Chapter 58
António Rodrigues, a Portuguese Architect with a Scientific Inclination

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Introduction

Mestre António Rodrigues (ca. 1520–1590) has been only recently acknowledged as an important personality of Portuguese architecture, in spite of his promotion to the post of First Architect of the Realm by D. Sebastião, in 1565, after Miguel de Arruda, and to Master of Fortifications, in 1575, after the death of Afonso Álvares. He performed both tasks for 15 years, which constitutes a unique event in our country (Moreira 1993: 148).

We owe to Rafael Moreira this re-evaluation; he calls Rodrigues “a Portuguese architect with a scientific inclination” (Moreira 1982: 56). Moreira attributed to Rodrigues the authorship of a Tratado de Arquitectura (Treatise on Architecture),¹ which was the textbook for the course in military architecture (Lição de Arquitectura Militar) for which Rodrigues was responsible in the School of Moços Fidalgos do Paço da Ribeira, as well as the architectural design of the church of Santa Maria da Graça in Setúbal (presently the Cathedral), for which Moreira found documentary evidence. On the basis of stylistic evidence, he also attributed to Rodrigues the Onze Mil Virgens Chapel at Alcácer do Sal, an addition


¹ Two versions of this Treatise exist: a preliminary version (Biblioteca Nacional de Lisboa, Cod. 3675 (Rodrigues 1576)) and another, revised for print ca. 1579 [Biblioteca Pública Municipal do Porto Ms. 95 Rodrigues (1579)]; both are incomplete.

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to the church of the convent of Santo António built as a mausoleum for Dom Pedro de Mascarenhas.²

In fact, these attributions confirm:

– A solid theoretical formation, classically based, built on treatises, mainly those written by Vitruvius, Serlio and Pietro Cataneo, and most probably nurtured by direct contact with the Renaissance homeland. King João III used to encourage learning in Italy; besides it is hard to believe that the architect of the Onze Mil Virgens Chapel did not have firsthand knowledge of his sources.

– A pedagogical viewpoint in conformance with a teaching model in which, according to Vitruvius, an architect’s formation could not be conceived without a strong scientific basis of mathematics, especially geometry, but where astronomy, music and the disciplines of the trivium were also taught.

This was indeed the method of teaching that took place at Paço da Ribeira’s School founded by Pedro Nunes, who was the director of the courses of mathematics and cosmography (the humanist philosopher João Pedro Lavanha was also part of its teaching staff). It was later closed by Filipe II, the first king of the Spanish dynasty in Portugal, and transferred to Madrid where it gave rise to the Academia de Matematicas y Arquitectura directed by Juan de Herrera.

– The capacity to translate this knowledge into built work and to achieve results of undeniable architectonic quality, the greatest being, in fact, the Onze Mil Virgens Chapel (c. 1565), built of pink marble from Estremoz (Fig. 58.1). The Cathedral of Setúbal (c.1570), with specific typological and programmatic constraints, is nevertheless a well-executed work.

In fact, both the Onze Mil Virgens Chapel and the Cathedral of Setúbal show a rigorous geometric structure, as expressed in the proportions and the purity of the stereometric shapes that were used as well as in the clarity of their spatial articulation. These characteristics are reinforced by the assuredness of a strong, clean drawing technique, which is a fundamental vehicle for its poetry.

The Onze Mil Virgens Chapel

The founder of the Onze Mil Virgens Chapel, Dom Pedro de Mascarenhas, was the well-known ambassador for King João III at the papal court in Rome and at the Emperor Charles V’s Austrian House in Brussels. This has most certainly influenced the exceptional character of his chapel.

²Other works by António Rodrigues are the Igreja de São Pedro de Palmela and the Igreja da Anunciada de Setúbal, no longer in existence, as well as the Chapter Room and Sacristy (demolished) from the Convento de Jesus de Setúbal, according to documentary evidence found by João Custódio Vieira da Silva.
This highly cultivated and cosmopolitan man, who was familiar with the artistic ways of his time as well as to some of its key personalities (he met Michelangelo during his stay in Rome, according to Francisco d’Ollanda), died in 1556 while a viceroy in Portuguese Indian colonies. He had trusted António Rodrigues with the mission of erecting at his homeland a Roman-style work worthy of his prestige—a sepulchral “temple” for himself and his family (where the relics of the virgins, among others, would be kept) near the church of the convent of Santo António commissioned by his mother, Dona Violante Henriques, the wife of Dom Fernando de Mascarenhas, Governor of Alcácer.

This determination to tie the new sepulchral chapel to the church, permitting their interconnection through an opening in the wall that becomes the link between the two spaces symbolically celebrating the union of mother and son, was bound to determine the spatial design of the new chapel, as well as its dimensions and proportional relationships.
The Franciscan church commissioned by Dona Violante between 1524 and 1528 (Fig. 58.2) is formed by a double-square nave, and a presbytery corresponding to a square plus a half to include the sacristy and a stairway, the whole being a rectangle of the proportions 3:2. Belonging typologically to the family of small single-aisled Romanesque and Gothic churches, it differs in the scale and in the nearly-square proportion of its transversal section, as well as in the presence of Renaissance architectural elements. Its main porch, indisputably Lombard, testifies to Dom Pedro’s mother’s appreciation of new architectonic styles.

Fig. 58.2 Plans of (A) the Santo António Church (left, 1528) and (B) the Onze Mil Virgens Chapel (right, 1565 ca.) [(a) nave; (b) sepulchral chapel; (c) reliquary; (d) altar; (e) sacristy); (C) galilee, constructed after 1565. Drawing: author
The Onze Mil Virgens Chapel (the Portuguese name means “chapel of the eleven thousand virgins”) was designed to sit side by side with the convent church nave, sharing its delimiting south wall, and adopting the same length (16.60 m or 77 palms) through a complex construction process, which entailed the demolition and subsequent reconstruction of this shared wall.

If this dimension, 16.60 m, is divided into three parts, and an allowance made for twice the thickness of the pilasters that support the triumphal arch (62 cm, nearly two palms and 7 in.), the result obtained is the side of the square sepulchral chapel where Dom Pedro’s remains were buried, the nave of which consists of a double square plus the above-mentioned dimension (Fig. 58.3).

The square piers of the serliana that divides the nave of the chapel and the church have a square section with sides measuring 62 cm. The theme of the repeated use of sides and diagonals of squares, reminiscent of ad quadratum geometry, begins here: the sides of the piers, 62 cm, and their diagonals, 87.7 cm, form the modules, combining to produce the length of the sides of the three squares that form the chapel, 5.11 m (4 sides \(2 \times 62 \text{ cm} + 3 \text{ diagonals} \times 87.7 \text{ cm}) = 5.11 \text{ m}, a deviation of only \(-0.0016\,\%\)) (Fig. 58.3a).\(^4\) The fact that the width of the pillars is not a round number (for instance, three palms) may be due to the fact that the dimensions of the pre-existing church conditioned those of the new chapel. The chosen dimension could be more convenient for establishing the connection between the general dimensions and the modular ones. Under these circumstances, it seems that the definition of the module was not done a priori.

As the sepulchral chapel is the main purpose of the new “temple”, this space becomes the prevailing element of the composition. On axis with the nave, in the position of a non-existent crossing, it precedes the presbytery in the east, which is subdivided into two spaces, the altar area and the relics’ enclosure. Presently separated by a railed opening, once the enclosure for the relics must have been closed by a double portal (the rabbet and some traces of former hinges are visible), which probably was a diptych. A difference in the floor level accompanies this spatial sequence: the chapel is 15 cm above the nave, the altar 72.7 and the reliquary 183.5.

The role of the sepulchral chapel is of such importance that it is tempting to consider the nave as a large antechamber, as happens in Alberti’s Tempio Malatestiano in Rimini. From another perspective, considering the sequence of the reconstructed wall, a serliana with an elegant alternation of arches and pilasters, the only open arch of which corresponds to the nave area, the fluidity between the two naves contributes to the preponderance of the sepulchre.

\(^3\)King Manuel I’s measurement system included the palm, 21.56 cm, which is divided in 8 in. One foot corresponds to 1½ palms; one ell to five palms; and one fathom to ten palms.

\(^4\)Surveying drawings were based on manual measurements taken by the author. Concerning the 5.11 m dimension, I verified the measurements of 12 sides of all 3 squares and the greatest deviation found was less than 0.4 \%. 
Other factors contribute to the importance of this central-plan space, namely, its resemblance to its more obvious models, the New and Old Sacristies of San Lorenzo, by Michelangelo and Brunelleschi, respectively.

António Rodrigues makes masterly use of this mighty spatial macchina, redefining it with marble and jasper, exploring the translucency and reflections of
those materials while proudly asserting its geometry. And he was the first one to do that in Portugal.

It should be emphasised that this spatial construction has an underlying *ad quadratum* geometry as well, as seen in the relationship between the sepulchral chapel and the dome that crowns it (Fig. 58.4).

The quadrangular coffers with inscribed circles that are present in the dome (and in the nave vault) allude to the geometry, and the alternate ones, with inscribed squares with vertexes in the middle position of the sides, reinforce this idea. In fact, the circle that might circumscribe the square of the dome coffers, the area of which would be the double of the inscribed circle, cannot be seen but is implicitly there. It would be the horizontal projection of the semi-sphere cut by vertical planes that correspond to the walls and that define the inscribed square. This square, in turn, circumscribes the circle resulting from the intersection of the same semi-sphere by a horizontal plane, where a small cylindrical wall sits. Over it stands the hemispherical dome crowned by a lantern. The part resulting from the first semi-sphere is apparent. The pendentives are spherical triangles that circumscribe blind circular oculi. I don’t think it would be otherwise even if Donatello were around (Fig. 58.5).

The transition between a cubical space bounded by four walls and the hemisphere of the dome was made with the insertion of a small drum that is not present in either of the sacresties of San Lorenzo but which can be found in the crossings of Santo Spirito in Florence or Sant’Andrea in Mantua. By means of this small elevation the springpoint of the dome is made to correspond to a side and a half of the square of the plan, obtaining in this way a 3:2 ratio.

The arches reveal the recurring influence of Serlio’s treatise both by its stereotomy and by the coffered interior vaults. They sit on Doric pilasters and form a portal 2.92 m wide. As the square space of the sepulchral chapel has a 5.11 m side, the dimension of the arches was calculated so that the vertexes of its opposing pilasters would form a 7:4 rectangle, a rational convergent of \( \sqrt{3} \), which determines the arrangement of the tombs. As the lesser side of that rectangle can be defined by opposing sides of a hexagon the presence of that figure can be indirectly acknowledged. This should not surprise us, as the hexagon’s connotation to lifelessness suits the chapel programme (see Fig. 58.3).

The dome deserves some special attention because of its remarkable formal expression, stereotomy, accuracy and material. It is divided in 24 semi-meridians and 7 parallels (the distance between them varies according to a gnomonic growth pattern), numbers of self-evident cosmic significance, aiming to symbolize, through expressly declared geometry, the mathematical order of the universe. But it is the translucency of the stone that increases its charm.\(^5\) Thanks to this singularity it becomes more than a metaphor to the celestial dome as the sun actually projects

\(^5\) It was not possible to determine the thickness of the stones, but they must be thin, underlining the quality and rigour of the construction. It is possible that its thickness diminishes approaching the lantern, but this does not prevent the dome from revealing itself on the exterior as a perfect semi-sphere. No covering was used, obviously, which is remarkable!
Fig. 58.4 Sepulchral chapel elements and its *ad quadratum* geometry, from bottom: chapel walls; arches and pendentives; drum; dome. Drawing: author.
I believe that this cosmic dimension, well expressed in the first version of Mestre António’s *Tratado*, is strongly corroborated by the frequent utilisation of the 5:4 rectangle—“hu sexiquarta proposição de hum quadrado e hu quarto”—in the making of different spaces (main chapel, sacristy, transversal section of the nave) and different architectural elements (the altar window, blind niches) of the Onze Mil Virgens Chapel.

If a gnomon is dimensioned according to the larger side of that rectangle, the length of its noonday equinoctial shadow will be its lesser side, or as Vitruvius

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6.“A sesquiquartal proposition of a square and a quarter”, proposition 2 from António Rodrigues, *Proposições Matemáticas* (BPMP, Ms 95).
would say,\(^7\) if the gnomon length is divided in five parts, the shadow will be four at Alcácer pole altitude (Fig. 58.6).\(^8\)

I think there is a strong possibility that this relationship is intentional because of the references concerning these matters in his *Tratado* and also because of this connection with the Great Cosmographer of the Realm, Pedro Nunes (born at Alcácer) who lent him his own translation of the Vitruvian text, although the Cesariano edition was already known among the Portuguese.\(^9\) In the Codex 3675 of the Biblioteca Nacional de Lisboa, there is a general description of the celestial sphere and the apparent movement of the sun. There is even an explanatory drawing for proposition 29, indicating his extensive knowledge of position astronomy (Fig. 58.7).

The 5:4 rectangle is present in several building spaces: the nave, the main chapel and the sacristy. I found that the springpoint of the vault is located at 6.42 m above the ground level, so that the transversal section is made of a rectangle of 6.42 \(\times\) 5.11 m, very close to 5:4 (a deviation of +0.995 \%). Considering the semicircle of the dome, the radius of which is half of the nave width, the section can be inscribed in a 7:4 rectangle, which was taken into consideration when discussing the width of the arches. The plan of the main chapel measures 3.47 \(\times\) 2.78. The sacristy, measuring 2.965 \(\times\) 2.42 m, is not exactly a 5:4 rectangle, but even so the deviation, –0.98 \%, is acceptable.

With respect to the architectural elements, we must mention the blind niches placed between the arches over the entablature of the *serliana* measuring 2.205 \(\times\) 1.764 m, or 5:4 (see Fig. 58.3b). When the *serliana* turns the corner, the blind niche is subdivided by the right dihedron angle this wall forms with the side ones. This division gives origin to two 8:5 rectangles, approximating the golden

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\(^8\) Alcácer do Sal latitude is 38º 30’ and the smallest angle of the right triangle of 5:4 cathetus measures 38º40’, a rather small difference. I thank Prof. Fernanda Alcântara (Geometry Course supervisor at FAUP) for the suggestion made by about the relationship between the 5:4 rectangle and the latitude or the celestial pole at Alcácer.

\(^9\) The whereabouts of this translation is not exactly known. It may have been sent to the Madrid Academia of Juan de Herrera.
section. The small window from the altar, measuring 120.8 × 95.9 cm, is also an element of 5:4 family.

In addition to the similitude, I looked for a proportional relationship between these figures. I found that, taking as a reference the longer side of the rectangle formed by the nave, 6.42 m, and successively dividing it by 7/6, it was possible to find the longer side of the rectangle represented by the great chapel plan. Following through with this operation values were obtained that were quite close to those for the other elements, which allows them to be considered as part of a geometrical progression (Fig. 58.8).

I found the 7:6 ratio of the geometrical progression in the rectangle formed by the back wall of the reliquary under the statue of Christ.

It must be added that, as the chapel plan is based on three squares, that of the sepulchral chapel having a special importance, the visitor entering the space can sense it as a well-proportioned harmonious whole. He has only to place himself at the intersection of the axis and the west side of the first square and look towards the altar. The concern with this work’s visual impact, or the way it would be seen and perceived, should not be undervalued, especially at a time in which perspective was being rediscovered. That António Rodrigues was concerned with perspective and visual impact is shown by the chapter on perspective (Livro de Perspectiva), included in his Tratado.
One of the most puzzling aspects of this temple concerns the main façade, which has been adulterated, or maybe never built according to the original design, due to the addition of a two-storied body that sits transversally to both churches. Both churches acquired a *galileu* (small porch, in Portuguese *galilé*) and the church of Santo António was given a choir, but the space over the chapel porch was obliterated (Fig. 58.9).

However, in spite of the running over of the mighty Chapel pilaster on the southwest corner, which, together with the body of the sacristy, sustains the stresses produced by the nave vault, the new building still manages to maintain some stylistic affinity with the Onze Mil Virgens. However, its disrespect towards the church of Santo António is complete: one of the new pilasters stands inexplicably in front of the Renaissance porch. It is a “plain”, 10 unpretentious work, 11 somewhat uneven, and that is why it stands closer to the chapel architecture, one of the first

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10 Georges Kubler emplyed the expression “plain” to name works made in our country from the second half of the sixteenth to the mid-seventeenth century. According to Horta Correia, “by the time ideological superstructures of counter-reformist nature grabbed the power in Portugal . . . the tendency to decorative simplicity, the adoption of a certain classicism based on treatises and an austerity with religious and military features converged to define a new architectonic era dominated by what Kubler called plain style” (Horta Correia 1991: 48).

11 In the west elevation I found that there were originally three more rectangular openings identical to the one still visible. Two of the openings were located where the oculi are presently. The third one was to the right of the existing one, over the central arch.
works in our country to show that style, which preceded the austere “Herreran” style.

One of the surprising elements is the interior elevation of the façade. The tile wall abruptly cuts the lateral *serliana* that are unfinished, in what seems to be a provisional solution. Only the cornice maintains the connection. I would prefer to see the *serliana* arching as it does on the elevation opposite, together with the cornice, the main entrance remaining confined to the inner arch. Figure 58.10 shows my hypothesis of a possible reconstruction that would make a lot more sense.

From the exterior, based on some existing evidence, I decided to try out one hypothesis for the façade drawing (I am somewhat less confident, but even so, it is a possibility to be considered). The galilee pavement is at the same level as the thresholds of the porticoes of both churches, higher than both naves, which is not logical. The chapel threshold is still there, untouched, and it seems to have been a step. The Tuscan pilaster of the southwest corner is unfinished at ground level; the base is missing, probably buried. Its reconstitution makes me believe that three steps would be needed to get to the chapel. As the pilaster can be measured on the south side, its size can be inferred in the main façade. Symmetry would require one pilaster on the other side of the porch and, besides, structural reasons would justify its presence. The former chapel could resist lateral forces produced by its vault, but, without the additional galilee, there would be no support to forces acting on the façade. Further, it seems obvious that the façade should be finished at the top. Observing the crowning of the existing pilaster, one can see that its capital is different from the cornice that goes around the church and where the roof sits. It is a detail of a portico, waiting for its pediment. In the present case, it is interrupted by a central window, as happens in San Sebastiano in Mantova, for instance. Finally, it must be remarked that if the façade were to be hypothetically rebuilt, the surface between the pilasters and the base of the pediment would form a square
and a half, the same figure as that of the sepulchral chapel. The level where the dome springs is one and a half times the length of the side of its plan (see Fig. 58.10).

All these possibilities seem more credible in the context of the reconstitution of the design. Even so, some doubts remain, as were pointed out. It is hard to believe that there was once a façade more or less similar to the one I have tried to design and that the building of the galilee body had entailed its almost complete destruction. That is why it appears that the decision of building that new area must have been taken before the completion of the chapel, the project being adapted to the new situation.

In the façade, the portico, which is still present, shortened because at least one step is missing, deserves comment. It is possible to compare its design to the picture included in the second version of the author’s treatise (the only one representing an architectural element), which differs from the one in Serlio’s treatise only by the suppression of the pinnacles over the pediment (Fig. 58.11).

Surprisingly, the trisection method cannot be applied to the portico of the Onze Mil Virgens, but even so, the upper corners of the door fall on the diagonals of the circumscribing square. Even more interesting is the fact that the subdivision of that square in 7:7 results in squares with sides of 62 cm, that is the dimension of the pillar that corresponds to the temple module, and that the portico’s opening forms a 5:3 rectangle (3.10 × 1.856 m), approximating the golden section.

As for the south elevation, distinguished by a strong and minimal design, it is impossible to hypothesize about its geometrical structure at present, as it there is no certainty about the ground level and the way the building was attached to it. However, it is possible to detect the important role of the square windows, opened in the limed white walls, contributing to impression of massiveness.
conveyed by the building. Paradoxically, its marble chamfered mouldings are extremely delicate, a subtle announcement of the preciousness of its interior.

**Conclusion**

Although the study of the Onze Mil Virgens Chapel is not yet completed, it has been demonstrated that this work discloses in several ways the omnipresence of geometry, ever in association with numbers and calculus, essential to the definition of an idea of architecture. The same can be said concerning the church of Santa Maria da Graça in Setúbal, the analysis of which is underway at the moment.

This realization is not a surprise, but I did not expect the relationship to be so close. It should be noted that there is still a lot to be discovered and that these results are preliminary.

In the chapters on geometry (*Livro de Geometria*) and perspective (*Livro de Perspectiva*) in the treatise by António Rodrigues are found a myriad of shapes and constructions that were also present in the treatises that inspired his. But even without a written sequence, lost or never completed, it is nevertheless possible to find them in the configurations of the architectural spaces he created.

On the other hand, the cosmic sense of this close connection is undeniable. In accordance to the neoplatonic ideal, every work is made as a microcosms, becoming the representation of a mathematically arranged macrocosms.

Although António Rodrigues considered that “he who will be an architect should also be a musician to understand the proportions of sounds, because their proportions will make him understand the proportions of buildings” [Rodrigues 1576: fol. 10v (my translation)], I don’t think that the proportional relationships he...
employed can be interpreted only in the light of musical theory. They have their own mathematical meaning, which can be sometimes related to musical intervals, but essentially follows the intrinsic logic of the building. And we have seen, in the present work, that its structure was conditioned from the start by the need to conform to the pre-existing building.

Like Vitruvius, Rodrigues warns his readers that it is “nesessario ser esperto na Giometria” (Rodrigues 1576: fol. 10v). Geometry is the instrument he uses to build bridges between reality and transcendence.

In the introduction to the chapter entitled, “What is geometry?” he explains, “Geometry is no more than figures, that can not be done without lines, angles and points... By the same Geometry we will see that nothing can be done without it, and Mathematical Art cannot be understood without one being a Geometry expert...”

He concluded with some worthy advice: “The one who is curious about this art should study Euclid, and will find there something to wonder about”.

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Biography João Pedro Xavier is an architect and a Professor of Architecture in the Faculty of Architecture of the University of Porto (FAUP), where he received his degree and Ph. D. in Architecture. He worked in Álvaro Siza’s office from 1986 to 1999. At the same time, he established his own practice as an architect. He is a member of the research group for Theory, Design and History of architecture at the Centro de Estudos de Arquitectura e Urbanismo at FAUP. His research focus is on architecture and mathematics, and in particular on perspective. He is the author of Perspectiva, perspectiva acelerada e contraperspectiva (FAUP Publicações, 1997) and Sobre as origens da perspectiva em Portugal (FAUP Publicações, 2006). He has participated in conferences, lectures and exhibitions, and has published a number of papers on the subject. He is on the Editorial Board of the Nexus Network Journal and is a member of the executive council for the journal Resdomus.

References


12 (Rodrigues 1576: fol. 25v). The original text is as follows: Quem for coriozo desta harte estude Hoclides, e nele achará bem couza em que se desemfade. It is part of the introduction to the chapter “What is Geometry”.

