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The Art of War: Tradition and Innovation in the Iconographic Representation of Alentejo Fortresses (17th-18th Centuries)

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The novelties in the representation of strongholds in Alentejo-southern Portugal, frontier with Spain, considered as a "theater of war" during the 17th and 18th centuries-followed European influences, which the theorists responsible for training the engineers in active in the country at this time, Luís Serrão Pimentel and Manuel de Azevedo Fortes, intend to apply. Several drawings bring testimony to this, by showing different ways of representing natural or built elements, allowing for comparisons with other regions of the country or even Europe. The comparison with earlier projects, and given the information contained mainly in the works of Luís Serrão Pimentel and Manuel de Azevedo Fortes, lead us not only to the conclusion of the acceptance of the proposed rules, in order to enrich the profile of military engineers in Portugal, but also to notice the changes that this acceptance signified, emphasizing especially the technical and artistic sensibility of the authors of these projects of military architecture.

Keywords: Luís Serrão Pimentel, Manuel de Azevedo Fortes, military engineering, south of Portugal, modern period, iconography

Introduction

Fortresses and fortifications represent a huge effort and technological progress for the modern period. During this time, fortresses and strongholds reflect synchronous scientific and technological advances, also denote the deepening of specific knowledge that would derive into the appearance of schools and of an immense corpus of treatises. Indeed, the scientific character of these fortifications and the works of military engineering allow us to demonstrate and strengthen the relationship between science and technology from the 16th to the 19th centuries. Fortifications, during this period, expressed, beyond their military content, an ideological testimonial, offering an example of harmony between military techniques and the historical moments.

The appearance of pyroballistic and its widespread usage in the battlefields led to alterations in the fortified spaces, in order not only to improve the fortified structures themselves, so as to enable them to resist attacks, but also to respond to the need of installing artillery pieces and cannons for defence. The bulwarked fortification was conceived not only to protect the surrounding terrain, but also the territory behind it.

The circulation of masters and ideas, in the most diverse domains, characterizes the modern period in a European level. Architecture and engineering were determining fields in this panorama, and, in respect to Portugal, the presence of architects and engineers from Italy, Netherlands, France, and others, would end up influencing creation in these matters. Considering the classical division of architecture into civilian, religious

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and military, the latter was always considered minor by historiography and treatise writers, especially given the primary objective of a strict functionality. Still, the advent of pyroballistic and the greater technical demands in constructions in the modern period, in terms of military architecture, lead to the latter being increasingly considered as a science that should be grounded in practical knowledge, in the field work of military engineers[1].

Already in 1557, Lanterini had thought the fortification as science and an art form, because it called upon mathematical principles in search for forms and proportions. Indeed, if the professions of engineer and architect had been very close since Antiquity, the essential difference resided in the fact that the engineer had the practice of war, originating in the militia; for Sebastiano Serlio, engineers were "*architects of war*", that designed other kinds of buildings during peace time.

The interest in the iconographic representation of fortresses from Alentejo, included in a European context, essentially underlines the idea that they reflect Portuguese culture and knowledge of the world in their time period, especially in areas such as geometry, calculation, and mathematics. Our main goal is to understand the iconographic representation of 17th and 18th centuries' fortress plans in order to register and decode their content, the tools and techniques used on firm ground and in cabinet studies and also the codes that were used[2]. Their observation enables us to analyse the whole process of development of this work, reflecting the training of the projects' authors and the circumstances (political, diplomatic, etc.) under which they were produced, as well as to draw comparisons regarding its technical production. Several phases were necessary until the final draft: with a strong distinction between the field work, an initial and more naturalistic task, and the cabinet work, with more abstract representations. Many of those authors that worked in south of Portugal, such as Nicolau de Langres, drew the representations in the field themselves, aided by some employees and instruments (for example, clocks and quadrants).

The profusion of military engineers and their projects in Portugal, especially in periods considered essential for the defence of the State, such as the second half of the 17th century[3], led to the need of a standardized language that could be, at the same time, highly specialized and easy to read, expressed through different types of lines, colours, and the use of orientation conventions. So, military cartography produced by the military engineers, especially from the 17th century on, resulted from the work of professionals with academic training (Military Academies) financed by the State, and could also be used as an instrument to demonstrate power. The scientific requirements imposed more and more work of rigor and technical capacity, to which many times beauty was joined, and was only possible after the definition of mapping methods especially by Manuel de Azevedo Fortes, with a clear pedagogical function, directed at his students from the Military Academy, and with a constant concern for update, even regarding the literature that served as its basis, the French. Before him, to approach these principles and how they were expressed cartographically, and also in

[1] Antónia Fialho Conde, "Alentejo (Portugal) and the scientific expertise in fortification in the modern period: The circulation of masters and ideas" in Roca-Rosell, A. (Ed.), *The Circulation of Science and Technology: Proceedings of the 4th International Conference of the ESHS*, Barcelona, 18-20 November, 2010. Barcelona: SCHCT-IEC Barcelona, 2012 (pp. 246-252). Retrieved from http://www.hdl.handle.net/10174/6917.

[2] Erwin Panofsky distinguishes between two levels of analysis for visual sources, the iconographic, which is the one we will privilege, and the iconological, which aims essentially at a symbolic reading linked to a particular ideology, an analysis which is much more complex. Erwin Panofsky, "Iconografia e iconologia: uma introdução ao estudo da Arte da Renascença", in *Significado nas Artes Visuais*, São Paulo: Perspectiva, 1979, pp. 45-88.

[3] Antónia Fialho Conde; Virgínia Henriques; Nuno Guiomar. "A costa algarvia três séculos depois-o olhar entre a História e a Geografia", in *IV Simpósio Luso-Brasileiro de Cartografia Histórica*, Porto, 9 a 12 de novembro de 2011. ISBN 978-972-8932-88-6. Retrieved from http://www.hdl.handle.net/10174/4066.

order to establish a comparative approach, we should remember Luís Serrão Pimentel. He had a great importance to the creation of a school of Portuguese engineers according to a method of his own devise, in which the techniques of iconographic representation are also discussed[4].

Portugal in the 17th Century: The European Context and the Innovation of the Portuguese Military Treaties

From the 16th century onwards, Portugal had several initiatives regarding the confirmation of its borders, such as the work of Duarte d'Armas, in 1509. The ascent to the throne of King João IV, on December 1640, meant a new attitude towards the importance of defensive reinforcements in the dry border of the kingdom, with the appearance of a permanent army and auxiliary bodies, and the creation of both a Council of War and a Border Committee [*Junta*] meant to inspect and treat the subjects of fortifications, each with very well defined functions, such as inspecting and dealing with all matters relating to fortifications. The Council and the *Junta* acted based upon new geographical, administrative, and military policies, due to the creation of six military provinces, each with its own governor. Alentejo was the most extensive, with 26,158 km^2. Given its topography, this province was very vulnerable from a military point of view, a fact that justifies the high concentration of modern fortresses, especially during the 17th century: The interventions meant exigency in constructive requirements, also involving knowledge of new techniques and tactics, as in representation and images. Although the forms and symbols used in mapping (such as units of measurement and scales) have started to improve during the transition from the 16th to the 17th century, reaching characteristics of technical rigor only in the following century, the information that they support help us nowadays to interpret/decode the data in these projects, by clearly indicating the options of the architect or engineer in both the military complexes built as well as in the surrounding area. Treaties about military matters, in different languages, influenced the design and production of national projects for military architecture after their circulation, and the information which they contain is essential to decode the military plants or projects, or to understand, for example, changes in the landscape. These were consistent practices, stating how to scratch and watercolour elements in the fortifications already built or projected and surrounding areas (highlighting the differences between basic and thin lines), the use of different colours for works already performed or planned, for the mitigation of shades and colours, in accordance with the terrain or the constructed spaces.

Within this context we find Luís Serrão Pimentel, author of *Methodo Lusitanico*. He was responsible, since 1647, for the course on Fortification and Military Architecture for the education of Portuguese military engineers, at a time in which those working on fortifications were mainly foreign engineers (French, Italian, and the Netherlands), some in the Iberian Peninsula serving the "Philip kings". From a theoretical point of view, Luís Serrão Pimentel based himself primarily on Adam Freitag, Mathias Dogen, Goldman, Marolois, Coheorn, and Stevin, while at the practical level he was inspired by foreigners active in Portugal at the time. We should also stress the fact that the question of topographic survey cannot be separated from the works of military engineering and architecture: The design of fortifications either depended upon pre-existent work at this level or led to the assessment itself, hence the relation between 17th century Portuguese cartography and military engineering. We also believe that several of the implemented projects, although valuable from a military

[4] Antónia Fialho Conde, "«Architectura militar hua sciencia»: Da formação dos engenheiros militares no período moderno em Portugal", in *Ciência, Crise e Mudança-3 Encontro Internacional de História das Ciências e da Tecnologia*, Évora, 26-28 setembro, Lisboa, Caleidoscópio, 2012. Retrieved from http://www.hdl.handle.net/10174/7407.

perspective, do not prove as much from a strictly cartographic point of view (due to the absence of details from the terrain). With Luís Serrão Pimentel we see the achievement of the ambition to educate national masters in the area of military engineering, that would be continued and implemented in the following century by Manuel de Azevedo Fortes's and the book *O Engenheiro Português* [*The Portuguese Engineer*]. This author acknowledges as indispensable to the education of good engineers knowledge in the areas of arithmetic, elements of Euclid, practical geometry, trigonometry, fortification, among others. Attack and defence of strongholds, the usage of the mathematical instruments pertaining to his profession, the method of designing and painting plants and topographical charts with their profiles, elevations and façades and the ability to draw; the good engineer should also not relinquish some knowledge in the area of artillery.

The role of Luís Serrão Pimentel

Luís Serrão Pimentel, author of the first Portuguese treaty about fortifications entitled *Methodo Lusitanico de Desenhar as Fortificações das Praças Regulares e Irregulares*, is essential for researchers in architecture and military genius of 17th century Portugal. The *Methodo* is a military engineering treaty, written in Portuguese, by a Portuguese, that circulated as "manual or syllabus" in the Course of Fortification and Military Architecture in Ribeira das Naus, Lisbon, founded in 1647 at the request of the king of Portugal, John IV. This Course was the first school specialized in military matters in Portugal, where Pimentel taught mathematics, navigation, and military architecture. There, future military engineers of the kingdom could learn the art of designing fortresses, an art based in pure mathematics and drawing. To this training, Luís Serrão Pimentel added, within the study of mathematical sciences, the principles of the design of fortresses, which was called "military architecture" in the Jesuit College de Santo Antão, in Lisbon. There were, in fact, some Jesuits among the major specialists in fortification in Portugal, such as João Pascácio Ciermans (also known as Cosmander[5]), a Flemish mathematician with training in Leuven, a former student of Christopher Clavius and a priest at the Roman College[6]. Cosmander was tutor to the heir of the Portuguese throne, the Prince D. Theodosius, especially in the field of geometry, and when the master retired to Alentejo, the Prince explained to his associates the 6 books of Euclid according with the exposure of Clavius. Beyond geography, the Prince applied to the marine, the hydrostatic and particularly to astronomy, which greatly appreciated, and he was provided with all mathematical instruments. This concern for the education of princes was much older, and Pedro Nunes, in 16th century, was preceptor of Cardinal D. Henry, which was much given to the mathematical sciences, as well as his brother D. Louis, learning arithmetic and geometry of Euclid's elements.

Luís Serrão Pimentel was cosmographer-chief of the kingdom after 1641 (the first year after the Restoration of Portuguese Independence from the Spanish king and his Empire), and finally, after 1671, chief

[5] Cf. Edwin Paar "As fortificações seiscentistas de Elvas e o primeiro sistema holandês de fortificação", in *A Cidade–Revista Cultural de Portalegre*, n 12 (nova série), 1998; Id., "Fortificações urbanas de Elvas: O melhor exemplo actual da Primeira Escola de Fortificação Holandesa" in *Clio: Revista do centro de História da Universidade de Lisboa*, 2006.

[6] He received from D. John IV the rank of colonel superintendent of Engineers, and, as engineer in the province of Alentejo, he renewed, expanded, or rebuilt the fortifications in the region: Fortification of Vila Nova del Fresno, Olivenza (works suspended because of spending), Santa Luzia, in Elvas (according to John Baptist de Castro) and in 1642, with John Gilofo, inspected all the squares border. In its formation, mathematics was very important, because since the late 16th century was an integral part of Jesuit pedagogy, as demonstrates the *Ratio Studiorum* of 1586, thinking that mathematics was the base of medicine, navigation, agriculture, and services to the state. Student of Christophe Clavius, priest at the Roman College, Cosmander, as him, also integrates mathematics with natural philosophy. In Jesuit colleges instruments support classes, such as the use of the compass of proportion, and the mathematics courses show an alert to new theories, also producing many works in the field of trigonometry and arithmetic.

engineer of the kingdom, head of the Alentejo army and lieutenant-general of artillery. Thus, the theoretical influences aforementioned, the physics of Galileo and the Cartesians questions of mathematization of the real influenced the modern science of fortification, from a method based on systematic and scientific knowledge, reaching its perfect expression in Portugal in the theoretical work of Luís Serrão Pimentel, [*Méthodo Lusitanico*], which summarizes his work for 30 years in the Course of Fortification. He was also active in the battlefields, and participated in battles (part of its action involves assistance in the siege of Badajoz in 1658, in battles along the lines of Elvas, 1659, in Ameixial in 1663, as well as in the offensives for the restoration of the city of Évora). From his activity in the field, he devised, or participated, in several projects for fortifications, such as Montemor-o-Novo, S. Luís Gonzaga in Setubal, Evora, and Estremoz. Pimentel also participated in several woks of reconstruction or modification in agreement with his method, improving fortified walls along the borders of Alentejo: in Vila Viçosa, Terena, Monsaraz, Elvas, Campo Maior, Aviz, Crato, Portalegre Alegrete, Marvão, Castelo de Vide, and Niza. We emphasize the educational/pedagogical role of his work, which foresees the creation of a capable body of military engineers in Portugal:

> "The goal with which I have written this work [Methodo Lusitanico], the last one I composed, is to keep the news conserved between us, and so that we can have natural Engineers, having a work in which to learn science, nevertheless experience is very necessary to practice; as everything in this piece comes with lesson, easily, and briefly they become able, in things they come to work, as in those where they will not; because the news of the lesson will empower them for each one; what not succeed only by experience without lessons. (...) This is why not only science nor just experience, aren't enough; both are needed to train a good Engineer. (...) ".
>
> Luís Serrão Pimentel, *Proemio* of *Methodo Lusitanico de desenhar fortificaçoens das praças regulares e irregulares,* 1680.

The *Methodo Lusitanico* is divided into two parts. The first, called "Operative" explains Pimentel's method, meaning that from the drawing of outer polygons to inside, and from proportions, we can set up all kind of terrains regular or not, in a regular frame. The second, entitled "Qualitative" tries to qualify with events and demonstrations, the operations made in the first part. At the end, we find two appendices of comments about the works of Comte de Pagan (*Trignometria pratica rectilinea; Compendio de alguns problemas de geometria pratica e teoremas da especulativa*), where Luís Serrão Pimentel defends the angle of 90 degree against the Pagan's obtuse. The method proposed by Luís Serrão Pimentel transformed military art into an exact science, considering, in the projects to the construction of fortresses, the importance of reason, mathematics, and geometry, giving perfection to the imperfections of the land on which the buildings would emerge. This principle, to place the terrain that would be fortified in a geometric representation of a regular or irregular polygon, was considered by Luís Serrão Pimentel as his own invention, the novelty of his work, reflecting the Cartesian European context. The defence of this method was the result not only of his experimentation on the field but also from the Portuguese experience, and its theoretical learning and updating at the international level. Even though *Methodo Lusitanico* was not printed until 1680, the drawing of some fortifications built before that date in the kingdom (or even in the colonies), such as Castelo Rodrigo, Salvaterra, Alfaiates, Rosmaninhal, Castelo Branco, were inspired in the *Methodo*. The publication of the text was not fast (it was completed in 1666, but 11 years later Pimentel was still asking for the king its publication–which ended up being posthumous). Due to censorship, the publication license dated from 1678. By reading the *Pareceres* (expert opinion) from this censorship, we can gather the contemporary perception and its criticisms regarding

the work and the methods it proposed: to Diogo Gomes de Figueiredo, the work, in general, has to be published because of the important and pioneering concepts "*tam certos e universaes*" that would permit "*fortificar em tudo perfeyto*". It's shown that the method is more accurate than European theories of the time, especially with respect to the angles of the walls and duplication of the building defences; the work is recommended as useful, because it allowed to built faster and easy, avoiding expenses; João Duarte, a specialist in mathematical sciences, emphasized the advantage of a method without fantasy drawings, which was made before as an art and not with accurate principles; João Mendes de Vasconcelos had a similar opinion; he considered the importance of working for the national military engineering, the result of a "*grande estudo trabalho e siencia*" of its author. With this method, eight days were enough for an engineer to master the main points of military engineering. Even though they are aware that this was little time to form a "*perfect engineer*", it was also true that Luís Serrão Pimentel's theory offered a quick understanding of how to design fortification plans. D. Nuno da Cunha de Ataíde also had a very positive opinion: "*me parece que o novo invento de luis serrão pimintel he o milhor, o mais façil e o mais Util de todos os que athe agora se tem achado dos Autores que sobre esta Arte tem escrito* [It seems to me that the new invention of Louis Serrão Pimentel is the best, easiest and most useful of all those who have so far been made by authors who have written about this Art]". Francisco Correia de Lacerda found that it was dangerous for engineers to despise many aspects of the art of fortifying by using only the proposed method, once they could not be discriminated against the thoroughness of an only manual "*huma simples delineação não pode infundir sciencia que comprehenda todas as circunstancias que são necessarias pêra constituir hum prefeito enginheiro.* [a simple delineation can not infuse science to understand all the circumstances that are necessary to constitute a perfect engineer]". Nevertheless, he recognized in the *Methodo Lusitanico* easier rules to learn military architecture. The 3rd Count of Ericeira, D. Luís de Meneses, who spoke regularly with Luís Serrão Pimentel, thought that training engineers based exclusively in this treaty would not be enough, because "*para a forteficação de huma praça são necessárias largas experiencias.* [for the fortification of a place of war broad experiences are necessary]". But it allowed for an easier assimilation of construction rules avoiding the entry of foreigners, once Portugal had already have a Portuguese Manual, an aspect of Luís Serrão Pimentel had already underlined in the Prologue of his work.

The end of the Restoration War against Spain (from 1640 to 1668) meant that, by order of the king, Luís Serrão Pimentel should dedicate himself to the lessons at Ribeira das Naus (Lisbon), and increase the number of students. Once peace with Spain was achieved, the method had no meaning at the dry border of the kingdom, but the training of engineers for the Empire, especially India and Brazil, was a priority, and provided further uses for the theorization of Luís Serrão Pimentel. Regarding the iconography and representation, *the Methodo*, in Chapter VIII, Part I, Section I, called:

> "Words, and Names of the science of the Iconography, or a fortress plant or fortified place with Bastions". In it, Pimentel considers that "architecture is a military science before being an art that teaches to fortify all type of Places, to defend them against invading enemies".

He describes what he calls "*Fundamental*" or "*Iconographic line*" as the continuous ink line. It is through this line that the walls should run. Other dashed lines are imaginary, but they have their own names for good intelligence, science, and calculations.

In Chapter IV, "The way to raise a plant so that it represents the fortification raised on the ground", the author teaches how to draw on paper what can be viewed on site, how to make a two-dimensional

representation, and how to draw fortifications in perspective. The image was essential for learning, establishing a bridge between the mind and the construction of reality. But these images also had codes for their construction, and this demanded knowledge in the geometric and mathematical principles to be applied. It was the use of perspective, in particular the military one or *cavaleira*, the profile drawings and the use of the *flight of bird*, also used in Europe in the architectural treatises. The language with these symbols, codes, and guidelines, used in the plans and military treaties, was based in mathematics and in mathematical education.

Manuel Pinto Vilalobos[7], a military engineer and architect (for the regions of Beira Minho e Trás-os-Montes), was a pupil of Francisco Pimentel, son of Luís Serrão Pimentel, and left written works on military science and technology. He makes use of the graphometer as an indispensable instrument for military architecture, an "*instrument of measurement and calculation of the value angles* [...]. *The layout of polygonal figures fortifications was* [...] *its main target*".

Continuity and Innovation in the Work of Manuel de Azevedo Fortes

The effort to standardize a vocabulary for maps and plans began consistently from the 16th century in Italy and the Netherlands, and would consolidate during the two following centuries, avoiding fantastic speech and personalized maps or with minimized spaces (legends, titles). All this movement is inserted, from the beginning, in the spirit of Humanism and the Renaissance, as we can see in the example of an illustrated edition of Ptolemy, whose symbols were refined until we get to the treaty of Buchotte *Les règles du dessein et du lavis*, 1722, as other similar treaties in France and England (the most recent reported with the survey), contributing to the standardization of the language in military maps. In fact, colour gradually loses its status to be restricted to a decorative, informative, and functional role.

The work of the Portuguese Manuel de Azevedo Fortes in this standardization is acknowledged mainly due to his synthetic character concerning the works of Ozamam (17th century, mathematics teacher, who spread the practice trigonometry applied to topographic surveys), Naudin (1696, with the work of *l'Ingénieur Français*) and Buchotte. Indeed, the teaching of specific contents regarding drawing maps appears in Royal Classes with the works *Tratado do modo mais fácil de fazer as cartas Geográficas* (1722) and *O Engenheiro Português* (two volumes, 1728-1729) both of Manuel de Azevedo Fortes, which would standardize the codes and conventions of cartography in Portugal. In addition to its educational role and synthetic character, Manuel de Azevedo Fortes' work about military plants was also a pocket book, always accessible.

In the remains of Évora Public Library[8] devoted to issues of military architecture and engineering, there is

[7] Manuel Pinto de Vilalobos (?-1734) *Tractado Do uzo do Pantometra de Desenhar as Forteficasoins Asim do lado do Polygono exterior p[ar]a fora, como do lado do Polyg[o]no exterior pera dentro Nas figuras tanto regulares como irregulares Pello Methodo de Luis Serrão Pimentel Eng[enhei]ro mor do R[ei]no e Cosmographo mor delle Tenente g[e]n[era]l da artelheria de q[u]alquer das Prov[in]c[i]as* [Manuscrito] / por M[anu]el Pinto de v[il]a Lobos Capp[it]am Eng[enhei]ro na Prov[i]nc[i]a do Minho [from 1688 to 1697]. (*Treaty of use of Pantometer to draw the fortifications on both from the exterior as interior of the Polygon, in both regular and irregular figures, following the Method for Luis Pimentel Serrao Engineer mor of Kingdom and cosmographer, Lieutenant general of the artillery of any of Provinces*. Manuscript written by Manuel Pinto Vilalobos, Captain-Engineer in province of Minho [from 1688 to 1697]).

[8] Biblioteca Pública de Évora, Fundo da Manizola (cód. 258), *Geometria Especulativa. Trigonometria esférica. Modo de riscar e dar aguadas nas plantas militares*, de Manoel de Azevedo Fortes, manuscript dated 1724 [Évora Public Library, Manizola Collection, Codex 258, *Speculative Geometry. Spherical trigonometry.Way to scratch and give watery in military plants*, Manoel de Azevedo Fortes, manuscript dated 1724] Part of this work was already published in 1722 under the title of the *Treaty of the Easiest Way to Make the Geographic Maps*, and has already been the target of several approaches.

a manuscript dated from 1724, of which we have analysed the last part, crucial for understanding the history of military architecture and engineering, historical cartography in Portugal, Brazil, and colonies (at the time). The goal of this part of the manuscript is to "*understand the practical geometry on paper and on the field; the use of instruments; the way to draw and give aqueous colours in military plants and, in the appendix, rectilinear trigonometry*". The justification, according to Manuel de Azevedo Fortes, was:

> "When the Prince gives order to take a fortification plan, in order to make a judgment of its strength, depending on the terrain that it occupies with their works, and how much enclosure is away from the shots of Artillery, besides the design of the Fortification, the engineer must also configure the terrain to the esplanade, and in this he shows his ability, because it must show mountains, elevations, or elevations of the terrain, valleys, woods, vineyards, gardens, farms, roads, slopes, ravines, quarries, water or wind mills, plowed lands etc., and all this reported, and all the more he found, must be configured in their proper distances and positions".

In the cabinet practice, a smooth and firm table was needed in order not to get the papers mixed or torn. Starting from a sketch taken during fieldwork, the design must be executed in pencil in an orthogonal frame and then with a quill pen. Then inks must be prepared in small bowls or shells, such as suggested by Buchotte. At Fl. 241, the manuscript of Public Library of Évora begins with the *Treaty on how to scratch and illuminate with aqueous in plants of military architecture* in which he mentions several colours and their respective recipes: carmine (from Brazil wood), green (leaves of lily purple), green bladder (asparagus seeds), China ink (from the best indigo), aqueous from rivers, *Rudo* (yellow), aqueous from tobacco, thin vermilion (red) or *Senabre*, shadow of Italy, gold, and silver in shells.

We are interested in highlighting how this *Treaty* influenced the production of cartography in Portugal, allowing us to decode maps made following the codes established by Manuel de Azevedo Fortes, and to understand not only the history of buildings but also the changes on landscape and vegetation. Indeed, the *Treaty* clearly states the ways in which to put aqueous in order to show built parts from the fortifications and their elements (grids, roads covered scarps, dry or watery ditches, and houses) as well as the surrounding spaces (fields, gardens, bushes, trenches, fountains, and rivers).

For the layout of the buildings, the author distinguishes lines he calls *fundamental* (because they are thicker) and those to be used for the body of fortifications and ravelins; with finer lines, grids, roads, and with even finer liner external works (ravelins, counterscarps). The use of colour also differs according to buildings: for those in rock and lime, lines are red; for those built with earth, black. Works already executed must be shown in aqueous carmine, and those only projected are to be striped with little yellow dots, and aqueous of the same colour. An example is the fortification of Almeida, designed by Manuel de Azevedo Fortes:

Manuel de Azevedo Fortes recommends the aqueous layer to be applied with uniform strokes, explains how to do shades, the mitigation of colour, the aqueous from various colours, the representation of squares and grids (aqueous from tobacco), benchmarks and roads covered (aqueous from tobacco or ink), water filled or dry ditches (aqueous streams and small points with aqueous ink, respectively); when the fortification is near the beach small points should be made of aqueous strong Ruão (yellow), with part of carmine, with yellow overlays.

With regards to the presence of Light (*Light and Dark in Plans*), we read that:

> "(...) The Light in a Plan must always be supposed to come from the left, assuming the sun Raised on the horizon, and that the rays of light are the base of the plan in the side of the paper, with an angle of 45 degrees, so that everything shown

in the plan must have its shadow. The shadows must be executed with a feather, wet in black ink, but with clearer lines of the thing we give the shade, and will be crossed with fine lines, almost parallel; other ones that cut first ones, always with more ink, which should be more obscure in places more opposed to the light: afterwards, we will give it an aqueous in the colour of a shade, that is a kind of mineral ink, decreasing to the part where Shadow will end. Regarding the enveloping Places, plowed land must be struck with very fine lines (after divided into courelas) with aqueous soil colour, shadows near the lines, something trembling, representing the swales made by the plow; the ground paths must be represented by lines almost parallel but twisted, in light shade until halfway. Grasslands should be green or green lily flower or clear bladder green, representing the place where the grass was born; hay with yellow dots parallel to the base of the plants. The vines must be scratched with short and fine lines, almost horizontal, with other almost perpendicular, black and after give with green lilies, yellow Ruão or saffron France, staying verdegaio colour. (…)".

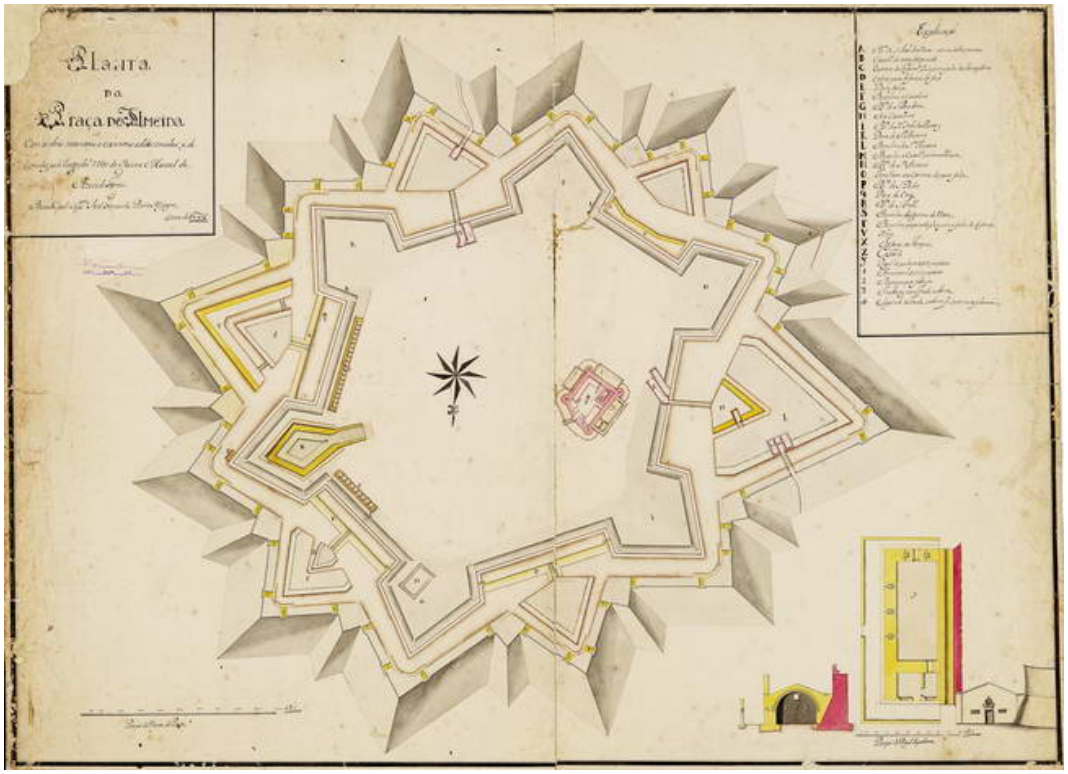

Figure 1. Project of Almeida. Source: Manuel de Azevedo Fortes (1736).

Serpa's project of Miguel Luis Jacob is an example of the application of these indications:

Marshy or flooded sites should be stripped with fine horizontal lines, joined by others with long points representing the reeds; then aqueous streams should be applied, leaving gaps that must take green water lily or bladder. For forests, bushes and woods, trees must be drawn, of different size, with black ink; places of forests, bushes, and trees should have shadows drawn with light green lily, similar to the ones used on hay or grass, and after the ink has dried a shadow made with darker green lily should be applied in the configurations of trees or bushes; it takes on another shadow when it dries in half the tree, and feet brushed with China ink not very dark.

As for terrain elevations, the author recommends:

"(...) Those [authors] who in charts represent elevations in perspective, commit a serious mistake, because they must be represented in plan, without any increase, and how they would be regarded from air, with perpendicular visual rays, called flight bird, we do the representation with black ink, and just thin parallel lines with each other, always following the configuration of the plane on which the elevations are found (…)".

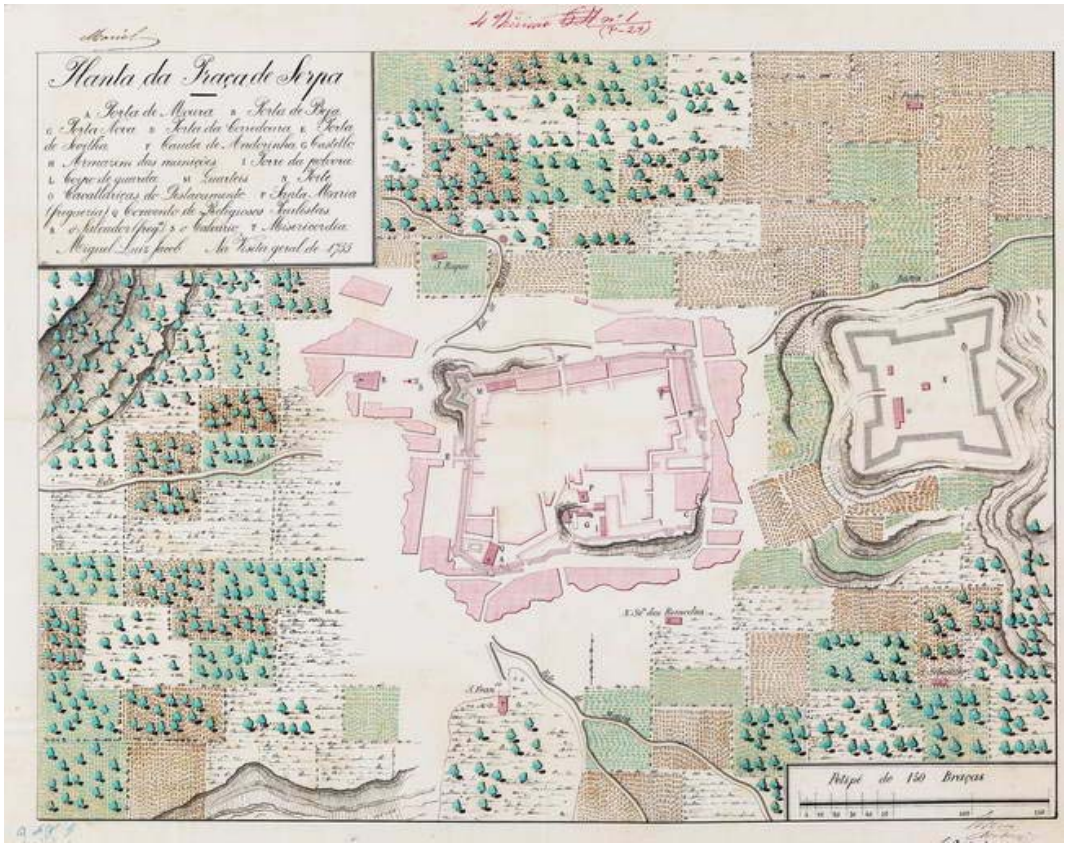

Figure 2. Serpa. Source: Miguel Luiz Jacob (1755).

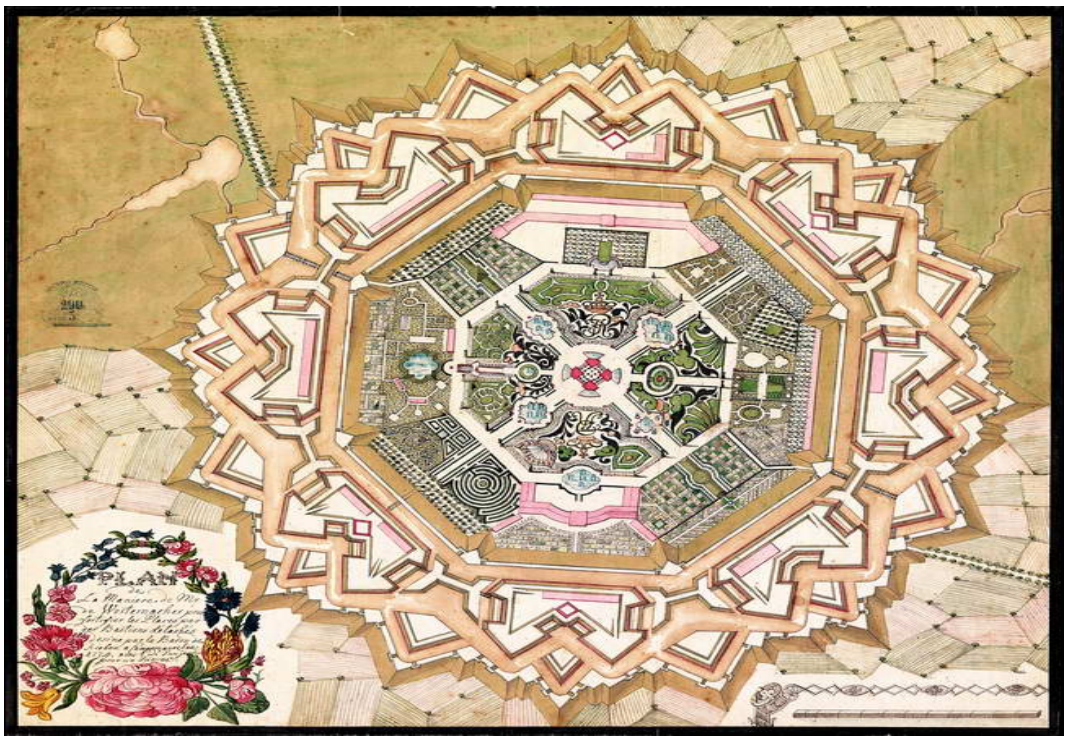

Figure 3. Plan of the Method of Mr. Westemacher to Fortify Places With Bastions, drawn for Campo Mayor, with the idea of a garden for a prince. Source: Baron Rieben (1774).

For gardens:

> "(...) For Gardens scratch squares or parallelograms, or other figures of which they consist, and the divisions are parallel with rays, and they shall present bladder green aqueous, and if that it is clear, and after drying, give long points, but extremely small, with the same green colour, but darker, that represents the plant that divides the marble, or other figures, and inside they are represented with different greens, Carmine points, Vermillion, Roam, and with the variety of Seinople as seems better, and the background colour of the earth, reddened (…)".

This idea of the formal garden, as defined by Manuel de Azevedo Fortes, could as been the inspiration for the project by Baron Rieben for Campo Maior:

Conclusions

Firstly. *Methodo Lusitanico* inaugurates a school based upon a method and a theory, which strengthen theoretical and practical autonomy in military matters, under the patronage of the Portuguese crown, also seeking his statement, confirming the primacy of reason over imagination. The importance of the work can also be assessed by comparison with the results of the European era.

Secondly. Until the 19th century, the work established by Luís Serrão Pimentel and Manuel de Azevedo Fortes aiming to dignify military architecture and engineering was crucial. Nowadays, it is possible to continue working on these documents; they represent the history and memory of the places: Military charts help to understand the *topos* and landscapes, static or dynamic, where colours are crucial.

Thirdly. The comparison with projects made before and after the dissemination of the information available mainly in the works of Luís Serrão Pimentel and Manuel de Azevedo Fortes lead us to the conclusion not only about the acceptance of the rules they proposed enrich the profile of military engineers in Portugal, but also implemented major changes, emphasizing especially the rigor and the usage of a common vocabulary in the authors of the military architecture projects in Portugal.

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