VERNACULAR TECHNIQUES AND LEARNED SOURCES: HOW TO CONNECT BUILDINGS, BOOKS, AND INDIVIDUALS IN TWO SEVENTEENTH CENTURY MANUSCRIPTS

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Abstract:

Reading and writing architectural books is a broad issue in the early modern European world, usually connected with scholarly or at least cultivated courtly milieu. When searching the knowledge transmission methods regarding vernacular construction techniques these books seem almost useless. Yet, it is possible to identify some links between buildings, technical writings, and individuals, somehow allowing us to connect two supposedly separated worlds in architectural and construction culture: the vernacular and the learned. Supported by an ongoing research project, we intend to highlight these links using two sources in particular: the architectural treatise read in 1631 by Mateus do Couto the Elder (ca.1581 – ca.1664), and the measurement's handbook of João Nunes Tinoco (1616 – 1690), both still extant in manuscript format. The examination of these sources reveals an entangled notion in what concerns construction materials and techniques, about which practical issues seem to prevail, but where the ancient citations back up are sometimes still required.

1. INTRODUCTION

The approach we intend to develop is closely related with our ongoing exploratory research project "Vaulted South - Vernacular vaulted houses in the south of Portugal"[1]. Addressing the outdated opposition between the vernacular and the learned, the main issue we want to debate is how can we co-relate construction knowledge techniques between the "high" level of learned sources and the "low" level of ordinary houses that show quite sophisticated constructive skills, as the masonry vaults, that are widely spread in southern Portuguese area.

Reading and writing architectural books is a broad issue in the early modern European world, commonly based on the discussion regarding Renaissance Italian treatises and usually related to architectural education and theory. The articulation between theoretical books and the construction history is a research field that has already been addressed in Portuguese context, with some general works, presenting the subject through time and typology, as the encompassing perspective due to João Mascarenhas-Mateus [1-2]. However, we may detect this knowledge dissemination process in other written sources, not exactly full printed architectural books, which we intend to address from the practical knowledge transmission issue, in search of the connections between buildings, writings and individuals (architects, engineers, masters, surveyors).

Our basic query is to track the possible connection (for slighter it may be) between the vernacular techniques in architectural writings, such as walls and masonry vaults, and its building materials. Some guidance questions were collected for that purpose. Was this sort of practical or technical knowledge restricted to building site transmission among workers or did architects still need to be really acquainted with? Was technical knowledge based on skills repetition only transferred by practice training or were textbooks helpful for that purpose and for whom? Was illustration important and how explanations were transmitted?

Different connections may be detected in the world of architectural education, of the design practice and of the building site monitoring: a chain relating theoretical and practical training, drawing skills, and building site procedures is clearly identified in the framework of the royal buildings administration in Portugal, thus providing reliable data, as shown in previous works [3-5].

As in other European regions, the architectural language was disseminated by courtiers and learned men, and the professional role of architect was officially integrated in building documents only step by step [6]. In Portugal, around 1594, a professionally oriented training started operating under the form of three apprenticeship positions for the learning of architecture, strictly connected to royal works management. The apprentices were trained by the master of the royal works: besides the attendance of the master's daily lesson the apprentices assisted "in the drawings that were made", as in the construction site surveys. Here we may have a reproduction of the old workshop format of knowledge transmission, based in the straight connection between the master and its disciples, yet recognizing the need of a "literary" guarantee.

Tied by an institutional training framework but also by strong family bonds, two manuscripts demonstrate these intertwined learnings. The largest one is headed by Mateus do Couto the Elder (ca.1581 – ca.1664), recording a sequence of lessons read in 1631 and transcribed by Pedro Nunes Tinoco (ca. 1583 -1640): *Tractado de Architectura que leo o*

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Mestre e Architecto Mattheus do Couto o velho no anno de 1631 (BNP Cod. 946). His son, João Nunes Tinoco (1616 – 1690), signed another manuscript, dated from 1660, *Taboadas Gerais para com facilidade se medir qualquer obra do officio de Pedreiro*..., 1660 (BNP Cod. 5166.). The three of them were former apprentices later appointed as royal architects with field and built experience. How their lessons and notebooks present construction techniques transmission, especially the most common or basic ones, will be the main scope of this enquiry.

2. INSTITUCIONAL FRAMEWORK: THE ROYAL POSITIONS

At least since the first years of the sixteenth century, some organizational procedures were codified (in contracts, and regulation documents or *regimentos)* to ensure control over all royal building execution, as some historians have demonstrated [7-10]. Different management positions were presented, where the word *architect* almost does not appear, however featuring the Master of works operating like one (design, drawings), side by side with other workers charged with management and other more technical tasks. These positions or assignments look decisive in controlling the building site: the *provedor das obras reais* (provider of the royal works) ruling the financial resources and the *medidor* (literally measurer), in fact a key figure, which performance in the quantity survey gives back to us not only the measures, but also the materials, techniques and costs; not by chance, at least in seventeenth century, this job was frequently assigned to an architect or engineer.

By the end of the sixteenth century an institutional training framework was organized under the supervision of this management directory. Sometimes mentioned as royal architecture lesson, this professionally oriented training began operating in around 1594 under the form of "three apprenticeship positions (or places) for the learning of architecture" (*três lugares de aprender arquitectura*). The first leading figure was then the Italian Filippo Terzi (1520 – 1597)[2], thus stressing the importance of a learned level architectural apprenticeship, the trace most acknowledged in historiography.

The three (later four) apprentices received a stipend from the Crown and were trained by the *master of the royal works*, which meant that this position was a kind of traineeship, in which the apprentices assisted or served "in the drawings that were made" (the most common expression at the time) as in the royal building sites [3-4, 12].

These "three positions" therefore paved the way for employment in the royal administration, as apprentices were trained to become "architecture officials" in the service of the king. Payed and with a limited number, places were rigidly passed on, revealing a somewhat endogamous tendency to give priority to members of the same family[3]. This resulted in the creation of a kind of "architecture school", in the sense of a methodological tradition transmitted over time, especially recognizable in the palaces and monasteries with royal patronage, with long active building sites.

Moreover, some of the professionals involved worked as civil architects and some as military engineers, while there were others who combined both functions. The remarkable number of engineers that emerged from this apprenticeship undermines the notion that the

[2] For a long time, it was believed that Terzi left his *taccuino*, a notebook filled with notes and sketches, related with the architectural training, but recently research showed that instead is an eighteenth-century manuscript. The first page bears the inscription *Filippo Terzi architetto e ingegnere militare in Portogallo 1578*, National Library of Portugal (BNP), Cod. 1295. [11].

[3] The sequence of members from the Tinoco and the Frias families are the most relevant [10, 13].

training was restricted to civil architecture[4], at least until the Fortification Class started working by 1654 [14].

The apprenticeship process has two main requirements as daily tasks: firstly, the practical training in the art (and the act) of drawing in assistance of the master design role; secondly, the attendance of the architectural lesson. On the one hand, basic training continued to centre upon the traditional method of knowledge transmission, namely learning by doing (that is, helping the master with his designs for the grand royal works). On the other hand, the discipline was approaching a turning point, when drawing would be definitively consolidated as a form of planning or design, and architecture would be understood as the art of conceiving, turning the lesson of architecture the most highlighted feature, also in connection with the remaining texts.

The attendance to the master of the royal works' daily lesson on architecture was compulsory. However, another lesson is always cited as a mandatory condition for admission and retention of the place. This was the lesson in geometry or mathematics, also known as the "head cosmographer's lesson", originally referred to as "João Baptista Lavanha's lesson"[5], which we consider a very interesting point [3-4].

This geometry lesson had an earlier origin. It had been a daily lesson given to nautical pilots which took place in the riverside warehouses (near the royal palace) from at least 1572. Very elementary geometry was taught, such as the correct use of navigational equipment like nautical charts, the astrolabe, cross-staff and quadrant, compass, and sundial. How this cosmography lesson subsequently developed into a lesson on the rudiments of geometry, more or less oriented towards architectural practice, is not really known. All that remains is documentary evidence of the insistence that apprentices attend the "cosmography lesson". As regards the appropriacy of the curriculum of the architecture apprentices, this is a question that is best left open.

After Terzi died in 1597, Nicolau de Frias (? – 1610) succeeded him as master of the royal works, and consequently became the master of the "three positions for learning architecture". Only Filipe Terzi, Nicolau de Frias and later Mateus do Couto are explicitly mentioned in the documents as masters of the "three positions for learning architecture".

3. THE TREATISE READ BY MATEUS DO COUTO

The largest manuscript recording the lesson contents is headed by Mateus do Couto the Elder (ca. 1581 – ca. 1664), who held various positions in civil architecture but was also engaged in military works. He was appointed apprentice in 1616 and soon held important positions as royal architect: architect of the Military Orders (1629), royal sites of Salvaterra and Almeirim, monastery of Batalha and the province of Alentejo (1631), architect of the Inquisition Court (1634), and was commissioned to assist in some fortification building sites near Lisbon (1643) [16]. Later, his nephew, Mateus do Couto the Young, would follow part of this path.

[4] However, in the second half of the seventeenth century, the lesson was more explicitly reserved for civil architecture, although there were still some occasional overlaps.

[5] This lesson was originally connected with the mathematician Pedro Nunes (1502-1578), appointed as head cosmographer in 1547 and obliged to give a daily geometry lesson providing a technical apprenticeship in the art of navigation. Lavanha also wrote a treatise on naval architecture and was the best person to demonstrate the connection between geometry and Vitruvian concepts. His prestige as head cosmographer after Pedro Nunes is testified by the fact that Phillip II contracted him to teach in Madrid in the *Academy of Mathematics and Architecture* (1582-1583) [15].

The codex is entitled *Architecture Treatise read by Master and Architect Matheus do Couto the Elder in the year of 1631* (*Tractado de Architectura que leo o Mestre e Architecto Mattheus do Couto o velho no anno de 1631*)[6], thus presented as a sequence of lectures, here transcribed (without the matching figures, yet with the caption) by a former apprentice and also royal architect, Pedro Nunes Tinoco (ca. 1580-1640), in other words, someone from within. Nevertheless, the link between Mateus do Couto and Pedro Nunes Tinoco is not completely clear, as they were about the same age, and it would not make sense to believe that the latter was an apprentice of the first. Yet we should emphasize that the manuscript is not an autograph text, rather a lesson, which means something to be read and written by an attendee or for training among members of the family Tinoco [13]. The text testifies the learning contents, allowing us to have a glimpse about what was considered important to be known, what was the knowledge expected for a royal architect.

The treatise contains four books (the last of which is very truncated), though there are certainly two others missing, one on military architecture and another on geometry, as it is stated in the text. The contents seem to be organized under educational criteria rather than theoretical, despite the Vitruvian readings and a deeper influence from Alberti's treatise and Serlio's books. Even without the fortification missing part, indications regarding implantation and construction of buildings take a significant extension of pages.

Mateus do Couto aimed to stress the ethical basis of the profession, involving both essentialness and responsibility, and he reveals an in-depth knowledge of Alberti's treatise, which he quotes frequently. Despite all this, it is not easy to distinguish between theory and practice, or rather, between reason and method, between "planning through reason" and "doing through practice", between lineaments and matter, in the manner closest to Alberti's expression. It should be pointed out that the concept of design in architecture is presented very explicitly: "Whoever designs with ease and clarity knows how to show what is conceived in the mind."[7] and this is in fact the main concern of the lesson.

After the main architectural statements, the five architectural orders and its bibliographical references fill almost entirely the First Book, whereas the Second Book is devoted to building organization and construction. In fact, several chapters are dedicated to the basics of construction techniques: the walls, how to assure its structural safety, stonework (materials for/from the stonemason art) and lime mortar making, woodwork for pavements and roofing, tiles, and bricks. Indeed, Mateus do Couto states the importance of the field experience in the building site, the architect "should be mainly very experienced in works"[8].

In fact, the discourse on building materials and techniques are more Vitruvian and Albertian like, a kind of compilation for study, more than a real experienced explanation. The Third Book gives us another reason for understanding the materials and building technique knowledge transmission, however. Even before, regarding materials for wall's construction, Mateus do Couto stresses the need of suitable proportions and the ability in a proper layout of the foundations. In fact, this third book concerns the different types of architectural drawings, underlying the correlation between plan and elevations, the articulation between spatial distribution and the openings, and finally the roofs and ceilings. Unfortunately, the last book (Fourth) has only one chapter and the beginning of a second one, that would be about vaults. Yet, despite the short sentences regarding the issue, he

[6] Biblioteca Nacional de Portugal (hereafter BNP), Cod. 946; the codex has 97 pages with apocryphal numbering.

[7] "Quer que tenha desenho para com facilidade, e clareza sayba mostrar o que concebe no entendimento." (BNP Cod. 946, p. 3).

[8] "[...] deve ser principalmente muito experimentado nas obras [...]." (BNP Cod. 946, p. 4).

clarifies why the architect should be trained on these topics: construction drawings were required.

It is a fact that Mateus do Couto only seems to express the need for construction drawings regarding stone vaults; before he warned that brick vaults were not adequate to inhabitants' health, especially in wet places[9]. Since the information regarding vaulting systems are scarce in this period, and the vault's types are not always easy to recognize in nowadays vocabulary, we transcribe the passage:

"[...] we will deal with the assembly / design [*montear*] of the vaults, so by groins, cloisters, lunettes, pendentives, domes, Squinches, round and round rampant Arches, Ogee arches, three-centered [*sarapaneis*], over-arches, Windows, in corners, Arches or Windows in round towers; so by the convex, as by the concave, cruises of all sorts, so to the modern, as to the ancient, curious Niches, and artifices, [*em bozinados*], as other things concerning to this which you will see ahead.

"First we shall know, that in the making of the trusses, and trace the angles [*ensutamentos*] for carving these pieces with the right cuts, and to order the formwork which is called to assemble / drawing [*montear*]: there is much lack of this, as necessity in these our times, and many of these things are not done if they do not understand; I speak of the officers operating the mechanics as the Architects must know. These drawings [*monteas*] are more necessary than one thinks, because in them is the safety of the works; and because ordinarily we need them. "[10].

Nevertheless, it remains as a teaching method stance, both conservative and pragmatic, explaining the main data interpolated from time to time with the master's own experience and advice. One chapter is dedicated to underwater foundations, almost the most original trace in this sequence, pointed out as a topic about which the ancient writers were silent; organizing some indications and warnings useful both for civil or military foundations, some preferences are chosen: e.g., concave ground is better, and scarps should be wisely used in the walls foundation (in a proportion of five inches of straight wall to one inch of scarp)[11].

An overview on the codex – precisely unfinished when the vault's construction was about to be developed – makes clear his balance. The construction techniques should be mastered by the architect of course, the building must be steady and straight, but the focus is other, however. The master's concern is related above all with the consonance between the design and the drawing – the architect's job – and finally its transposition to the building site. That's why the author states that it is essential that the implantation task (*cordear os*

[9] "Advertindo que as Cazas de abobadas de tejolo cauzam grandes doenças aos habitadores, mormente sendo frescas" (Mateus do Couto, BNP, Cod. 946, p. 28).

[10] "[...] trataremos do montear das abobadas, asim por aresta, engras, lunetas, rincães, meyas laranjas, Perchinas, Arcos direitos, e de viagens, Contraviagens, sarapaneis, sobrearcos, Janelas, em cantos, Arcos ou Janellas em torres redondas; assi pello convexo, como pelo concauo, cruzeiros de toda a sorte, assi ao moderno, como ao antigo, Nichos curiosos, e artificiozos, em bozinados, como outras coisas tocantes a isto que ao diante verão. / Primeyramente hauemos de saber, que no fazer das serchas, e ensutamentos para estas pessas se lavrarem com os cortes certos, e ordenarlhe os simples se chama montear: disto ha tanta falta, como necessidade nestes nossos tempos, e muitas coisas destas se deixam de fazer por senão entenderem; fallo nos officiaes operantes da mecanica que os Architectos obrigação tem de o saber. Estas monteas são de mais necessidade do que se cuyda, porque nellas está a segurança das obras; e porque ordinariamente dellas temos necessidade", (Mateus do Couto, BNP Cod. 946, p. 73), these are the final words of the treatise.

[11] "On building in the sea, or in some impetuous river, and deep, with losing stones" ("Sobre o edificar no mar, ou em algum rio impetuoso, e fundo, com pedras perdidas [...].", BNP Cod. 946, pp. 32-33).

edifícios) must be followed by the architect himself, as the royal regulations establish, actually [13, 17].

Likewise, also the measurement tasks were crucial and apparently not so easy to perform. This sort of survey was regulated, and the surveyor position could be assigned to stonemasons, carpenters, architects, engineers. All of them had to manage their expertise on the job and several notebooks are attached to the topic. The link between the learning / learned level and the construction know-how is somehow stated, and all connections with a vernacular stance should be made only very carefully. The architect was (is) a mediator between drawing-design and the building site working tasks.

4. THE MEASURING BOOK BY JOÃO NUNES TINOCO

João Nunes Tinoco (1616 – 1690), also former apprentice (appointed in 1631) and royal architect (appointed in 1665) with a long built curriculum [13], son of Pedro Nunes Tinoco, keeper of Couto's lectures and certainly his reader, signed a manuscript, dated from 1660: *General tables to easy measure all kind of work of stonemason craft, as of masonry, with other various curiosities on practical geometry much needed for the same effect of the measurements*[12] [18].

Somehow, these writings demonstrate the architect's commitment with the building site sufficiency. João Nunes Tinoco was then an important architect with large activity and engagement in fortification surveys too, however he organized this compendium explaining the most basic operations in measurement. Paulo Varela Gomes [19] already noted that there is any theoretical remark, being only a usual handbook rooted in the European old tradition of knowledge transfer among stonemasons, still alive in the seventeenth century and used by those, he argues, who conceived architecture more as a technical accomplishment than a Vitruvian set of rules. Moreover, the owner of the book was a friar who held the position of Master of the Province of Portugal Works of the Augustinians, which means a senior architect in a religious order, thus revealing a much more intertwined learning.

This handbook, as others, explicitly serves all types of building measurements. It is composed by a long sequence of tables from the basic arithmetical operations (including knowing by heart the multiplication table of Albrecht Dürer, still summoned by that time) and units of measure equivalence, followed by detailed explanations with practical exercises. Here the scope is to learn the calculations, the material construction explanation is absent, and only the list of different kinds of walls, vaults, roofs, tiles, water pipes, is given to the reader. Special instructions are added for big enterprises, such as palaces as fortresses, again calling the specificity of the wall scarps, as the vaulting concave surfaces, requiring fewer simple procedures for measuring.

As a handbook with the commitment to be as practical as possible, in part it is devoted to a precise counting of materials needed to build and budget the works, giving in advance the description of the Portuguese units that are used, and further the geometrical knowledge needed for the calculations. In this sense, the manuscript starts with the *General measures of Portugal*, from the small quantities and elements to rural or urban lands' measurements. It addresses not only the quantities of materials used in different types of constructive elements but also the way to be transported. As an example, for the construction of one *braça*

[12] *Taboadas Gerais para com facilidade se medir qualquer obra do officio de Pedreiro, assim de cantaria como de Aluenaria, com outras varias curiozidades da geometria pratica muy necessarias para o mesmo effeito das mediçoensfeitas pello architecto de Sua Mag.de João Nunes Tinoco. Em o anno de 1660*, BNP Cod. 5166.

(a Portuguese unit of length corresponding to 10 x a span, i.e., 2,2 meters) of a simple vault it is necessary three hundred and twenty bricks and for a doubled vault, six hundred and forty bricks[13]. So, the first section is the presentation of a range of tables to measure different works: stone works (*pedrarias*), girts (*cilhares*), slabs (*lagedos*), walls and vaults, followed by the section *Explanation of the exposed Tables and their use. Reasoning and intelligence*[14], followed by an example with the application of the method.

The procedures taught aim to cover all the range of buildings, from the current ones with a small scale (for which the tables have direct application), to bigger buildings such as palaces, noble houses, city walls, fortresses, or convents (for which it is needed to double the tables' quantities), as it can be noticed in the passage:

"[...] It is to be reminded, that in the event of measuring some great building of a palace, or noble houses, or walls of fortresses, or walls of cities, or towns, or other thing of great work, such as convents, and walls of fences, or farms, in which a great quantity of spans is found in the measurements, which exceeds and exceeds the number comprising each of the said tables. In this case the numbers will be doubled where necessary, or it will be searched in the columns of the spans included in the ten tables until the number of the spans are found in the measurements that are made of the things said."[15]

After the tables' presentation and explanation, Tinoco presents the *General warnings that are practiced in the court of Lisbon and throughout the kingdom about the measurements of the works*[16] applied to roofs. It is followed by the *Brief treatise of the things most needed by the Measurer To do the accounts of the measurements more easily*[17], and "supposing that one must first know very well the four principal species of Arithmetic, namely, to add, subtract, multiply, and divide. And for that we put the following table here to bring well in the memory", taking as an example the different ways and units for the measurement of walls.

Tinoco keeps going by approaching geometrical calculations, e.g. "how circular lines will be extended", to then introduce the way for measuring different geometries of vaults: "Measurement of the concave of a brick or stone dome"[18], leading to the application of a

[13]"[...]A braça de abobada singella leva trezentos e vinte tijolos. E a dobrada leva seiscentos e quarenta tijolos." (BNP Cod. 5166, p. 3).

[14] "Explicação das Taboadas retropostas e do uzo dellas. Advertencia e a inteligencia". In that explanation, the ninth and tenth tables are devoted to the vaults: "[...] The Ninth and Tenth Tables, which are entitled Vaults contain 1000.00 surfaces reduced to the measure of doubled or simple brick vaults." ("A Nona e a Decima Taboadas, que tem por titulo Abobadas contem 1000.00 superfeciaiz reduzidos a braças de Abobadas de tijolo dobradas ou singellas", BNP Cod. 5166, p.11).

[15] "[...] Adevirtasse que sucedendo medirse algum edificio grande de hum palacio, ou cazas nobres ou muralhas de fortalezas, ou muros de cidades, ou villas, ou outra couza de grande fabrica como sao conventos, e muros de cercas, ou quintas, em que se ache nas midiçoens grande quantidade de palmos, que exceda e passe do numero que comprehende cada huâ das ditas taboadas. Neste cazo se dobrarão os numeros aonde for necessario, ou se buscarão pellas columnas dos palmos incluzos nas ditas dez taboadas athe perfazer o numero dos palmos que se acharem nas ditas medicoens que se fizerem das couzas sobreditaz." (BNP Cod. 5166, p.12).

[16] "Advertências gerais que se praticam na corte de Lisboa e em todo o reino sobre as medições das obras" (BNP, Cod. 5166, p.13).

[17] "Supondo primeiro que hade saber muito bem as quatro especies principais da Aritmetica a saber somar, diminuir multiplicar repartir. E para isso pomos aqui a taboada seguinte para se trazer bem na memoria", in *Breve tratado das coisas mais necessarias ao Medidor Para fazer as contas das medicoens maiz facilmente* (BNP, Cod. 5166, p.16).

[18] "Como se estenderam linhas circulares" and "Medição do concavo de hua Meya Laranja de abobada de tejolo ou de pedraria" (BNP, Cod. 5166, pp. 25 v., 27).

precise example such as "Measurement of a house closed by a groin or cloister vault"[19], with all the calculation recipes given the material used, if bricks or stone. Then, he continues the explanation of how to measure "round vaults in barrel mode", recessed vaults or *sarapaineis*[20] and gives the estimation of the quantity of bricks needed to build a *braça* [2,2m] of doubled or simple vault[21]. By the end, a section with geometric drawings includes the geometry of recessed vaults "by the third and fourth part" and by "the fifth and the sixth part"[22].

The Tinoco's handbook was explicitly done to be an instrument to instruct other architects builders, with a careful calligraphy and text organized within frames[23]. Those architects probably took their own notes too. It is what an anonymous manuscript from the last quarter of the seventeenth century points to. The contents of *Measurer for military and civil architecture works both by stonemason as by carpenter, painting, sculpture, blacksmiths, and locksmiths*[24] are related to Tinoco's teachings, not as a direct copy of the manuscript, but as a reorganization of some information that Tinoco presented separately: it is organized in 22 chapters with a faster handwriting, as a personal notebook. The relationship between the two manuscripts, or others produced in the same context of knowledge transmission from a master to his students, could be deepened in further studies.

5. CONCLUSIONS

The two seventeenth century sources analyzed above show primarily both an institutional training framework and a family bond in the learning transmission sequence. The large experience in built works that these two architects have is the basis of the scientific and practical knowledge necessary for the writing of these manuals, intended to teach others about how to build, or how to plan the building process.

The unfinished "treatise" (or lessons) read by Mateus do Couto the Elder in 1631 demonstrates a deeper concern regarding the learned sources quotation, thus the concern to upgrade the level of royal architects, almost the only individuals officially named as so. The early modern requirement of architectural design materialized in drawings was by then firmly established.

When dealing with construction materials and techniques, whether simple or complex, Mateus do Couto carefully follows these learned sources, there is to say, the Ancient and Modern matrix of architectural theory, Vitruvius, and Alberti. Customized professional experience barely arises in the book, yet it is present and generally stated when needed. This "learning book" indeed features the basic theoretical knowledge the architect was required to show, and we may perceive that even a simple set of masonry walls should be conceived and designed properly, designed and calculated to communicate with the building site

[19] "Medição de hua caza fechada de abobeda de aresta, ou barrete" de tijolo ou de pedraria (BNP, Cod. 5166, p. 28).
[20] BNP, Cod. 5166, pp. 31,32.
[21] "Como se sabera quantos tijolos leva hua braça de abobada dobrada ou singella" (BNP, Cod. 5166, p. 34).
[22] "Forma de sarapaineis ou abobadas abatidas pela quinta parte e pela seista parte, como se ve nestas duas figuras" and "Forma de sarapaineis e abobadas abatidas pela conta da 3ª parte e da 4ª parte" (BNP, Cod. 5166, p. 43).
[23] This fact leads to the conclusion that probably it had a previous draft, once in the end some drawing captions stood alone since the drawings were not made.
[24] *Medidor das obras de Architetura Militar e Civil assim de pedreiro como de carpinteiro, Pintura, Escultura, ferreiro e sarralheiro*, after 1673, BNP Cod. 5167. [19]

workers, the ones that were not acquainted with the correct rules and proportions. Thus, the learned level is somehow a methodological construction, more than in the final building materiality.

Concerning Tinoco's document, his approach to construction materials and techniques presents a more practical perspective directly to be employed in the constructions, and references made to the learned sources are scarce (only to the Albrecht Dürer's multiplication's table). His pragmatic sense (through the dissemination of measurements tables and respective practical examples) brings his "handbook" closer to the builders of the construction sites than to the apprentices of the classes, like with Mateus do Couto "learning book" manuscript.

Our aim was to track the possible connections between vernacular techniques in the architectural writings and building materials. Indeed, these can be directly associated through the case of the constructive system of vaults, revealed briefly by Mateus do Couto and deeply by Tinoco, applied as a roof or a pavement construction solution. For that purpose, a geometrical and arithmetical knowledge must be acquired by the "builder" to draw, project, calculate, budget, and build a vault as a constructive system. This premise leads to the context where that knowledge is shared, strengthening the idea that both architects, builders and even the commissioner of complex buildings, need to be really acquainted with this kind of scientific and pragmatic know-how. Moreover, this architectural knowledge transfer occurred clearly at the classes, and outside them, at the building sites. In fact, the use of textbooks (sometimes using drawings and often tables) was helpful for the transfer of technical knowledge among those involved in the construction of buildings, where training took place through practice and repetition of skills, whether of architectural forms, constructive solutions, or textbooks.

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