with Vignola's *Regola delli cinque ordini d'architettura*, to assume a distinction between the two first editions: a first *editio princeps* (Barlet-Iasserme, or de Ville, 1628) and a second *editio princeps* (Barlet-Barlet, or de Ville, 1629). They have the same *Privilege du Roy*, dated August 1628, the same number of numbered pages, 441, and the same 55 *planches*.

(3) A fundamental forerunner was Vignola, who based his *Regola* on the use of the dimensionless modulus rather than on the unit of measurement, which at the time was not standardized and therefore extremely variable. Given de Ville's studies and the success of the *Regola* in the early 17th century, it might have been that the Frenchman knew and appreciated Vignola's 'module' *operandi*.

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