Chapter 52
Perspective in António Rodrigues's *Tratado de Arquitectura*

João Pedro Xavier

Introduction

The aim of this chapter is to discuss the *Liuro de Perspectiva* (*Book of Perspective*), found in the extended manuscript *Tratado de Arquitectura* of 1576, which has been attributed to António Rodrigues (c. 1520–1590) (Moreira 1982).

Considering the historical context of this work, its relevance lies mainly in the introduction of an innovative perspective rule that was designed to solve the questions raised by the propagation of inaccuracies and insufficiencies of previous methods, particularly evident in Serlio's second book, *Di Prospettiva*. However, the author's scientific limitations prevented him from fully understanding the enormous potential of his geometrically accurate construction. He employed traditional techniques of measuring distances, commonly used in maritime Portugal, related to the basic principle of similar triangles, shapes that Alberti could assemble as a *piramide visiva*, promoting its *intersegazione* with a surface (*finestra*), and thus obtaining a section that represents the exact perspective of the object. Decoding and verifying the validity of this peculiar perspective rule leads to the centre of the debate surrounding the origins of the *perspectiva artificialis*, which is still a matter of intense dispute in spite of new contributions, reinforcing the theory that considers practical geometry the mathematical basis of this representational system.

Rodrigues's work demonstrates a striking fidelity to central perspective, likely evidence of the Italian school Rodrigues belonged to. This is particularly obvious in some of his perspective representations of architectural objects, especially one

First published as: João Pedro Xavier, "The Book of Perspective of António Rodrigues's Architectural Treatise from 1576", pp. 63–78 in *Nexus VII: Architecture and Mathematics*, Kim Williams, ed. Turin: Kim Williams Books, 2008

J.P. Xavier (✉)
Faculdade de Arquitectura da Universidade do Porto, Rua do Gólgota 215, 4150-755 Porto, Portugal
e-mail: jpx@arq.up.pt

K. Williams and M.J. Ostwald (eds.), *Architecture and Mathematics from Antiquity to the Future*, DOI 10.1007/978-3-319-00143-2_5,

centrally-planned composition called *edeficio quadrado* (squared building) with *ad quadratum* and *ad circulum* geometry, traditionally discussed in the treatises on perspective and architecture at the time. In terms of architecture, we are dealing with one of the most perfect realizations of an anthropocentric vision of the world, the very core of the spatial research undertaken in the Renaissance, although by the time that this *Tratado* was written, this was already being questioned by the counter-reform movement.

Indeed, the inventory and analysis of architectural structures built following this typological unit, consecrated in the representation of this *edeficio quadrado* in the *Liuro de Perspectiva*, is one of the most important chapters in the history of modern architecture, one in which Rodrigues inscribed his name with the construction of Onze Mil Virgens Chapel (Xavier 2015), built some time before 1565 in Alcácer do Sal.

The *Tratado de Arquitecture* and Perspective in Sixteenth-Century Portugal

The *Tratado de Arquitectura* is a treatise related to the origins of architectural teaching and theorization in Portugal. It was used as a textbook at the Lição de Arquitectura Militar, a course in military architecture that began in 1573 under Rodrigues's direction in Paço da Ribeira School,[1] which had been founded by Pedro Nunes in 1559. According to Rafael Moreira,

> in addition to Pedro Nunes's lessons on Mathematics and Cosmography, António Rodrigues taught there the young nobles the elementary notions of Geometry applied to architectural drawing and perspective, the theoretical principles of engineering and fortification and methods and secrets of the art of building well and cheap in order to serve the best interests of the king (Moreira 1982: 75).

This was a Vitruvian curriculum, where one could not conceive of an architect's training that did not have a strong scientific foundation in mathematics, in arithmetic and especially geometry, but which included astronomy and music as well, completing the *Quadrivium*.

The treatise shows its inherent pedagogical inclination, especially obvious in our *Liuro de Perspectiva*[2]; it is clearly meant to be a textbook. The approach to this science, "which can be better learned by demonstration than by trial" (Rodrigues 1576: fol. 44v), begins with the foreshortening of surfaces, evolves to solid bodies, and culminates with the perspective representation of objects and architectural

[1] This school was shut down and transferred to Madrid by Filipe II, giving rise to the "*Academia Real Mathematica*" directed by Juan de Herrera. Later, this sovereign, by then Filipe I of Portugal, ordered its reinstitution in Lisbon, in 1594, with Filippo Terzi (c. 1520–1597) and João Baptista Lavanha (1550–1624) as its directors.

[2] An extended analysis of the *Book of Perspective* can be found in Xavier (2006).

spaces, revealing its purpose and the reason for its being part of an architectural treatise. Serlio did the same with his *Secondo Libro*, *Di Prospettiva* in 1545, and Pietro Cataneo reinforced this with *Libro Ottavo*, when he added, in 1567, four new books to his *Quattro primi libri di Architettura* of 1554.

The question was the definition of a new instrument for representation, one which was capable of contrasting the need for models, and which, in association with the orthogonal projections in use—plan, elevation and section—would considerably enrich the resources available to the architect for describing, and especially for visualizing, space.

Perspective was at that time regarded as essential among the elements of the Vitruvian *dispositio*, as António Rodrigues says,

> one of the parts that architects should master, [because] it was convenient for someone who wanted to practice architecture to understand perspective so that he could show the outside and the inside of the sketched building in order to avoid expenses with wood, wax or clay models (1576: fol. 11r).

Although Rodrigues, and Cataneo as well, praised perspective pragmatically for its economic value, I must emphasize that the claim that drawings can replace models is based in the consolidation of a technique of representation, perspective, that enables one to approach the three-dimensional nature of the architectonic object. This claim is strengthened if we add axonometry to perspective, which was already well known at the time.

As Gelabert Lino Cabezas states,

> one of the consequences of perspective will be to allow drawing architecture according to new spatial rules, both for representing pre-existing architecture, the ancient one, and for visualizing and projecting new works. The verisimilitude attained with this new perspective representation will allow new architects to control from the drawing (the *disegno italiano*) a new concept of architecture, even coming to replace models . . . in the presentation of works to be built. . . [Cabezas (1989): 167 (my translation)].

And so as the *disegno science* was growing, its first steps in Portugal were closely connected to the establishment of the Lição de Arquitectura Militar.

Considering its context, the importance of Rodrigues's *Liuro de Perspectiva* (*Book of Perspective*) lies mainly in the presentation of an original perspective rule intended to break a deadlock caused by the diffusion of inaccuracies—by Gaurico (1504), Dürer (1525 and 1538) and Serlio (1545)—although the author's scientific capacity wasn't sufficient for him to understand fully the potential of the geometrically accurate construction he produced. Most probably, Rodrigues tried to overcome the errors of Serlio's first rule (Fig. 52.1), his main reference, through the definition of a new non-canonical but flawless rule of his own.

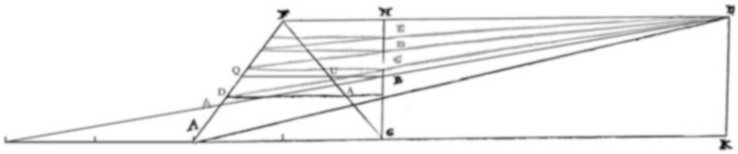

Fig. 52.1 Serlio's first perspective rule with the superimposition of the correct construction of the second square QUAD. Drawing: author, after (Serlio 1600: Libro secondo, fol. 19r)

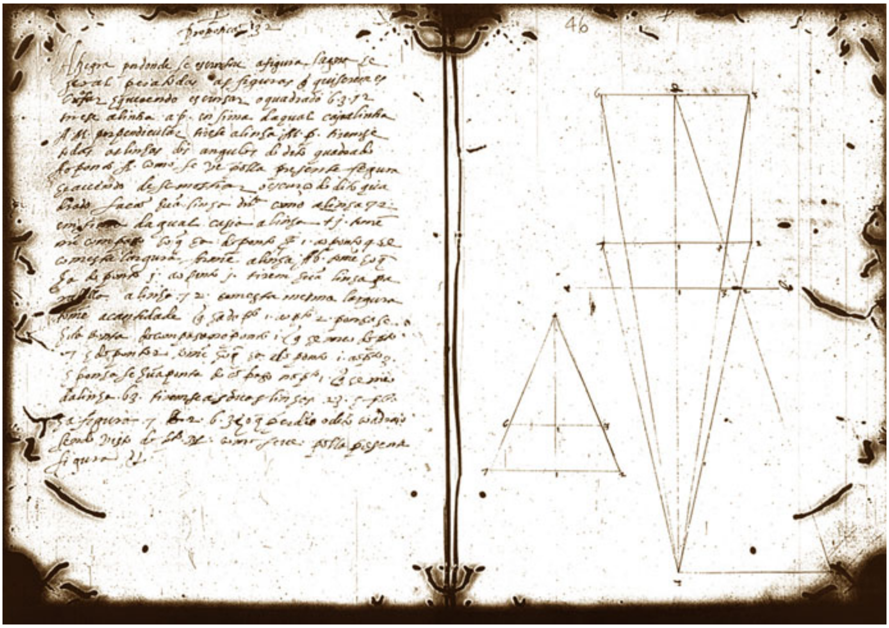

Fig. 52.2 Proposition 32, from Rodrigues (1576): fol. 45v/46r

Rodrigues's First Rule of Perspective

Rodrigues's first rule opens his *Liuro de Perspectiva* and is applied to the foreshortening of a hexagon.[3] As traditionally the square was the preferred figure for representing a plane, let us use instead the following example, found in proposition 32, where the ensemble of procedures to obtain its perspective is explained (Rodrigues 1576: fol. 46v) (Fig. 52.2).

[3] The second rule appears in proposition 34 and it is said to be the same rule used by Serlio: "Sebastianus Serlio bolognese in his "Book of Perspective" has foreshortened all the figures with this rule" (Rodrigues 1576: fol. 47v).

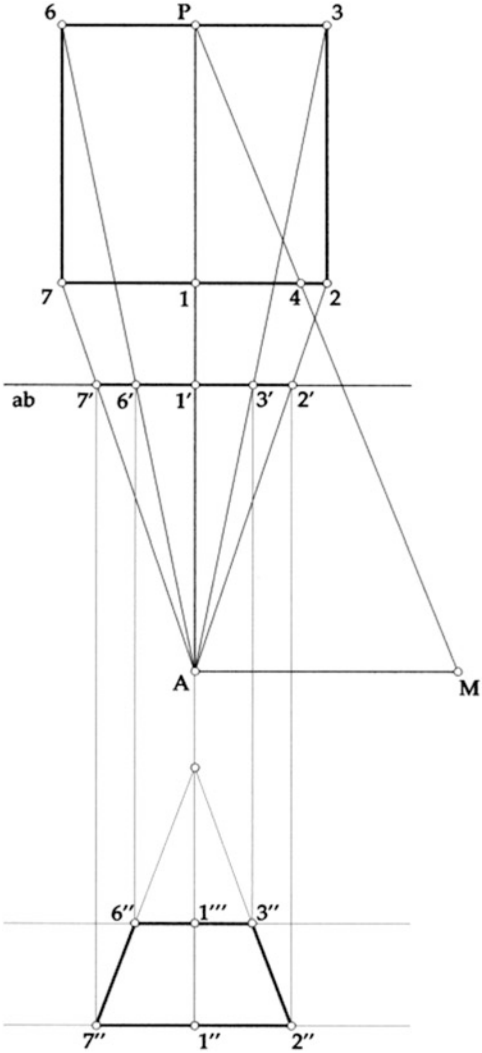

Fig. 52.3 Rodrigues's first perspective rule (Proposition 32). Drawing: author

Here is a modern translation of those steps, numbered in order to facilitate their identification (Fig. 52.3):

Proposition 32. The rule used to foreshorten the hexagon figure is general for all the figures we want to foreshorten. And if we want to foreshorten the square **6.3.7.2**:

1. draw the line **A.P**;
2. draw the line **A.M** perpendicular to it;
3. draw the line **M.P**;
4. join all the vertexes of the square to point **A**;
5. and if we want to show the foreshortening of this square, construct a straight line like line **7″.2″** and draw over it the line **1″.1‴**;

6. with the compass take the distance from point **1** to point **4**;
7. and with this length construct line **ab**;
8. take the distance from point **1** to point **1′**, and draw a parallel line to line **7″.2″**, with the same length
9. take the distance from pt **1′** to pt **2′**, put the point of the compass in pt **1″** which is the midpoint between pt **7″** and pt **2″**;
10. take the distance from pt **1′** to pt **3′** and put the point of the compass in pt **1‴** which is the midpoint of line **6″.3″**;
11. draw two lines **2″.3″** and **7″.6″**.

The figure **6″.3″.7″.2″** shows what is lost by the square when it is seen from point **A** as can be observed in the illustration.

Is it? Could figure **6″.3″. 7″.2″** be the exact perspective of the square **6.3.7.2**?

The first thing to note is that we have a plan and an elevation superimposed where line **A.P** is simultaneously:

a. the horizontal projection of the central visual ray, **A** being the Foot of the Observer and **6.3.7.2** the horizontal projection of the square;
b. the side projection of the ground plane, **M** being the Eye of the Observer and **1.P** the side projection of the square; here **M.P** is the side projection of visual ray **A.P** as it is of visual rays **A.6** and **A.3**.

In the original drawing the perspective construction is shown to the side of this system. I have aligned it with the horizontal projection in order to clarify the correspondence of widths.

We must then point to the striking lack of correspondence between the representation of the Picture Plane in plan and side elevation. Actually, line **ab** is its horizontal projection, while its side projection is a line coincident with points **1.2**.

Contrary to what might be expected, there is no relationship with *costruzione legittima* where the intersection of visual rays with the Picture Plane is achieved with the aid of a systematized double orthographic projection.

However, the foreshortening of the square is obtained by combining the widths taken from line **a.b** and the heights from the line passing through points **1.2**, as is the case of length **1.4** (equal to length **1.1′**) used to graduate the depth of the transversal side **6″.3″**.

We wonder if this can be possible!? . . . And surprisingly, the answer is yes!

Using an up-to-date drawing of proposition 32 (Fig. 52.4), with the lateral elevation placed to the side, I verified the exactness of Rodrigues's first perspective rule using distance point construction. I checked the relationship between the Observer and the Picture Plane and, as distance **PD.PS** [4] is equal to distance **PF**, I could be sure that line **ab** in plan indicates the correct position of the Picture Plane. So, the square represented in perspective is not in the square $\mathbf{A_1B_1C_1D_1}$ shown in plan, but the homothetic square **ABCD**, with its side **CD** coincident with the

[4] Rodrigues extends the orthogonal sides of the square to the central vanishing point (PS) but he doesn't take advantage of it in the construction.

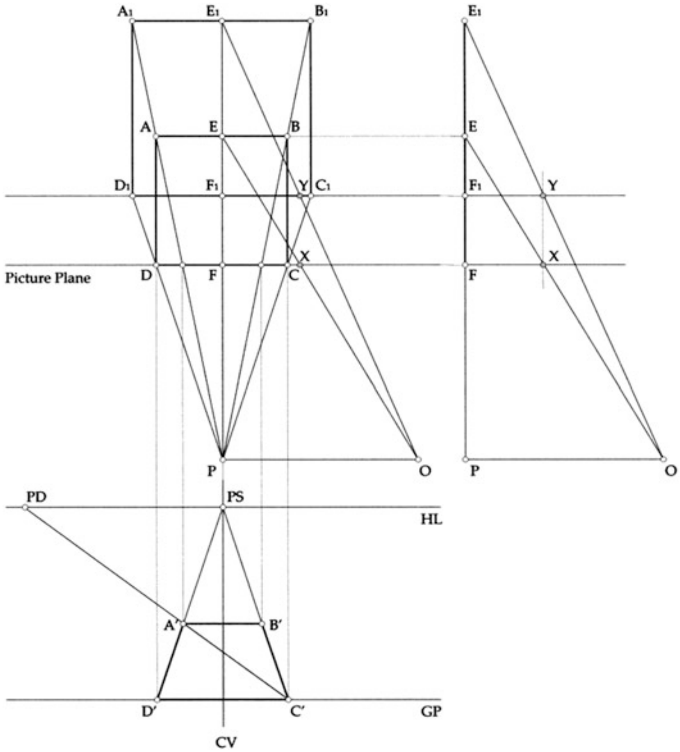

Fig. 52.4 Testing the validity of Rodrigues's first perspective rule. Drawing: author

Ground Line, although Rodrigues doesn't draw it there. But if this is true we have to check, using the side elevation, if height $\mathbf{F_1Y}$ used to graduate the depth of transversal side $\mathbf{A_1B_1}$ is equal to height **FX** which determines the depth of side **AB**.

More than this, we should prove that for any position of the square $\mathbf{A_1B_1C_1D_1}$, similar to square **ABCD** in a homothety of centre **P**, the segment **FX** is always equal to segment $\mathbf{F_1Y}$.

With the aid of the famous theorem attributed to Thales we can assert that the triangle **PEO** is similar to triangle **FEX**, and so:

$$\frac{\mathbf{PE}}{\mathbf{PO}} = \frac{\mathbf{FE}}{\mathbf{FX}}. \tag{52.1}$$

On the other hand, the triangle $\mathbf{PE_1O}$ is similar to triangle $\mathbf{F_1E_1Y}$, so:

$$\frac{\mathbf{PE_1}}{\mathbf{PO}} = \frac{\mathbf{F_1E_1}}{\mathbf{F_1Y}}. \tag{52.2}$$

From these two proportions we can deduce the following equality:

$$\mathbf{PO} = \frac{\mathbf{PE}}{\mathbf{FE}} \cdot \mathbf{FX} = \frac{\mathbf{PE_1}}{\mathbf{F_1E_1}} \cdot \mathbf{F_1Y}. \tag{52.3}$$

As there is a homothetic relationship of centre **P**,

$$\frac{\mathbf{PE}}{\mathbf{FE}} = \frac{\mathbf{PE_1}}{\mathbf{F_1E_1}}, \tag{52.4}$$

one may conclude from expression (52.3) that

$$\mathbf{FX} = \mathbf{F_1Y}.$$

QED!

Finally, one might be puzzled with the indication of step 7 to place the line **ab**, the Picture Plane, taking the height **1.4**. There is no geometric reason for that, although it might be a way to control the dimensions of the perspective result. I tried to overlap the orthogonal projections with the perspective drawing and at least it is possible to recognize a good adjustment of the whole (Fig. 52.5). But, unfortunately, this is more a sign of the author's incapacity to understand the implications of his own perspective rule fully, namely the perfect control of viewing distance in relation to the object and the Picture Plane locations.

Rodrigues's *Liuro de Perspectiva* in Context

If we look at Rodrigues's *Liuro de Perspectiva* within an international frame of reference we have to admit that it never achieved a position of great importance. Although Vignola's *Le due regole della prospettiva pratica* (ca. 1545) was only printed in 1583 by Egnatio Danti, the truth is that these perspective rules were already known to a select few, those who went down in history.

However, I believe that Rodrigues's *Liuro de Perspectiva* is much more interesting than it might appear on the surface if we look at the reasons that led the author to search for a thoroughly successful solution where Serlio and his predecessors failed.

We must remember that Serlio's first, erroneous, rule of perspective is one more in a series of attempts to draw the geometric construction described by Alberti in *De Pictura* (1435). So, by criticizing Serlio's work, Rodrigues ended up close to the methodological assumptions underlying Alberti's construction. When I realized this unexpected similarity in methodology it became necessary for me to re-examine the different interpretations of the perspective representation described in *De Pictura*. The absence of graphic illustrations in Alberti's work has given rise

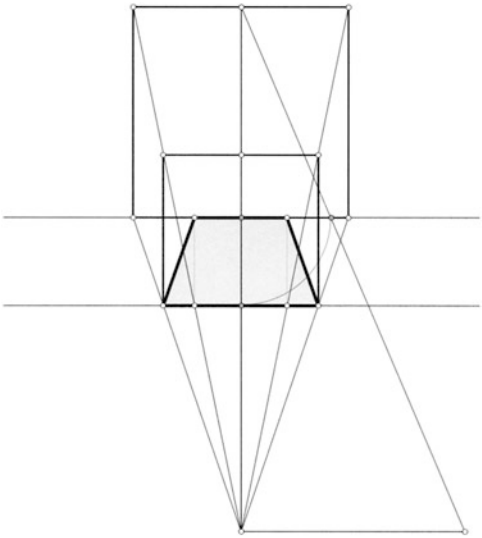

Fig. 52.5 Rodrigues's first perspective rule with the foreshortening of the square overlapping the plan and side elevation. Drawing: author

to the ongoing proliferation of several hypotheses that intertwine with the discussion of the origins of the *perspectiva artificialis* and take us back to Brunelleschi, to whom Alberti dedicated his work. I undertook this journey back to the origins starting with a thorough review of Alberti's original work, and I verified that, within the time span from its appearance until the edition of Rodrigues's book, several authors translated its *modo ottimo* with only a graphic representation—such as Filarete (1461–64, Fig. 52.6), Francesco di Giorgio (c. 1485), Leonardo da Vinci (c. 1492) and Jehan Cousin (1560)—or with some theoretical contents as well—as was the case with Piero della Francesca (c. 1460, Fig. 52.7), Giacomo Vignola (c. 1545), Federico Commandino (1558) and Daniel Barbaro (1568), although this last made exclusive use of Piero della Francesca's contribution.

The problem was, in fact, the noise coming from works produced in the first half of the 1500s, which determined a state of disturbing uncertainty due to the ignorance of reliable sources (or to their inadequate decoding) and the prevalence of practical recipes, not always correct, and without a theoretical basis.

Viator's handbook, *De Artificiali Perspectiva* (1505), was an exception, as it was irreproachable regarding operational matters, but lacked an indispensable conceptual foundation. Viator took it upon himself to give legitimacy to the idea of perspective as a graphic representation of natural as well as panoramic vision, remaining within the sensory concept of a virtual pyramid (Fig. 52.8), in opposition to Alberti's attitude, of a rational nature, expressed in the concept of *piramide visiva* and *intersegazione* (Mesa Gisbert 1994: 112). In the beginning of the following century the first picture in *Perspective* (1604) by Hans Vredeman de Vries (Ioannes Frisius) (1526–1609) (Fig. 52.9) will express eloquently the visual theory already present in Viator's work, placing the observer in the centre of the Horizon and the pyramid vertexes in the circular line that defines it (Alpers 1983: 57).

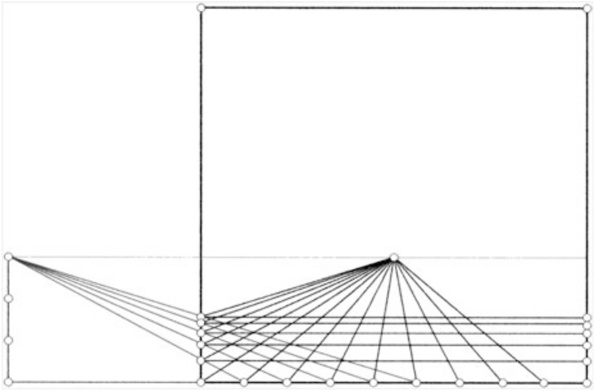

Fig. 52.6 Alberti's *modo ottimo* by Filarete. Drawing: author, after *Tratatto di Architettura* (Bk. XXIII, fol. 177v)

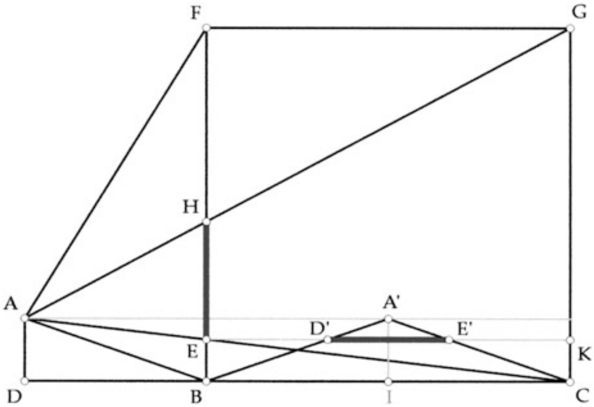

Fig. 52.7 Piero's perspective proof. Drawing: author, after *De Prospectiva Pingendi* (Bk. I, prop. XIII)

It was against this destabilized background that Rodrigues worked to legitimise his book and its original perspective rule. That rule rests in the methodology and instruments concerning the evaluation of inaccessible distances, which the discipline called "practical geometry", whose main driving force was nautical science, along with astronomy and cosmography, in Portugal as well as in other countries. In consequence, it is the actual application of the principle of similar triangles—in which the observer's eye is at one of the vertexes, and at the others there may be a tree, or a tower top, or a mountain summit, or else the sight of the coast line from a caravel or a twinkling star in the sky—that drove Rodrigues to the discovery of a functional perspective rule, in spite of its lack of the conceptual purity already known at the time but which he hadn't heard of.

Even so, the fact that it was supported by the proportionality principle applied with remarkable flexibility, fully mastering Thales theorem, usually employed in practical measuring tasks, is sufficient in itself to make it worthy of note.

Indeed, this principle is the essence of the perspective representation system, although its simple application occurs at a relatively basic stage of development,

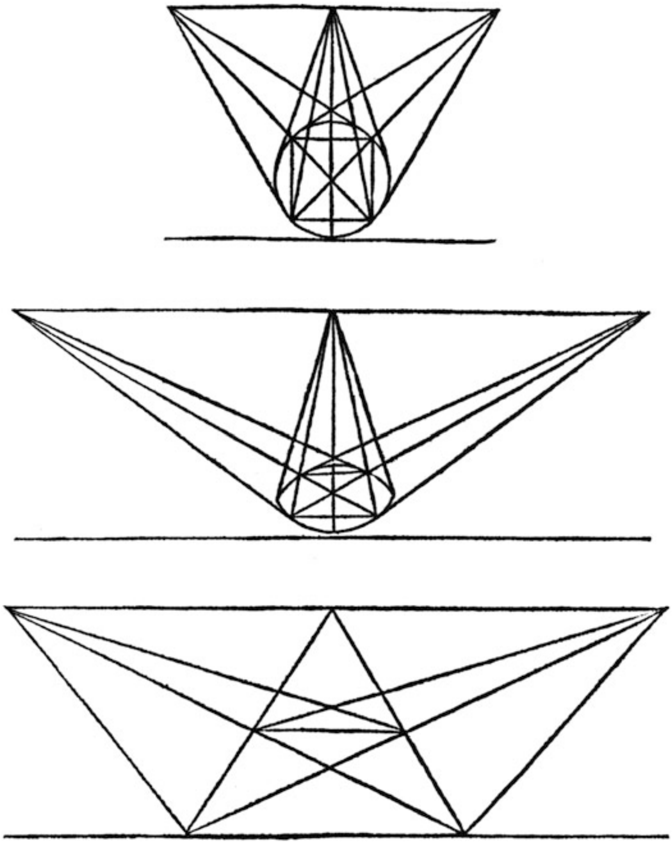

Fig. 52.8 The visual pyramids and the 'tiers-points' perspective construction. Image: Viator (1505)

taking us back to the origins of *perspectiva artificialis* and to the issue about the mathematic principles underlying its genesis.

I suspect that the capacity to deal easily with proportionality, based in similarity and homothetic relationships, contributed to Alberti's definition of his *modo ottimo*. The precedence of a practical activity of measuring for the definition of his rule can be felt in his work, especially in the *Ludi Matematici*. The illustrations of Francesco di Giorgio that appear in his *Trattati* (Fig. 52.10) in the context of a thorough inventory of typical problems of practical geometry unequivocally warrant that connection.

Following Alberti's requirement, Giorgio isolated the side elevation and physically materialized geometric entities, drawing planes with rods and visual rays with threads. In addition to the requirement of drawing the side elevation separately, a decisive step for achieving the accurate definition of depth grading, Alberti gave us the enigmatic indication that a small space (*picciolo spazio*) would

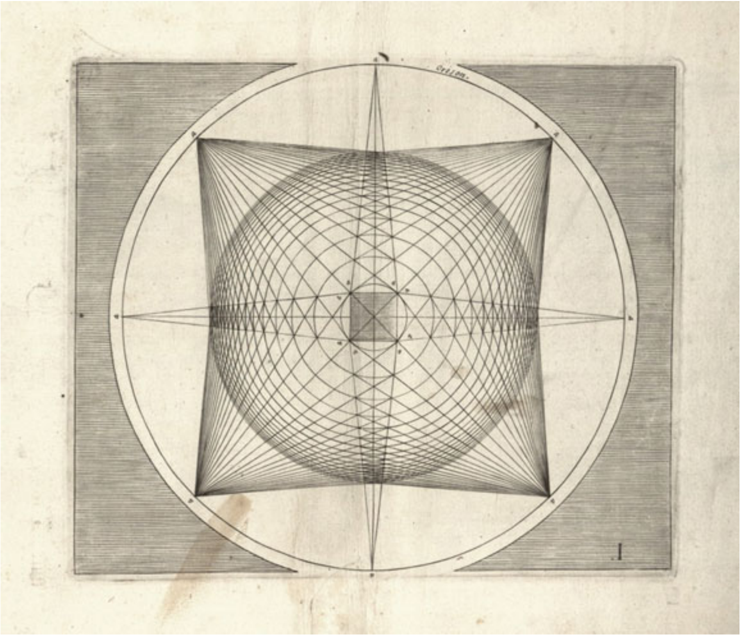

Fig. 52.9 Panoramic natural vision. Image: De Vries (1604)

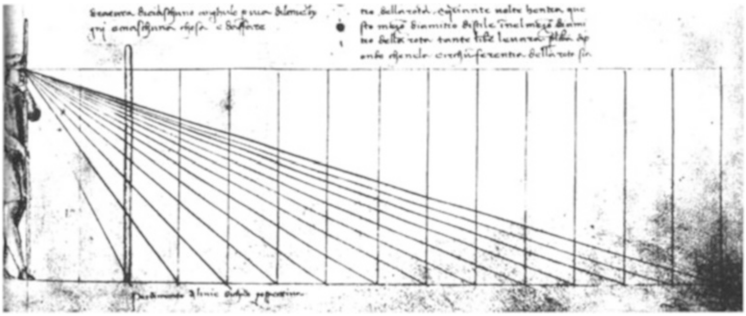

Fig. 52.10 Alberti's modo ottimo by Francesco di Giorgio Martini (ca. 1490: fol. 33)

be enough for its execution. This compression of the drawing frame allows us to think of the possibility of working with dimensions smaller than the *braccio*, the unit that divides the ground line (Fig. 52.11), as suggested by Pietro Roccasecca (2001). And then their mutual dependence could be supported by a proportional relationship, without compromising the transverse lines, which together with the orthogonal lines already drawn would define the ground plane or *pavimento*.

In this particular matter, Rodrigues's approach to perspective through a rule based in homothetic principles was similar in its essence to methodology suggested by Alberti, even though it appeared later.

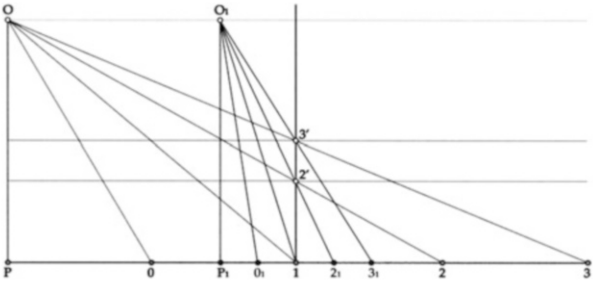

Fig. 52.11 Alberti's *modo ottimo*. Interpretative drawing of Roccasecca's proposal (2001: 66). Drawing: author

Rodrigues's Rule of Perspective and Centrally-Planned Architecture

The mathematical systematization of the representational space conceived by Alberti is primarily a project for space itself, which runs parallel to the need to map the earth and sky for exploration.

If the general order of the universe was mathematical, a Pythagorean belief that rested on Plato's *Timaeus*, and geometry was the connection to subjects that dealt with spatial problems, then the issue of the representation of visual space would be dealt with by perspective, while cosmography would be charged with representing the earth and sky. So there was a need for improved knowledge about the sphere, with the contributions of geography and astronomy, facilitated by the discoveries of the epoch. Eventually it was acknowledged that the first accurate maps of the terrestrial globe and the celestial sphere were based on conic projections that had been known since Antiquity: gnomonic in Mercator maps, in that case the surface of projection being a cylinder tangent to the equator, and stereographic in Ptolemy's Planisphere. And, as in this last situation the surface of projection was a plane that cut the sphere along the celestial equator, Federico Commandino realized (at last!) the intimate relationship between this cartographic projection and perspective (Commandino 1558).

The core idea of space codified by Alberti, which translated into a very particular type of perspective—central perspective—corresponded to a concept of centralized space, with its inherent fidelity to central (or at least bilateral) symmetry and, naturally, the strict obedience to a measurement system, which implied a system of proportional relationships of an arithmetic and geometric nature and which, in terms of perception, would change into a system of harmonic proportions that, through the correct rule, could be transferred to paper in order to become perspective.

This could be a description of San Sebastiano, an exceptional centralized space, but can also be applied to S. Andrea, both in Mantua. It is possible to evoke Brunelleschi's works, San Lorenzo or Santo Spirito, on which Wittkower founded his attribution of the discovery of *perspectiva artificialis*. It is Leonardo's thorough investigation of *prospettiva liniale*, and his studies of projects of buildings with central plans (Xavier 2008) and, from there, the effective materializations by Bramante and others that disclose the first evidence of this connection. Even so, I think it is sufficient to recall the panels produced by the circle of Urbino regarding the depiction of an ideal city in order to verify the convergence of a global plan of space centralization, which is inevitably anthropocentric, and because of that, avails itself of central perspective to affirm its value, but also to persuade.

In architectural treatises in general, and in the books on perspective that became part of them, as well as in specialized textbooks—even in the first of them, *De Prospectiva Pingendi*—centralized spaces from cities to architectural objects, closely associated with central perspective, are always given a place of privilege. In parallel, a specific representational system that will end up in axonometry was being developed mainly for cities, with an intuitive approach by Francesco di Giorgio, already with its own rules by Maggi and Castriotto, and would soon be preferred for military architecture and engineering.

Because perspective apprenticeship always started with a plane represented by a square, which could be squared according to the most convenient measurements conveying the Albertian spatial core, buildings or small spaces with square plans have always been given preferential treatment. One can see them in Filarete's early sketches, in the treatises of Piero della Francesca, Francesco di Giorgio, Serlio and Hernan Ruiz, and we should not forget that this was one of Leonardo's favourite subjects, although his spatial research was linked to his own particular representational system (Xavier 2008).

Generally speaking, the Observer, standing, perceives space according to his plane of axial symmetry—*sia sempre la sua distantia all' entrare di esse*, as Serlio stated (1600: fol. 18r)—emphasizing that formal characteristic and amplifying the centrality that the space already possessed.

It was in this context that one *edeficio quadrado* appeared in *Proposição* 42 of Rodrigues's *Liuro de Perspectiva*, foreshortened according to the first rule. It was crowned with a dome, embodying the *ad quadratum* and *ad circulum* geometric composition that was synthesized so well in Caesare Cesariano's representation of the Vitruvian man (Fig. 52.12).

I tested the reconstruction of this ideal building (Fig. 52.13) and compared it with the sepulchral space of Onze Mil Virgens Chapel (Figs. 52.14, 52.15, and 52.16) and I found that this space could be considered as typological variation of that ideal building. As the Onze Mil Virgens Chapel, according to Rafael Moreira, was designed by the author of the sixteenth-century architectural treatise and its book of perspective, António Rodrigues, I think that this attempt to represent an archetype in perspective is a proof of the decisive role this unit played in the formalization of centrally-planned churches, from its appearance in Byzantine through the Mannerist period.

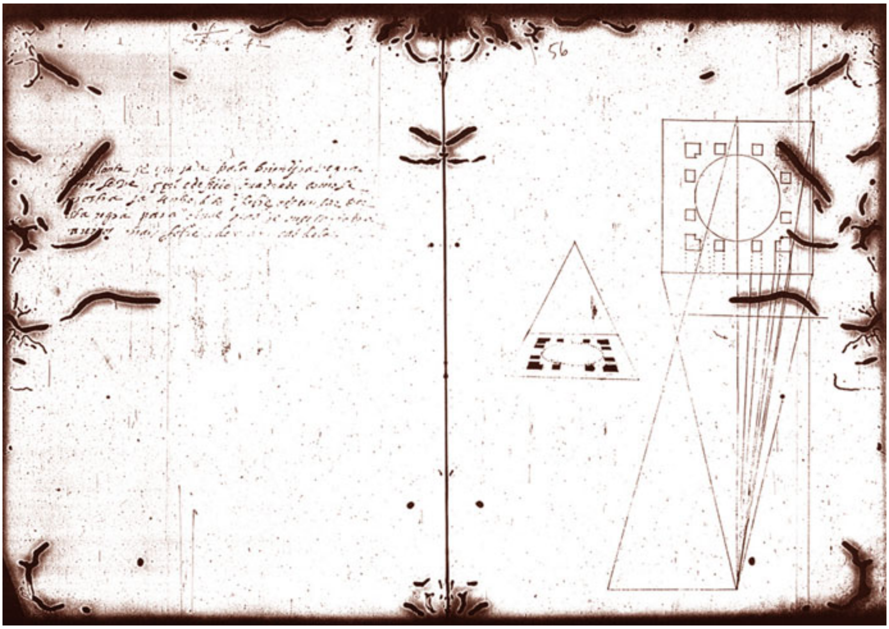

Fig. 52.12 Proposition 42 from Rodrigues (1576): fol. 55v/56r

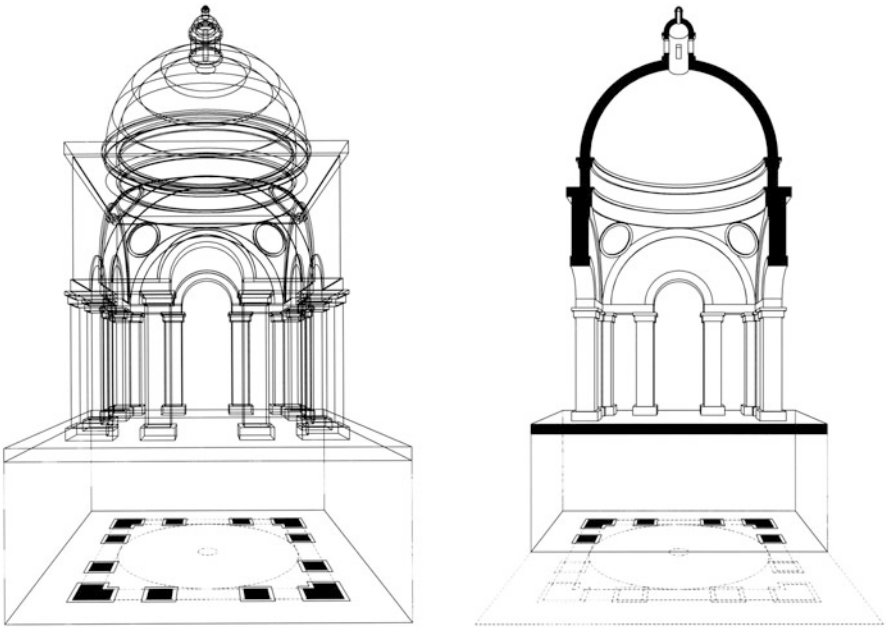

Fig. 52.13 3D models of the proposal for the 'squared building' reconstituted from the foreshortened plan shown in Rodrigues (1576: Prop. 42, fol. 56r). Drawing: author

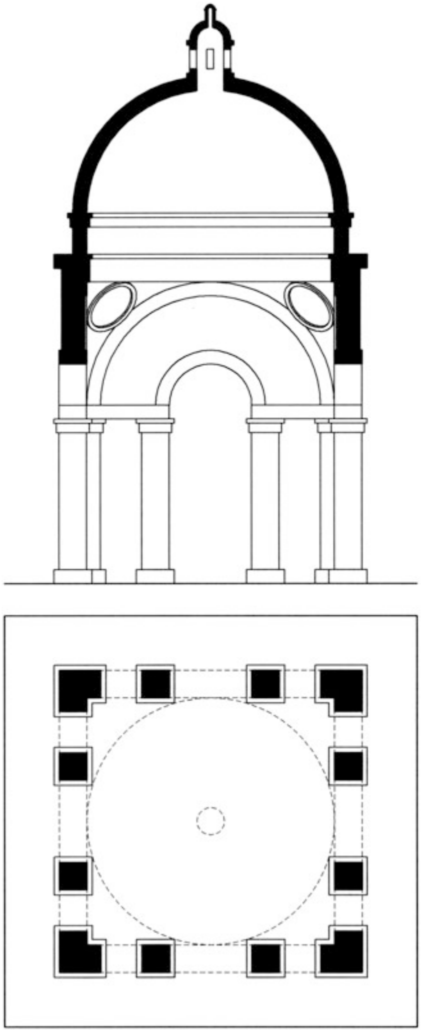

Fig. 52.14 The 'squared building' of Proposition 42. Drawing: author

Based on the extensive analysis done from the Onze Mil Virgens Chapel (Xavier 2015), in which one can recognize mainly rectangular shapes that express consonances from the Pythagorean tetrachord, as well as other secondary consonances, as well as other relationships that are specifically geometric, I must emphasize that the utilization of the proportional ratios built as homothetic situations evolving from centres, carefully located according to the modular structure of the temple (Xavier 2006: 378–444), shows much the same methodology that underlies the definition of Rodrigues's perspective rule.

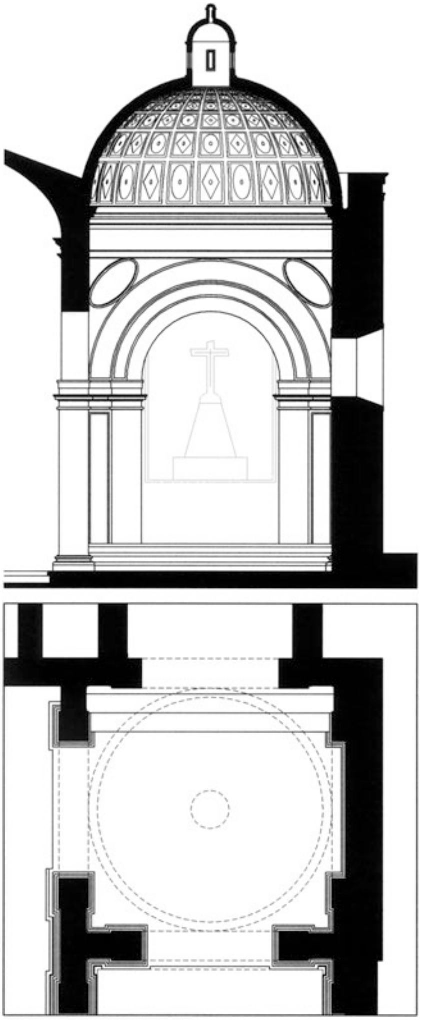

Fig. 52.15 The sepulchral space of the Onze Mil Virgens Chapel. Drawing: author

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*.

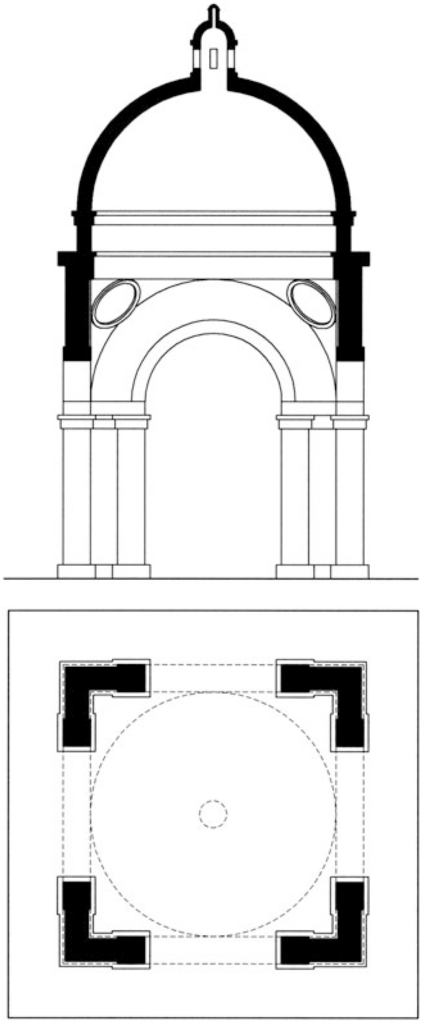

Fig. 52.16 Typological variant of the 'squared building'. Drawing: author

References

ALPERS, Svetlana. 1983. *The Art of Describing*. Chicago: University of Chicago Press.

BARBARO, Daniele. 1568. *La pratica della perspettiva...* Venice: C. & R. Borgominieri.

COMMANDINO, Federico. 1558. *Ptolemaei Planisphaerivm. Iordani Planisphaerivm. Federici Commandini Vrbinatis in Ptolemaei Planisphaerivm commentarivs. In quo uniuersa Scenographices ratio quambreuissime traditur, ac demonstrationibus confirmatur*. Venice.

DE VRIES, Hans Vredeman (Ioannes Frisius). 1604. *Perspective*. Leiden.

FRANCESCO DI GIORGIO MARTINI. ca. 1490. *Tratatti di Architettura, Ingegneria e Arte Militare*. Florence, Biblioteca Nazionale Centrale ms. Magliabecchiana 11.1.141. Published as: *Tratatti di Architettura, Ingegneria e Arte Militare*, 2 vols. Corrado Maltese, ed. Milan: Cassa di Risparmio di Jesi, 1967.

LINO CABEZAS, G. 1989. La "Perspectiva angular" y la Introducción de la Perspectiva artística en la España del siglo XVI. *D' Art* **15:** 167–180.

MESA GISBERT, Andrés de. 1994. Entre la Práctica Artesanal y la Teoría de la Visión. El Concepto de Pirámide Visual en el Tratado de Perspectiva de Jean Pélerin (Viator). *D'Art*, 1 (20): 59–113.

MOREIRA, Rafael. 1982. Um Tratado Português de Arquitectura do séc. XVI (1576–1579). Master's thesis, Universidade Nova de Lisboa, Faculdade de Ciências Sociais e Humanas.

ROCCASECCA, Pietro. 2001. La Finestra Albertiana. Pp. 65–78 in *Nel Segno di Masaccio: l'invenzione della Prospettiva*. Filippo Camerota, ed. Florence: Giunti.

RODRIGUES, António. 1576. *Tratado de Arquitectura*. Lisbon: Biblioteca Nacional de Lisboa, Codex 3675.

SERLIO, Sebastiano. 1600. *Tutte l'Opere d'Architettura, et Prospettiva di Sebastiano Serlio Bolognese*. *Diviso in sette Libri*. Dam. Gio. Domenico Scamozzi Vicentino. Venice: Presso Heredi F. de' Franceschi.

VIATOR (Jean Pélerin Le Viateur). 1505. *De Artificiali Perspective*. Toul. (2nd ed. 1509.)

XAVIER, João Pedro. 2006. *Sobre as Origens da Perspectiva em Portugal. O "Liuro de Prespectiua" do Códice 3675 da Biblioteca Nacional, um Tratado de Arquitectura do século XVI*. Porto: FAUP Publicações.

———. 2008. Leonardo's Representational Technique for Centrally-Planned Temples. *Nexus Network Journal* **10**, 1 (Spring 2008): 77–100.

———. 2015. António Rodrigues, a Portuguese Architect with a Scientific Inclination. Pp 165–181 in Kim Williams and Michael J. Ostwald eds. *Architecture and Mathematics from Antiquity to the Future: Volume II the 1500s to the Future*. Cham: Springer International Publishing.