On the Use of Perspective by Juan de Herrera, Architect of Philip II of Spain

Ana López-Mozo

Published online: 28 February 2015
© Kim Williams Books, Turin 2015

Abstract There are only two perspectives among the extant drawings of Juan de Herrera (1533–1597), who succeeded Juan Bautista de Toledo as architect of the Escorial. Both belong to the collection of engravings of that building made in 1589, after construction had already been completed. One is a bird's eye view showing the exterior of the building; the other is an interior perspective of the main altar. Although both drawings appear to be rigorous, the external perspective shows a cupola with an unrealistically high tambour, dome and lantern. This paper analyzes both of these, along with a third, a bird's eye view drawing of the building site by an unknown artist, conserved at Hatfield House (England), contextualizing them within the Escorial's construction process and Herrera's knowledge of perspective. The analysis argues that the elongated representation of the cupola was not an error caused by the difficulty of constructing a rigorous perspective or representing curve forms but was instead a deliberate choice made by the architect to make the cupola appear taller and slimmer.

Keywords Juan de Herrera · The Escorial · Hatfield drawing · Sixteenth century · Perspective drawing · Sebastiano Serlio · Daniele Barbaro · Giacomo Barozzi da Vignola

Introduction

At the end of the sixteenth century, rigorous perspective drawings were based on widely disseminated texts. However, not all of the geometrical layouts were correct. Drawings from that time of existing structures are scarce. However, those that do

A. López-Mozo (✉)

Departamento de Ideación Gráfica Arquitectónica, Universidad Politécnica de Madrid, Av. Juan de Herrera 4, 28040 Madrid, Spain
e-mail: ana.lopez.mozo@upm.es

exist allow for a comparison between perspective construction and actual buildings that deepens scholars' understanding of how this resource was used, how rigorous it was and whether or not it was intentionally manipulated to show a distorted reality.

This research focuses on three perspective drawings of the Escorial dating from the end of the sixteenth century. Two of these perspectives were drawn by Juan de Herrera, who succeeded Juan Bautista de Toledo as architect of the Escorial, and are the only extant perspectives created by him. The third one is a drawing of the Escorial's construction site by an unknown artist, now conserved at Hatfield House (England), showing a bird's eye view from the east side of the building. The present paper presents a study of the collection of engravings which Herrera's drawings belong to, showing when they were drawn, what was included and the differences from what was actually built; also included is research on Herrera's knowledge on perspective and an analysis of all three drawings to determine the accuracy of the geometrical representation and possible connections between them.

First, a geometric restitution is performed to test the graphical construction and locate the position of the original station point. The process of each drawing may then be reconstructed and the accuracy of the work checked. Concerning the main cupola, a 3D modeling after a laser survey of the dome made by the author makes it possible to obtain a rigorous perspective and compare it with Herrera's view.

Engravings of the Escorial by Juan de Herrera in the Context of the Design and Building Process

Once the Escorial was completed—the last stone was placed in September 1584—Juan de Herrera, architect of Philip II, asked the king for permission to print and sell drawings of the building. These drawings became the well-known *Estampas* drawn by Herrera and engraved by Pedro Perret between 1583 and 1589. Complete collections of these works are preserved at the Spanish National Library and Madrid Royal Palace Library and there are facsimile editions (Cervera Vera 1954; Kubler 1982). Herrera also published a book containing descriptions and a legend of the drawings (Herrera 1589; a facsimile appears in Cervera Vera 1954).

Cervera Vera gathered first-hand accounts of the creation of the drawings to reconstruct the process (1954, p. 33–63). In August 1583, Herrera sent a memorandum to the House of Castile asking for permission to print and sell a collection of engravings of the Escorial throughout the kingdom for 30 years, which the king granted but reduced to 15 years. At that time, Herrera invited Perret to live in his home, where he engraved three small sheets of the collection. The entire set, comprising twenty-three drawings, was described in a new request Herrera submitted to the king in 1584, in which he asked for permission to sell the following engravings in America: four elevations, a cross section, a longitudinal section, an internal perspective, four external perspectives, a drawing of the altarpiece, three drawings of the tabernacle, one of the monstrance and six floor plans. Herrera eventually decided to print only twelve drawings, which occupied eleven sheets, as had been agreed upon in the contract signed with Perret in October 1584. These are the ones that have come down to us: the ground plan (First

Drawing); the upper plan (Second Drawing); a section of the westernmost cloisters (Third Drawing); a section (north–south) of the large cloisters (Fourth Drawing); a longitudinal section of the basilica and forecourt (Fifth Drawing); the south elevation (Sixth Drawing); an external bird's eye view perspective (Seventh Drawing); a cross section of the main altar (Eighth Drawing); an elevation and cross section of the tabernacle (Ninth and Tenth Drawings) and an elevation and plan of the monstrance (Eleventh Drawing) (Fig. 1). However, Herrera completed one additional drawing, a perspective of the main altar, which was not published.

The drawings were likely completed in late 1584; Herrera's last will contains a payment order to Francisco de Mora, who had been his assistant in that task (Cervera Vera 1954: p. 42). Herrera's original drawing for the Sixth Engraving is conserved in the Spanish National Library; the whereabouts of the remaining originals are unknown. In February 1589, Herrera published the *Sumario*, comprising a short description of the contents of the drawings and a comprehensive legend of the parts of the building they depicted. Engravings continued to be produced until 1589, and the last one is dated that year. Of the two perspectives included in the collection, the external bird's eye view (Seventh Drawing) was

Fig. 1 *Estampas* of the Escorial drawn by Juan de Herrera and engraved by Pedro Perret. Digital files from the Spanish National Library bibliotecadigitalhispanica.bne.es

Fig. 2 The Seventh Drawing and the Perspective of the main altar of the Escorial, drawn by Juan de Herrera and engraved by Pedro Perret. Digital files from the Spanish National Library bibliotecadigitalhispanica.bne.es and Cervera Vera (1954)

engraved in 1587, and the main altar perspective was engraved in 1598, after Herrera's death in 1597 (Fig. 2).

Although the building was already completed when these drawings were made, they do not accurately reflect the actual structure. Some authors believe that this inaccuracy could be a deliberate attempt to perpetuate an idealized image of the building that could not be realized for various reasons (Ortega Vidal 1999: p. 208). Alternatively, it is possible that the drawings used for engraving were the available layouts, most likely the initial ones, on which modifications made during the construction process would not have been recorded (Aramburu-Zabala et al. 2003: p. 334). Because most of the Escorial's original layouts are now missing, primarily because of fire damage (López-Mozo and 2009a: p. 3–5), the *Estampas* may be exceptional documents that facilitate the reconstruction of the original building design.

Differences between the *Estampas* and what was actually built are particularly notable in the case of the main dome of the basilica and its towers. Herrera's original 1579 layouts for the church towers are kept at the Library of the Madrid Royal Palace and comprise several plans and a complete elevation. The initial project changed during construction: in the fabric actually built, the domes are thicker, the lantern diameter is larger and the external projections are missing.¹ However, the elevation depicted in the *Estampas*, drawn after the building was finished, reflects Herrera's initial layout, except for the height of the tower body. Thus, this was perhaps the design that he wished could have been built (Fig. 3).

Herrera's initial project plan for the main dome is now missing. However, according to first-hand accounts, several changes were introduced during construction. Because cracks appeared in the piers of the crossing in the first quarter of 1579, before the cupola was even built, it was decided, against Herrera's wishes, to

¹ The survey of the Escorial's towers was performed by the author in 2002 using a laser total station (López-Mozo 2003).

Fig. 3 From *left to right*, at the same scale: the tower elevation in Herrera's initial plans (1579); the tower actually built (finished in 1582) after author's survey and the elevation in the *Estampas*' Third Drawing (1589) (López-Mozo 2009a)

remove the pedestal measuring 11 Castilian feet² (3.06 m) (Sigüenza 1605: part II, XII).³ Although the building was completed when Herrera created the *Estampas* drawings, they do not reflect the dome actually built. Considering his dissatisfaction with the changes and what later happened with the towers, it is possible that he engraved the project he wished had been built. According to this hypothesis, the *Estampas* drawings may reflect a stage in the initial plans; according to the records, at least one additional version that included a pedestal would have existed. Differences between the engravings and existing dome suggest that the weight was

² The Castilian foot was the measurement unit used at the Escorial and it was drawn by Herrera at full scale in *Estampas* drawings. It is equivalent to 0.2786 m. In this paper, feet units always refer to the Castilian foot.

³ The only first-hand account of this episode was recorded by Sigüenza (1605). His information must be regarded with a certain degree of caution, considering that he visited the building site only occasionally (Rubio González 2006: pp 315–317). However, he met everyone involved in the construction process.

reduced by lowering the lantern (Ortega Vidal 1999: p. 206–211) and reducing the thickness of the dome, which is 1 foot thinner in the intrados and 3/4 foot thinner in the extrados (López-Mozo 2009b: p. 766–767) than initially planned (Fig. 4).⁴

Herrera's Knowledge about Perspective

Juan de Herrera was born in Cantabria, northern Spain, in 1533 and died in Madrid in 1597. He joined the army and participated in Prince Philip's two tours of Europe. His visits to Valladolid in 1559 and Alcalá de Henares in 1561–1562 correspond to the itinerary of Prince Charles, whose educational milieu may have included Herrera (Aramburu-Zabala et al. 2003: p. 89). In 1563, he was hired as an assistant to Juan Bautista de Toledo, first architect of the Escorial, who had worked as Michelangelo's deputy at Saint Peter's between 1546 and 1548.

Herrera was seen by many of his contemporaries as a mathematician. He not only founded the Madrid Academy of Mathematics promoted by the King but also participated in the discussions at the House of Castile that resulted in the establishment of mathematical studies in all Castilian cities.

The inventory of Herrera's goods made in 1597 after his death was published by Ruiz de Arcaute (1936). A proposal to reconstruct its index was made by Sánchez Cantón (1941) and reviewed by other authors (Aramburu-Zabala et al. 2003). These works provide information about the contents of his library and, in this paper, to his understanding of perspective. The objective of this study is to analyze the geometrical correction of the two available drawings and identify the causes of the elongated representation of the cupola in the external perspective of the Escorial.

Differing significantly from a post-Renaissance understanding of perspective, Euclid's studies on the geometrical aspects of vision interested Herrera; he owned four copies of Euclid's *Optics*. Two of these copies, Italian and Spanish editions, are explicitly identified in the inventory of his goods: *La prospettiva di Euclide* by Egnatio Danti (1573) and *La perspectiva y especularia de Euclides...* by Ondériz (1585). He also owned three copies of Witelo's *Óptica* (1535). His collection also comprised works on perspective, including a copy of *La pratica della prospettiva* by Daniel Barbaro (1569), a copy of *Le due regole della prospettiva pratica* by Giacomo Barozzi da Vignola (1583) and three unidentified works by Sebastiano Serlio "on architecture". One of these Serlian works may have been the 1552 Spanish edition of Serlio's third and fourth books by Francisco de Villalpando (1552). Serlio's second book, on perspective (1545), was first published in Paris in 1545, and although there is no evidence indicating that it was part of Herrera's library, it was in the King's library (Rodríguez Gutiérrez de Ceballos 1987: p. 121). Thus, the architect was likely familiar with it.

These three texts by Serlio, Barbaro and Vignola are now analyzed to determine whether their readers could use them to learn the principles of geometrically correct perspective drawing. In Serlio's work, which is the earliest, he demonstrates the

⁴ A survey of the Escorial's cupola was performed by the author between 2006 and 2008 using a laser total station (López-Mozo 2009a, b).

Fig. 4 Comparison between the dome actually built (finished 1582) after author's survey (*left*), and the elevation reflected in the Fourth Drawing of the *Estampas* in 1589 (*right*)

construction of a single vanishing point perspective in a simple and clear manner. Serlio first computes the perspective of a square plan via its diagonals, following Piero della Francesca (ca.1475). He then measures heights from the ground line and puts them in perspective using horizontal lines aligned with the corresponding vanishing points. For all other types of plans, he first draws a base of square tiles. Nevertheless, his method could be extrapolated to any plan inscribed in a rectangle, as Piero della Francesca had already indicated (ca.1475: lib. I, teor. XXIII, c. 10v). He also demonstrates how to draw horizontal and vertical circumferences using the diagonals of the circumscribed square. The problem of representing a sphere, a fundamental issue for Herrera's dome perspective, is not addressed by Serlio, nor

does he solve the problem of drawing an object in a two vanishing points perspective. Instead, he approximates the plan using a floor of square tiles, always positioning the main horizontal directions so that they form an angle of 45° to the picture plane (Figs. 5, 6).

Barbaro (1569) also addresses the construction of a perspective using the method of diagonals, which is applied in his work to any type of rectangular plan. Using this method, he reproduces a drawing by Piero della Francesca (ca. 1475: lib. I, teor. XXIII, c. 10v) (Fig. 7). He then demonstrates how to draw volumes for a numerous series of polyhedral forms. His method for drawing circumferences is not as accurate as Serlio's, which is curious considering that Barbaro knew the Italian's work and reproduces some of his drawings. However, Barbaro demonstrates the representation of a sphere by drawing parallels and meridians. This could have made a valuable contribution to Herrera's work (Fig. 8).

Vignola's *prima regola* instructs readers to establish the station point and lay out the visual rays so that they radiate from that point to intersect with the picture plane, thus solving the main geometric problem of perspective drawing (1583: p. 65). He demonstrates a high level of spatial understanding as he computes the locus of the vanishing points of lines in vertical parallel planes (1583: p. 107). He accurately draws circumferences using visual rays (1583: p. 77) or lines forming a 45° angle to the picture plane, in accordance with his *seconda regola* on the use of the distance point (1583: p. 111) (Fig. 9).

Herrera, likely familiar with at least these sources, was in a position to control the geometric accuracy of his perspectives, both of which use a single vanishing point, with regard to the location in plan and height of any point. Instructions for circumference control, essential to drawing the horizontal lines of the tambour, dome and lantern, were also found in the books in his library. Such instructions would also have been necessary for drawing the spherical shape of the dome, following Barbaro's method of using parallels and meridians.

Fig. 5 Serlio's perspective constructions (1545, fols. 34r, 46r and 61r)

Fig. 6 Serlio's perspective constructions. Locating a point using the diagonal (1545, fol. 34r, with author's overlay)

Analysis of the Drawings

The Seventh Drawing

The Seventh Drawing of the *Estampas* collection, which shows a bird's eye view from the west side of the Escorial, was engraved in 1587. Herrera wrote this introduction to the drawing in the preface of the *Sumario*:

El septimo papel, es una perspectiva de toda esta fabrica mirada por su delantera principal del Poniente, esta papel no lleva letras porque de la

Fig. 7 Daniele Barbaro's use of the method of diagonals to draw perspective (Barbaro 1569: p. 35)

Fig. 8 Daniele Barbaro's representation of a sphere with parallels and meridians (Barbaro 1569: p. 166)

inteligencia, que se avra tenido de los demas papeles y diseños ya dichos: y por lo que del se dira, se vendra en conoscimiento de todo lo que se viere en este diseño (1589: p. 5r).

The seventh paper is a perspective of the entire building as viewed from the main façade on the west, this paper has no text because from the information

Fig. 9 Vignola's perspective constructions (Vignola et al. 1583: pp. 65, 107, 77 and 111)

contained in the rest of the papers and drawings, thanks to which it is possible to know everything that can be seen in this drawing).

The drawing is a frontal perspective drawn from a station point in front of the main western façade. Examining the geometric correctness of the drawing requires determining how accurately the plan and heights are represented. The prolongation of supposedly perpendicular lines to the main façade indicates the location of the principal point, the orthogonal projection of the station point to the picture plane, and the position of the horizon line. The station point is 532.010 feet (148.218 m) high. Using Serlio's and Barbaro's method of diagonals for drawing a plan in perspective, it is possible to verify that the measurements of depth are correctly determined: Fig. 10 shows the layouts needed to test the positions of the palace cloister piers. To analyze the position of the cupola, the location of the dome terrace—its plan position and height—is first determined (Fig. 11). The analysis shows that it is off-center from the main symmetry axis of the drawing even though the left part is accurately placed. Surprisingly, its height is nearly 2 ft (0.5498 m) lower than it should be. The remaining drawing heights match the data from Herrera's sections and elevations. This part of the test was conducted using data extracted from the *Estampas* drawings.

The height of the cupola itself is easily confirmed because the frontal section shows no distortion in the perspective. Figure 12 shows a comparison of heights between the cupola in Herrera's perspective and two versions of its section: the one shown in Herrera's Fifth Drawing of the *Estampas* and the section of the existing dome, based on the author's survey. The comparison reveals that the dome in the perspective is higher than what was actually built, and higher still than the section depicted in the Fifth Drawing, which Herrera had drawn for the same collection. Compared with this section, the most elevated element in the perspective is the lantern base, which stands 19.25 feet (5.50 m) higher than it should. The total height of the cupola in the perspective, measured from the spire ball, is 14.9 feet (4.16 m) higher than depicted in Herrera's section. Compared with the actual built section, the most distorted level of the perspective is that of the spire ball, which stands 27.5 feet (7.68 m) higher than it should. Table 1.

Fig. 10 Examining the plan points in Herrera's Seventh Drawing (color overlays by the author)

The dome is the most distorted element in the perspective: 36.8 % higher than it should be, according the Fifth Drawing. However, within the context of Herrera's pattern of increasing the heights, it is surprising that the lantern is lower in the perspective than in his own section.

Fig. 11 Examining the dome terrace position in Herrera's Seventh Drawing (color overlays by the author)

Fig. 12 Comparison among the cupola in Herrera's perspective and two versions of its section: that depicted in Herrera's Fifth Drawing of the *Estampas* (left) and the actual built one, based on the author's survey (right) (2009b)

Table 1 shows the data obtained for the individual elements

	Fifth Drawing		Perspective		Actual building	
	Meters	Feet	Meters	Feet	Meters	Feet
Tambour	12.93	46.4	14.14	50.25	11.57	41.53
Cupola	11.64	41.77	15.93	57.18	11.98	43.00
Lantern	8.64	31.01	7.49	26.88	6.98	25.05

Fig. 13 Heights correction of Herrera’s perspective made by the author using image-editing software: on the *left*, the heights are matched to Herrera’s section; on the *right*, the heights are matched to the existing dome section

Figure 13 shows Herrera’s perspective, which has been modified using image-editing software to match heights, first with his own version of the section (Fifth Drawing) and second with the actual building section.

The final step in the process of analyzing Herrera’s Seventh Drawing was to create a perspective of the existing dome from the same station point, which is 532 feet (148.218 m) high. To locate its position in plan, the intersection of several visual rays must be determined. Two points on the same visual ray are vertically aligned in the perspective. Thus, we select a pair of vertically aligned points that must be identifiable in the plan so that the ray can be drawn: it should be placed as far away as possible from the principal point to reduce error when determining the intersection. Through the repetition of this process, very similar positions were obtained averaging a distance of 200.70 m (720.38 ft) from the main façade. Thus, the station point deduced through the geometric restitution of the perspective is identified as 148.218 m (532 ft) high and 200.70 m (720.38 ft) away from the midpoint of the façade (Fig. 14).

A perspective of the actual dome was created using the station point obtained through the geometric restitution and was compared to Herrera’s version. This process relied on the availability of a 3D model made by the author following her laser survey Fig. 15.

Fig. 14 Location of the perspective's station point as determined by the intersection of visual rays (color overlays by the author)

The Main Altar Perspective

After the collection was published, Perret engraved a perspective of the main altar in 1598 that was not included in any subsequent edition. Herrera had died the previous year. This engraving is also a frontal perspective, with the principal point placed

Fig. 15 In *red*, a perspective of the actual dome from the station point used by Herrera is overlaid on the Seventh Drawing

11.64 m high (41.78 ft), matching the altar's second level. This area of the building is also represented in the section of the Eighth Drawing of the *Estampas*. Again, the drawing does not accurately reflect the existing building: the actual cornice is lower (Fig. 16). By assuming that the picture plane is the plane Herrera shows dissected and by placing the plan and section of the main altar (First and Eighth Drawings) at the proper scale, the drawing can be analyzed to identify the position of the original station point. Because Herrera's plan in the First Drawing does not match the actual building, each version has been placed in half of the plan (Fig. 17). Tests of the heights produced positive matches, but the barrel vault is lower than it should be, according to the elevation. Regarding plan positions, the first part of the staircase appears to match Herrera's plan, but the second coincides with what was actually built. Therefore, it is difficult to determine which data were handled and the level of geometric correction.

By drawing visual rays in perspective and locating them in the plan, a possible station point was identified in the church crossing, although not exactly in the center (Fig. 17).

Fig. 16 Section of the Main Altar in Herrera's Eighth Drawing; color overlays reflecting the actual building by the author

The Hatfield Drawing

This drawing, kept at Hatfield House (England), shows the Escorial's building site and reflects a stage of the construction corresponding to 1576. Thus, it is thought to have been created at that time. A complete study of its content and context was conducted by Navascués Palacio (1986). Its author is unknown, but Navascués proposes a Flemish origin based on the style and nature of the drawing. Bustamante García (1994: p. 419) suggests the name of Rodrigo de Holanda, who lived at the Escorial. Navascués dismisses Herrera as a possible author (see also Íñiguez 1963: vol. 2, p. 106; Cervera Vera 1985: pp. 220–222) because of serious errors in the drawing: a legend indicates a west orientation for an east façade and a dimension of 645 ft for one of 740 ft, the proportion of a set of windows is distorted, the cornice corbels and surrounding buildings do not follow the laws of perspective, and the human and animal figures are not drawn to scale.

This drawing is also a frontal perspective with an off-center station point. By placing the picture plane in the east façade, it is easy to determine that the heights are magnified. The station point is located at a distance of 234.77 m away from the façade: an accurate assessment of its height is difficult to obtain because of the aforementioned distortion. The depth of the drawing is correctly controlled; Serlio's diagonal method shows that the position of the Main Cloister is perfect. However, several crossing piers are placed inaccurately (Fig. 18). Figures 19, 20 show a digitally edited transformation of the drawing in which the heights are lowered to restore the proportion of the east façade.

This paper offers additional arguments against Herrera's authorship of the Hatfield drawing. The drawing's author was either not familiar with the works of

Fig. 18 Analysis of the Hatfield drawing

Serlio (1545); Barbaro (1569) or did not understand them. The drawing fails in the easiest task: computing heights. There could also be a mistake in the length of the east façade, considering that a legend of the drawing itself shows erroneous data. Either the heights are correct and the widths are mistaken, or vice versa.

Conclusions

Herrera's initial design for the church towers at the Escorial, which has been preserved, was modified during construction. However, these changes were not reflected in the *Estampas* drawn by Herrera after the building was finished; instead,

Fig. 19 Modification of the Hatfield drawing to restore the proportion of the east façade

the *Estampas* reproduce previous layouts. Herrera's design for the main cupola is now missing, but it was changed during construction against his opinion and will, according to first-hand accounts. The *Estampas* drawings do not accurately reflect the completed dome. Based on an analysis of the towers, it is reasonable to conclude that for the *Estampas*, he depicted his initial project. Structural design in the sixteenth century had an empirical basis, and architects copied rules from existing buildings. The *Estampas* drawings include a cross-section of the main dome, which was a fundamental document for an architect. Herrera had to guarantee the safety of the design reflected in the *Estampas*, which he could not finally build, because it would become not only an architectural reference model but also a structural design pattern. Following the publication of the *Estampas*, dome construction in Spain at the end of the sixteenth century changed, and projects were altered to include extradosed domes and tambours. The proportions of the Escorial's section were also borrowed, and its constructive arrangement was copied (López-Mozo 2013: pp. 95–99).

Herrera had in-depth knowledge of the geometric construction of perspective. He owned what were, at the time, the essential books on this subject, and he correctly draws both plan and heights, particularly the Seventh Drawing, with the exception of the height of the cupola. Herrera's section in the Fifth Drawing is higher than the existing dome, but the perspective magnifies it even more. The remaining heights of the building are correctly controlled in the perspective. Barbaro's method for representing a sphere may have given Herrera basic instructions for controlling the drawing. Thus, he intentionally used this graphic resource to depict an elongated main cupola, which appears to have been a fundamental part of his design.

The main altar perspective does not allow for an assessment of the geometrical correctness of the drawing. The position of the barrel vault should be higher and the lower part of the stairs matches the plan while the upper part matches the actual

Fig. 20 Original Hatfield drawing (*top*) and correction proposed to restore the proportion of the east façade (*bottom*)

building, suggesting that the drawing contains several mistakes. Considering that there is no evident intention in these changes and that Herrera had already died when the drawing was engraved, it is reasonable to conclude that Herrera was not the final author.

The author of the Hatfield drawing fails the easiest task: computing heights. The lack of proportion in the representation of the east façade provides one more argument to the reasons given by Navascués Palacio (1986) for dismissing Herrera as a possible author. It is earlier than the *Estampas* perspectives, but, if it was actually drawn in 1576, it should reflect the knowledge being disseminated by Serlio's and Barbaro's works. Regardless, at that time, Herrera would not have made those mistakes. However, it is possible that the proportions were intentionally modified.

The lack of geometrical rigor in some elements of these three drawings does not diminish their interest. Instead, they constitute valuable documents for many reasons and contribute to construction history by showing initial projects and building sites in progress at the end of the sixteenth century.

Acknowledgments The fieldwork for this paper was conducted as part of the “Ashlar construction in the Hispanic area. Documentary sources and built heritage” research project, which was funded by the Spanish Ministry of Education (BIA2006–13649). The initial conception of this paper was part of the author’s Ph.D. Dissertation, which was supervised by Enrique Rabasa Díaz. Image credits: *Estampas* of the Escorial drawn by Juan de Herrera and engraved by Pedro Perret: Digital files from the Biblioteca Digital Hispánica of the Biblioteca Nacional de España, <http://www.bne.es/es/Catalogos/BibliotecaDigitalHispanica/Inicio/index.html>. Perspective of the main altar of the Escorial, drawn by Juan de Herrera and engraved by Pedro Perret: reproduced by permission of the Spanish National Library. Perspective of the Escorial in construction: Hatfield House, Hertfordshire, England, reproduced by courtesy of the Marquess of Salisbury.

References

- Aramburu-Zabala Higuera, Miguel Ángel, Ana Cagigas Aberasturi and Celestina Losada Varea. 2003. *Biografía de Juan de Herrera*. Santander: Fundación Obra Pía Juan de Herrera.
- Barbaro, Daniel. 1569. *La pratica della prospettiva...* Venice: Camillo & Rutilio Borgominieri. http://mathematica.sns.it/media/volumi/38/Barbaro_perspettiva.pdf, accessed 6 January 2015.
- Bustamante García, Agustín. 1994: *La octava maravilla del mundo (Estudio histórico sobre el Escorial de Felipe II)*. Madrid: Alpuerto.
- Cervera Vera, Luis. 1954 (1998). *Las Estampas y el Sumario de El Escorial por Juan de Herrera*. Madrid: Tecnos. Facsimile edition in Madrid, Fundación Cultural C.O.A.M.
- Cervera Vera, Luis. 1985. *Años del primer matrimonio de Juan de Herrera*. Valencia: Albatros.
- Danti, Egnatio. 1573. *La prospettiva di Euclides....* Florence: nella stemperia [sic] de’ Giunti.
- Della Francesca, Piero. ca 1475. *De prospectiva pingendi*. (Electronic facsimile in Biblioteca Panizzi Reggio Emilia <http://digilib.netrib.it>. Accessed 3 October 2013).
- Herrera, Juan de. 1589. *Sumario y breve Declaración de los diseños y estampas de la Fábrica de San Lorenzo el Real del Escorial*. Madrid: Viuda de Alonso Gómez.
- Íñiguez, Francisco. 1963. Los ingenios de Juan de Herrera. In *El Escorial. 1563-1963*. Madrid: Patrimonio Nacional, 181-214.
- Kubler, George. 1982. *Building the Escorial*. Princeton: Princeton University Press.
- López-Mozo, Ana. 2003. Extradosed vaults in the Monastery of El Escorial: The domes at the church towers. Pp. 1.321-1.326 in *Proceedings of the First International Congress on Construction History*, Santiago Huerta Fernández, ed. Madrid: Instituto Juan de Herrera. http://www.sedhc.es/biblioteca/actas/CIHC1_125_Lopez%20A.pdf, accessed 6 January 2015.
- López-Mozo, Ana. 2009 a. *Bóvedas de piedra del Monasterio de El Escorial*. Ph.D. dissertation, Universidad Politécnica de Madrid.
- López-Mozo, Ana. 2009 b. La cúpula de El Escorial: geometría, estereotomía y estabilidad. *Actas del Sexto Congreso Nacional de Historia de la Construcción*. Madrid: Instituto Juan de Herrera. (Electronic facsimile in Spanish Society of Construction History, [http://www.sedhc.es/biblioteca/actas/CNHC6_%20\(72\).pdf](http://www.sedhc.es/biblioteca/actas/CNHC6_%20(72).pdf)).
- López-Mozo, Ana. 2013. The influence of the Escorial on Spanish domes at the end of the 16th century. The case of Cerralbo Chapel in Ciudad Rodrigo. *Informes de la Construcción* vol. 65, no. Extra-2, 95-109.
- Navascués Palacio, Pedro. 1986. La obra como espectáculo: el dibujo Hatfield. In *Monasterio de El Escorial. Las Casas Reales. (El Palacio)*. Madrid: Patrimonio Nacional, 55-68.
- Ondériz, Pedro Ambrosio. 1585. *La perspectiua y especularia de Euclides. Traduzidas en vulgar Castellano... por Pedro Ambrosio Onderiz...* Madrid: Viuda de Alonso Gómez.
- Ortega Vidal, Javier. 1999. *El Escorial; dibujo y lenguaje clásico*. Madrid: Sociedad Estatal para la Conmemoración de los Centenarios de Felipe II y Carlos V.

- Rodríguez Gutiérrez de Ceballos, Alfonso. 1987. En torno a Felipe II y la arquitectura. *Real Monasterio – Palacio de El Escorial. Estudios inéditos en conmemoración del IV centenario de la terminación de la obras*. Madrid: C.S.I.C., Centro de Estudios Históricos, Departamento de Arte « Diego Velázquez», 107-125.
- Rubio González, L. 2006. Cronología del Padre José de Sigüenza. Homenaje al P. Fray José de Sigüenza en el IV Centenario de su muerte († 1606), *La Ciudad de Dios*, vol. CCXIX, núm. 1, enero-abril 2006, 315-317.
- Ruiz de Arcaute, Agustín. 1936. *Juan de Herrera, arquitecto de Felipe II*. Madrid: Espasa Calpe. Rpt. Madrid: Instituto Juan de Herrera, 1997 (with introduction by Javier Ortega Vidal).
- Sánchez Cantón, Francisco Javier. 1941. *La librería de Juan de Herrera*. Madrid: Consejo Superior de Investigaciones Científicas.
- Serlio, Sebastiano. 1545. *Il primo [-secondo] libro d'Architettura di Sabastiano Serlio...* Paris: Jean Barbé. <http://fondosdigitales.us.es/fondos/libros/1038/19/il-primo-secondo-libro-darchitettura-di-sabastiano-serlio/>, accessed 15 October 2013.
- Sigüenza, José de. 1605 (1988). *Tercera Parte de la historia de la orden de San Geronimo Doctor de la Iglesia*. Madrid: Imprenta Real. 1988 edition in Madrid: Aguilar.
- Vignola, Giacomo Barozzi da, and Egnazio Danti. 1583. *Le due regole della prospettiva pratica/di Iacomo Barozzi da Vignola; con i comentari del R.P.M. Egnatio Danti dell'ordine de Predicatori...* Roma: Francesco Zanetti. <https://archive.org/details/ledueregoledella00vign>, accessed 10 October 2013.
- Villalpando, Francisco de. 1552. *Tercero y Quarto Libro de Architectura de Sebastia Serlio Boloñes...* Toledo : En Casa de Iuan de Ayala.
- Witelo [Vitellio]. (1535). *Vitellionis mathematici doctissimi Περὶ ὀπτικῆς id est de natura ratione et proiectione radiorum visus... quam vulgo perspectiva vocant*. Nuremberg: Johannes Petreius.

Ana López-Mozo is an architect. Her Ph.D. dissertation was awarded the Extraordinary Doctoral Prize of the Polytechnic University of Madrid in 2009. She is Professor of Geometry, Architectural Drawing and Construction History at the School of Architecture of the Polytechnic University of Madrid. She has also lectured in graduate courses on architectural restoration and computer graphics. Her research focuses on stereotomy, arches, vaults and domes and has appeared in international conference proceedings, journals and books such as *Cantería renacentista en la catedral de Murcia* (2005). She is now co-leading a research project on knowledge transfer in European late Gothic architecture, funded by the Spanish Ministry of Economy and Competitiveness.