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Design drawing and representation science in 16th to 17th C. architectural treatises

El dibujo de proyecto y la ciencia de la representación en los tratados de arquitectura de los siglos XVI y XVII

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Abstract: In architectural treatises, the design drawing exhibits specific interconnections with the representation science. In the sixteenth and seventeenth centuries, Italian architectural literature offered considerable scope for reflection relevant to the subject of this article. This paper aims to highlight the contributions to the representation science made by sixteenth and seventeenth century architectural treatises. To this end, a selection of printed treatises and images of design drawings is examined. The design drawings in sixteenth and seventeenth architectural treatises reflect the characteristics of contemporary figurative thought, highlighting connections to the artistic and geometric realms, where methods of graphic representation are scientifically defined. The contribution of these treatises to the representation science lies not only in the application of projective methods—some of which had not yet been scientifically formalized—but also in innovative representational solutions, driven by the need to convey models and examples to other designers and builders effectively.

Keywords: design drawing; representation science; descriptive geometry; architectural treatises.

Resumen: En los tratados de arquitectura, el dibujo de proyecto presenta interconexiones específicas con la ciencia de la representación. Durante los siglos XVI y XVII, la literatura arquitectónica italiana ofreció un amplio margen para la reflexión sobre el tema que aborda este artículo. El presente trabajo tiene como objetivo destacar las aportaciones a la ciencia de la representación realizadas por los tratados de arquitectura de los siglos XVI y XVII. Para ello, se examina una selección de tratados impresos e imágenes de dibujos de proyecto. Los dibujos de proyecto contenidos en los tratados de arquitectura de los siglos XVI y XVII reflejan las características del pensamiento figurativo de la época, poniendo de relieve sus vínculos con los ámbitos artístico y geométrico, en los cuales los métodos de representación gráfica se definen de manera científica. La contribución de estos tratados a la ciencia de la representación no reside únicamente en la aplicación de métodos proyectivos —algunos de los cuales aún no se habían formalizado científicamente—, sino también en soluciones representacionales innovadoras, impulsadas por la necesidad de transmitir eficazmente modelos y ejemplos a otros proyectistas y constructores.

Palabras clave: dibujo de proyecto; ciencia de la representación; geometría descriptiva; tratados de arquitectura.

INTRODUCTION

In architectural treatises, the design drawing exhibits specific interconnections with the representation science.

As Roland Recht argues, "architectural drawing, having a purpose that is entirely external to it—namely, architecture—maintains, throughout its historical evolution, a more or less noticeable distance between the architectural object and its graphic representation", since "firstly, in drawing, the architect employs stylistic conventions specific to his or her time and cultural milieu, which determine his or her 'manner'. Secondly, whilst drawing, the architect imagines the architecture as if in a dream and, consequently, conceives the structure outside any physical constraints, which are, on the other hand, inherent to the reality of what is actually built."[1] In architectural treatises, given their purpose of transmitting knowledge, design drawings represent both typological models and works of the authors' own invention.

In the 16th and 17th centuries, architectural literature in Italy was rich in points for reflection relevant to this article's subject.

The 16th century saw a flourishing of architectural treatises, following the rediscovery of Vitruvius's text[2] in the second decade of the previous century, which had given rise to the first Renaissance theories, with the works of Leon Battista Alberti,[3] Antonio Averlino detto il Filarete,[4] and Francesco Di Giorgio Martini.[5] Also in the XVth century, the rediscovery of perspective led to the scientific formalization of the method in art theory by Alberti himself,[6] Piero della Francesca,[7] and Leonardo.[8] In the 17th century, as René Taton observes, the theorization of methods of graphical representation shifted from the artistic to the scientific sphere, through figures such as Galileo, Kepler, Descartes, and Desargues, who embodied the geometric thinking that underpinned the future formalization of the methods of descriptive geometry by Monge in the late 18th century.[9]

This paper explores the contributions to the representation science made by 16th- and 17th-century architectural treatises. To this end, a selection of printed treatises and images of design drawings will be examined.

The author in a previous work has explored the interrelationships among the drawing of antiquity, architectural design, and the representation science, drawing on architectural treatises as primary sources. The present article revisits and expands upon the work of several authors discussed in that earlier study, incorporating new references to other authors and books.

Numerous studies have examined the relationships between the representation science and the architectural theories presented in treatises. The research by Agostino De Rosa, Anna Sgrosso, and Andrea Giordano,[10] published in three volumes and spanning from antiquity to the present day, offers an examination of the projective foundations of images and a historical analysis of the methods and forms of representation. Roberto de Rubertis's work[11] examines the significance of architectural drawing in relation to design and the representation science, tracing the history of architectural theories.

James S. Ackerman[12] brings together a series of his own contributions to outline the history of representation in architecture through the concepts of invention and model, and imitation and convention.

Martin Kemp[13] explores the relationships between the optical sciences and the visual arts, examining the links between painting and science, and between artists and theorists.

Monographic studies, focusing on individual treatises or authors, form the critical framework underpinning this contribution.

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THE REDISCOVERY OF PERSPECTIVE IN PAINTING AND ARCHITECTURE

As early as the fifteenth century, Alberti, in his *De re aedificatoria*, addressed the question of the function of drawing in both painting and architecture, and shed light on the methods of representation best suited to these two artistic practices, highlighting their different purposes. Thus, whilst the painter endeavours to "make objects stand out in relief on the panel through shading and the foreshortening of lines and angles",[14] the architect "avoids shading, depicting reliefs through the drawing of the plan, and represents in other drawings the shape and extent of each façade and each side using true angles and unvarying lines: as if to ensure that his work is not judged based on illusory appearances, but rather assessed precisely based on verifiable measurements".[15]

In this regard, Scolari notes that in the architect's drawing, shadows and foreshortening would only create ontologically flawed images. The conception of the design would lose, along with its precision, the clarity of its reasoning. De Rubertis emphasizes that Alberti's call for order must be assessed within a context, such as that of the fifteenth century, in which the 'rediscovery' of perspective had almost obscured, in the practice of architectural drawing, the accuracy of orthographic projections, already in use in the medieval world.[16]

With the dawn of the new century, the use of orthographic projection became more systematic. Within Bramante's circle, drawings employing double orthographic projection and section views—with a direct comparison (in the same drawing, divided in half) between the section and the elevation—can be traced back as far as 1506–1507.[17]

The Letter to Leo X,[18] dated 1519, reiterates Alberti's emphasis regarding architectural drawing: "And since the method of drawing most appropriate to the architect differs from that of the painter, I shall explain what I consider necessary to understand all the measurements and to know how to identify all the parts of buildings without error".[19]

The Letter documents focuson orthographic representations of architecture and emphasize the correlation between the three views: "The drawing of buildings is therefore divided into three parts; the first of which is the plan, or, as we might say, the floor plan; the second is the external wall, with its ornamentation. [...] The third part of this drawing is the one showing the interior wall with its ornamentation. And this is no less necessary than the other two and is drawn in the same way as the plan, with parallel lines, just like the exterior wall; and it shows half of the building from the inside, as if it were divided down the middle".[20]

ORTHOGRAPHIC ORDER AND STEREOMETRIC RESEARCH

The sixteenth-century design drawings in the treatises of Serlio and Palladio reveal a desire to combine typological models and personal innovations, through the use of double orthographic projection, with the concept of measurability—already referred to by Alberti—and the control of proportional relationships between rooms through the definition of dimensions, as is particularly evident in the designs for palaces and villas by these two authors.

Sebastiano Serlio's treatises,[21] together with those of Palladio, herald a new era of works intended for didactic, manual, and practical purposes, as evidenced by the typological themes addressed—themes which, before them, had been based almost exclusively on theoretical assumptions and which, with him and Palladio, now refer to concrete architectural works, both ancient and modern.[22]

Irace observes that Serlio's work is directed not at the expert architectbut at the client and the humble and obscure practitioner,[23] and that the

didactic value of invention emerges within it: "seeing inventions often leads one to do those things that one might not do were one to see them in reality".[24]

Serlio aligns with Vitruvian *scaenografia,* focusing on the representation of architectural elements, buildings, and urban settings, illustrated through the construction of perspective compositions that bear witness to the emergence of modern theatrical scenography. Compared with Alberti and Piero, he makes no theoretical contributions, confining himself to the practical application of the method and offering, in particular, examples of the use of the direct method, starting with the projection of the plan onto a plane and specifying that the height of the horizon plane is equal to that of the human eye.

The depiction of invented models features in Books V, VI, and VII, which provide an extensive typological overview of religious and civil architecture.

In some books, text and drawings occupy every space on the page, breaking with a tradition inherited from Filarete and Francesco di Giorgio; in others, the drawing occupies the entire page, alternating with the description, in a graphic style that Palladio would later adopt. As De Fusco notes, Serlio's critical analysis, conveyed through the illustrations, employs a representational technique that varies with building type, scale, and the richness of elements, capturing the most significant features of each monument and rendering them most clearly and concisely.[25]

In Book V, on temples and churches, some floor plans, dimensioned with key measurements, are accompanied by elevations or sections and, on occasion, by an elevation and a section (Figure 1) separated by the axis of symmetry, whilst certain elements in the background are depicted in perspective to emphasize the three-dimensionality of the building, which is also highlighted by the shadows.

The design drawings of villas and palaces in Book VII strictly adhere to the method of orthographic projections, with a layout in which the elevation and, occasionally, the section are shown in their corresponding projections (Figure 2). In the text, the two horizontal dimensions and, occasionally, the vertical one describe the rooms. This makes it possible to verify the presence of rectangular ratios,[26] as Serlio himself describes in Book I.[27]

Andrea Palladio's *I quattro libri dell'architettura,*[28] published in 1570, comprises studies and surveys of antiquity—developed through numerous journeys to Rome—and an overview of his intense design activity, highlighting mutual influences and a clear didactic and practical intent.

Surveys and designs are rendered through drawings, conceived as full-page plates, whose consistency suggests the maturation and development of a personal, conventional visual language.[29]

The representation of the buildings uses orthographic projections expressed in the ground-floor plan and the main elevation, or in the elevation-section separated by the axis of symmetry—as already seen in some of Serlio's drawings—arranged in a projective correlation. In particular, the plan is usually placed above the elevation, which, in turn, represents the underside of the plan as an orthographic projection[30]. Significant measurements, inscribed on the plates, enable us to understand the proportions of the individual compartments and to discern the proportional relationships—often inspired by musical harmonies—that govern the entire composition[31] (Figure 3). The versatility of orthogonal projections is evident in the application of the local geometric flip of the sectional elevation (Figure 4).

Pietro Cataneo, architect and military engineer, published *I primi quattro libri di architettura* in 1554[32], followed in 1567 by *L'architettura*[33], with an additional four books.

His role as a military engineer in the service of the Republic of Siena is evident in the First Book, which is devoted to the layout of the city's blocks and the

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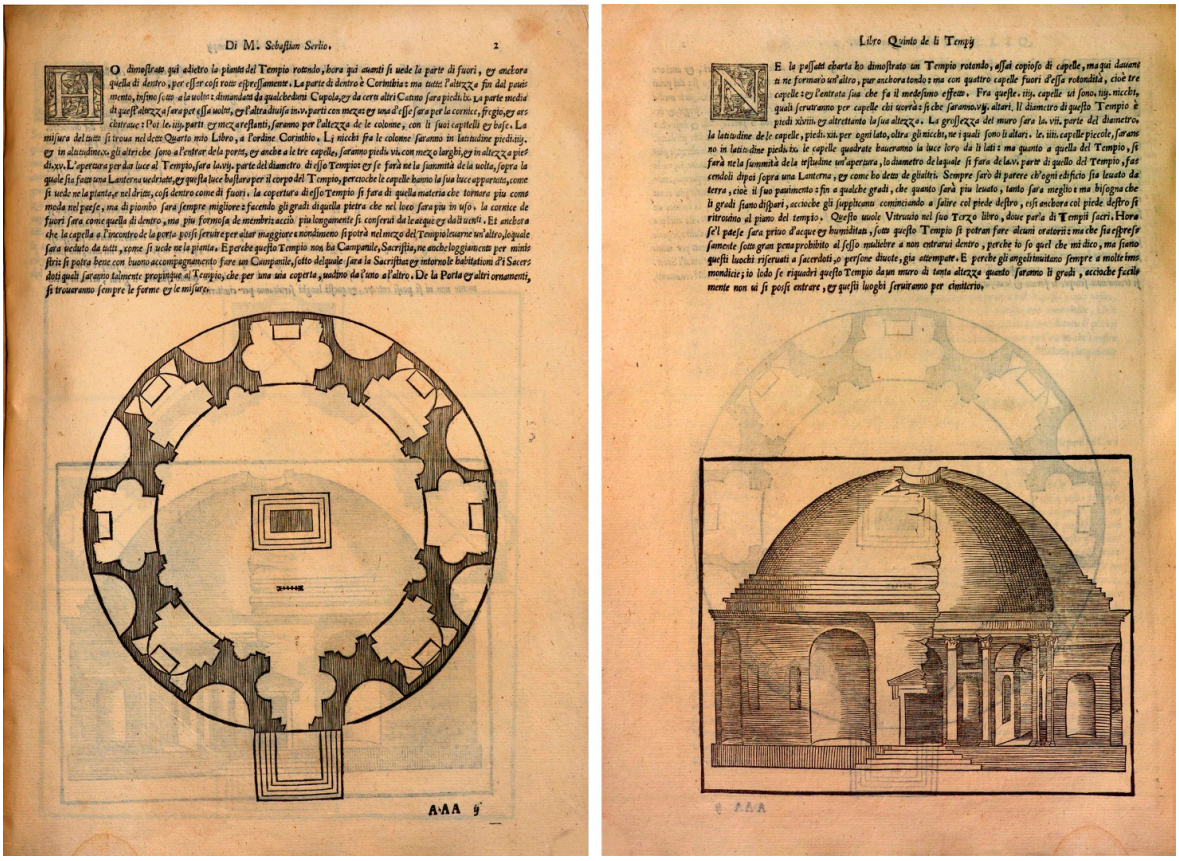

Figure 1. Design model for a circular temple. Plan and elevation-section with perspective niches. Source: Serlio, *Quinto libro d'Architettura*, 2-3.

bastioned walls that defend it. Francesco di Giorgio Martini, mentioned above, had already addressed fortifications in his treatise, attesting to the importance of the modern fortification techniques that had emerged in Italy to meet the defensive requirements posed by new firearms, namely the cannon and the musket.

From the mid-sixteenth century, military treatises began to break away from architectural treatises, through authors who were men-at-arms, military engineers and mathematicians such as Maggi and Castriotto (1564) and Lorini (1609), whose works are noted as significant in the history of representation methods[34]; to these are added Zanchi (1554), Belluzzi (1598), De Marchi (1599) and Manneson Mallet (1672), who contributed to the establishment of military axonometry—then known as 'military perspective' or 'soldiers' perspective'—particularly in relation to the construction of physical models, to study the effectiveness of fortification systems in response to siege techniques based on the use of firearms.[35] The rise of military axonometry was driven by the aim of measuring fortification systems in three dimensions, thereby facilitating ballistic calculations.

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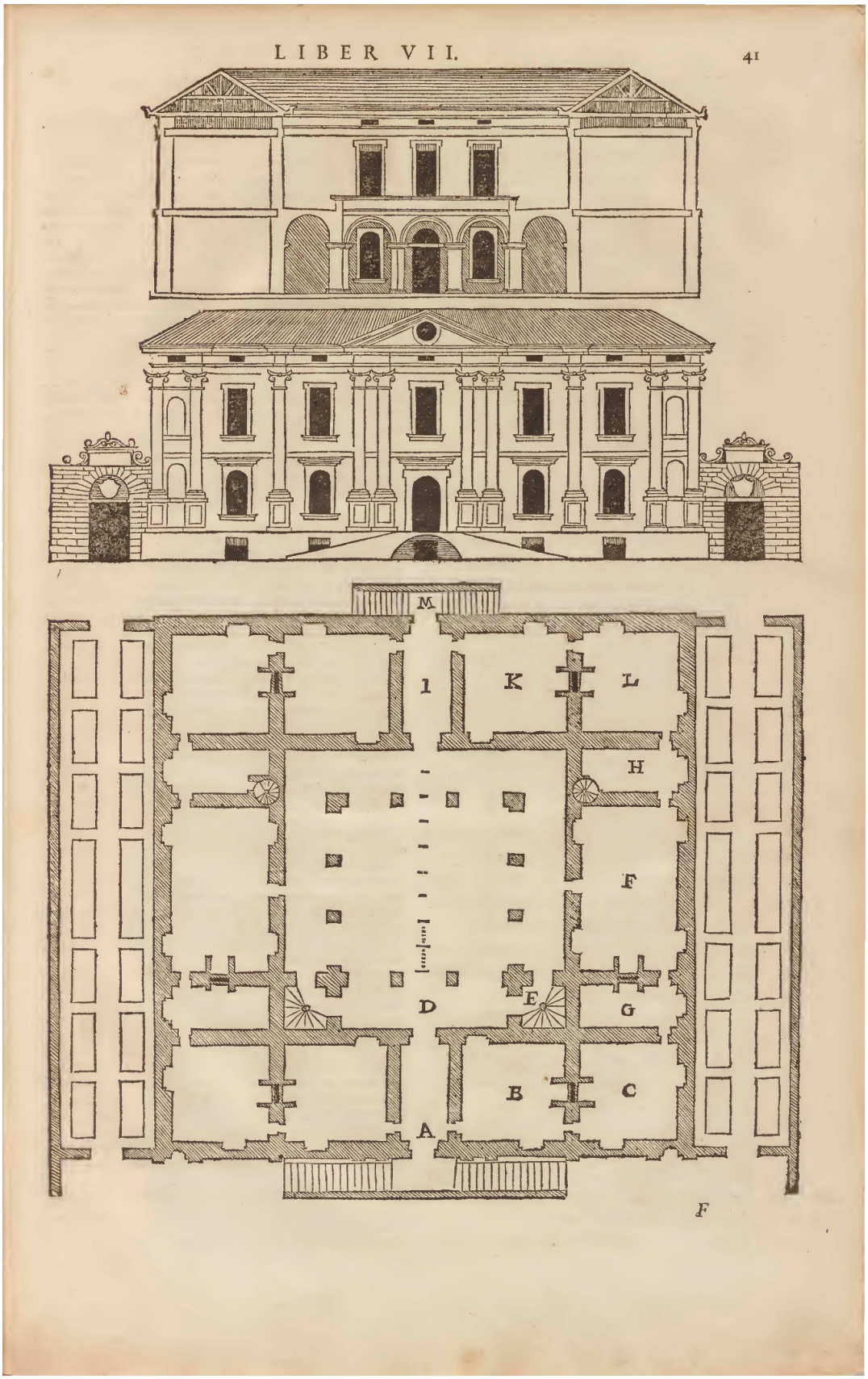

Figure 2. Design model for a villa. Plan, elevation and section. Source: Serlio, *Il settimo libro d'Architettura*, 41.

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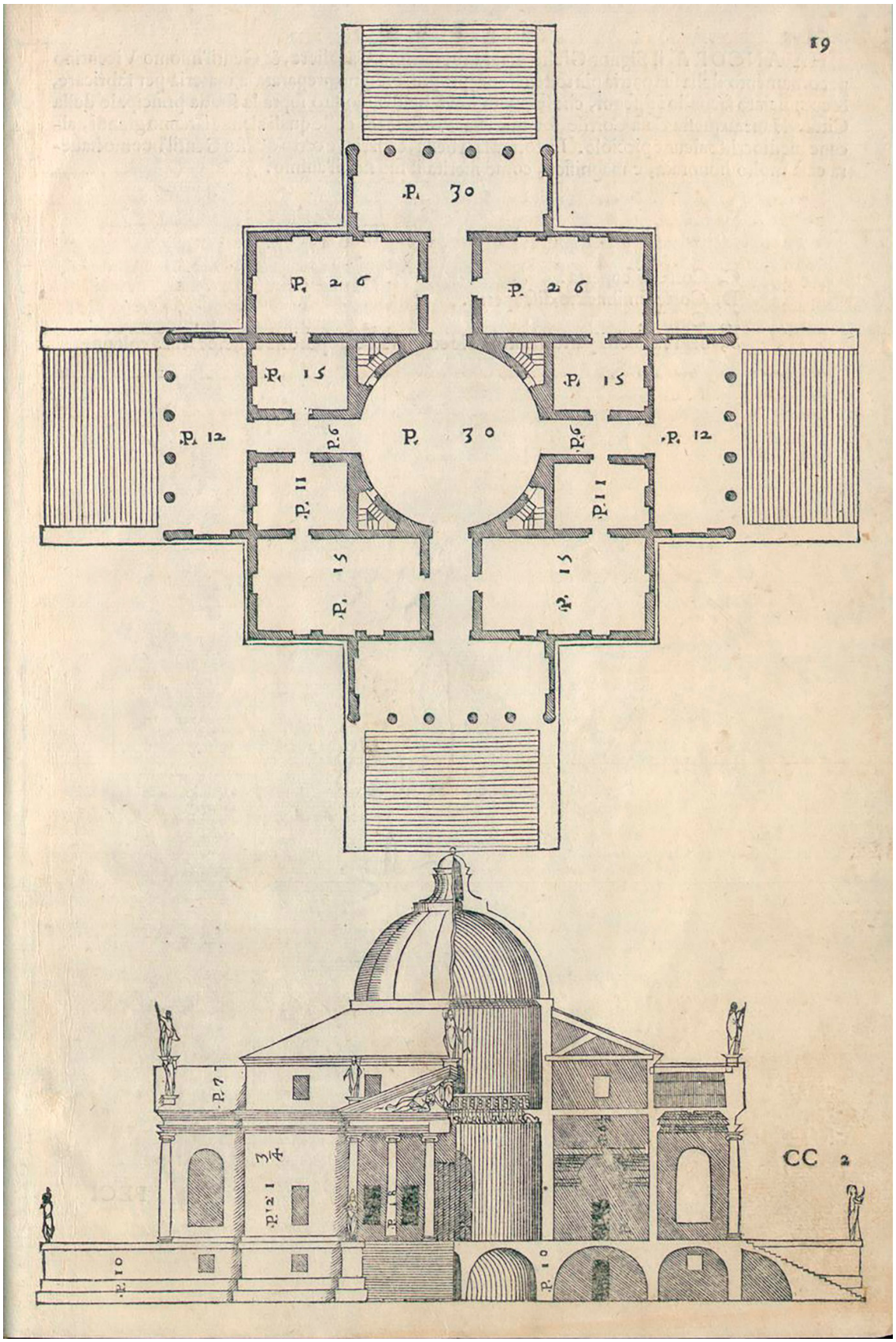
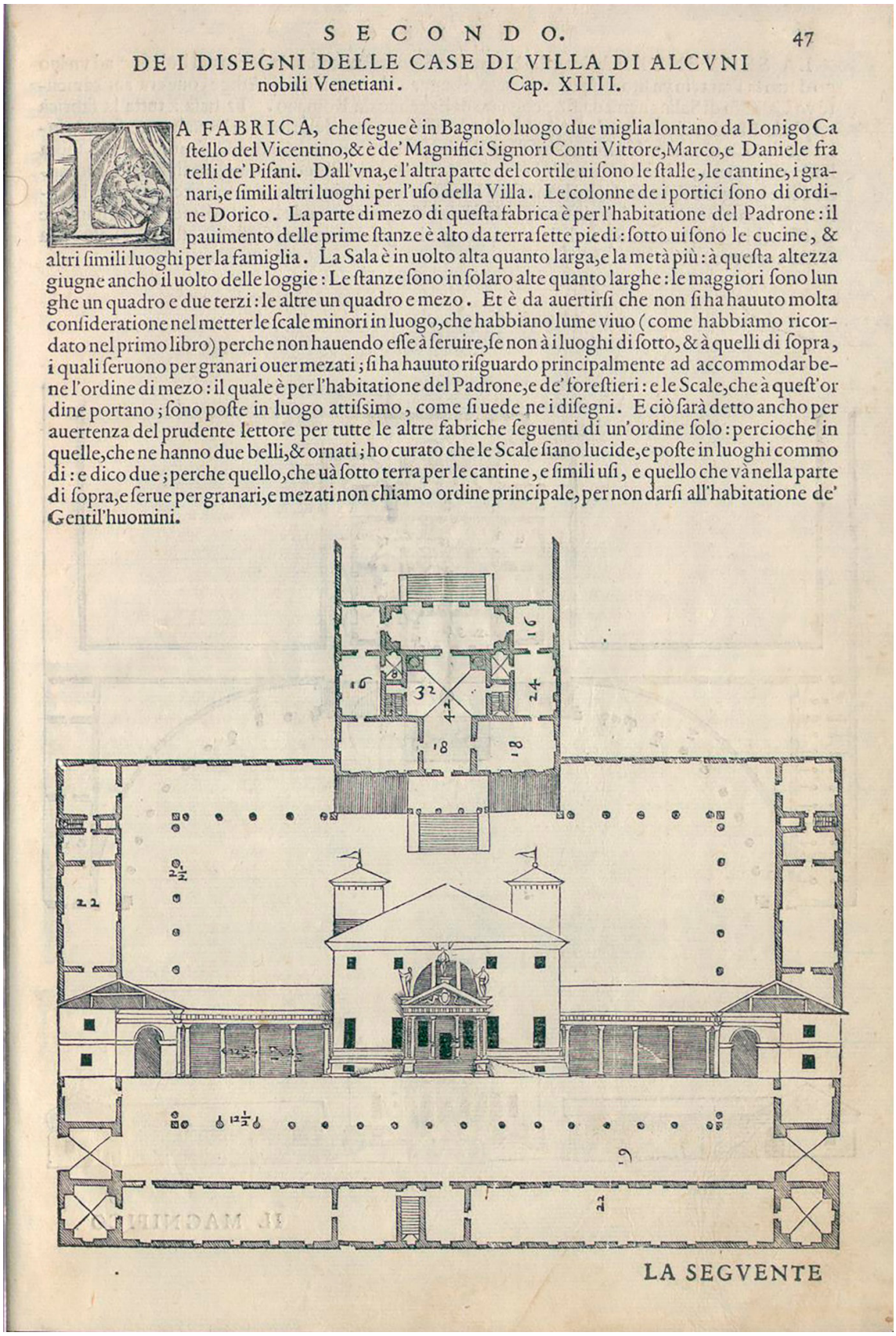


Figure 3. Design drawing of villa "La Rotonda". Plan and elevation-section. Source: Palladio, *I quattro libri dell'architettura*, 19.



SECONDO. 47

DE I DISEGNI DELLE CASE DI VILLA DI ALCVNI nobili Venetiani. Cap. XIIII.

LA FABRICA, che ſegue è in Bagnolo luogo due miglia lontano da Lonigo Caſtello del Vicentino, & è de' Magnifici Signori Conti Vittore, Marco, e Daniele fratelli de' Piſani. Dall'vna, e l'altra parte del cortile ui ſono le ſtalle, le cantine, i granari, e ſimili altri luoghi per l'uſo della Villa. Le colonne de i portici ſono di ordine Dorico. La parte di mezo di queſta fabrica è per l'habitatione del Padrone: il pauimento delle prime ſtanze è alto da terra ſette piedi: ſotto ui ſono le cucine, & altri ſimili luoghi per la famiglia. La Sala è in uolto alta quanto larga, e la metà più: à queſta altezza giugne ancho il uolto delle loggie: Le ſtanze ſono in ſolaro alte quanto larghe: le maggiori ſono lunghe un quadro e due terzi: le altre un quadro e mezo. Et è da auertirſi che non ſi ha hauuto molta conſideratione nel metter le ſcale minori in luogo, che habbiano lume viuo (come habbiamo ricordato nel primo libro) perche non hauendo eſſe à ſeruire, ſe non à i luoghi di ſotto, & à quelli di ſopra, i quali ſeruono per granari ouer mezati; ſi ha hauuto riſguardo principalmente ad accommodar bene l'ordine di mezo: il quale è per l'habitatione del Padrone, e de' foreſtieri: e le Scale, che à queſt'ordine portano; ſono poſte in luogo attiſsimo, come ſi uede ne i diſegni. E ciò ſarà detto ancho per auertenza del prudente lettore per tutte le altre fabriche ſeguenti di un'ordine ſolo: percioche in quelle, che ne hanno due belli, & ornati; ho curato che le Scale ſiano lucide, e poſte in luoghi commodi: e dico due; perche quello, che uà ſotto terra per le cantine, e ſimili uſi, e quello che và nella parte di ſopra, e ſerue per granari, e mezati non chiamo ordine principale, per non darſi all'habitatione de' Gentil'huomini.

LA SEGVENTE

Figure 4. Design drawing of villa Pisani a Bagnolo. Plan and sectional elevation. Source: Palladio, *I quattro libri dell'architettura*, 47.

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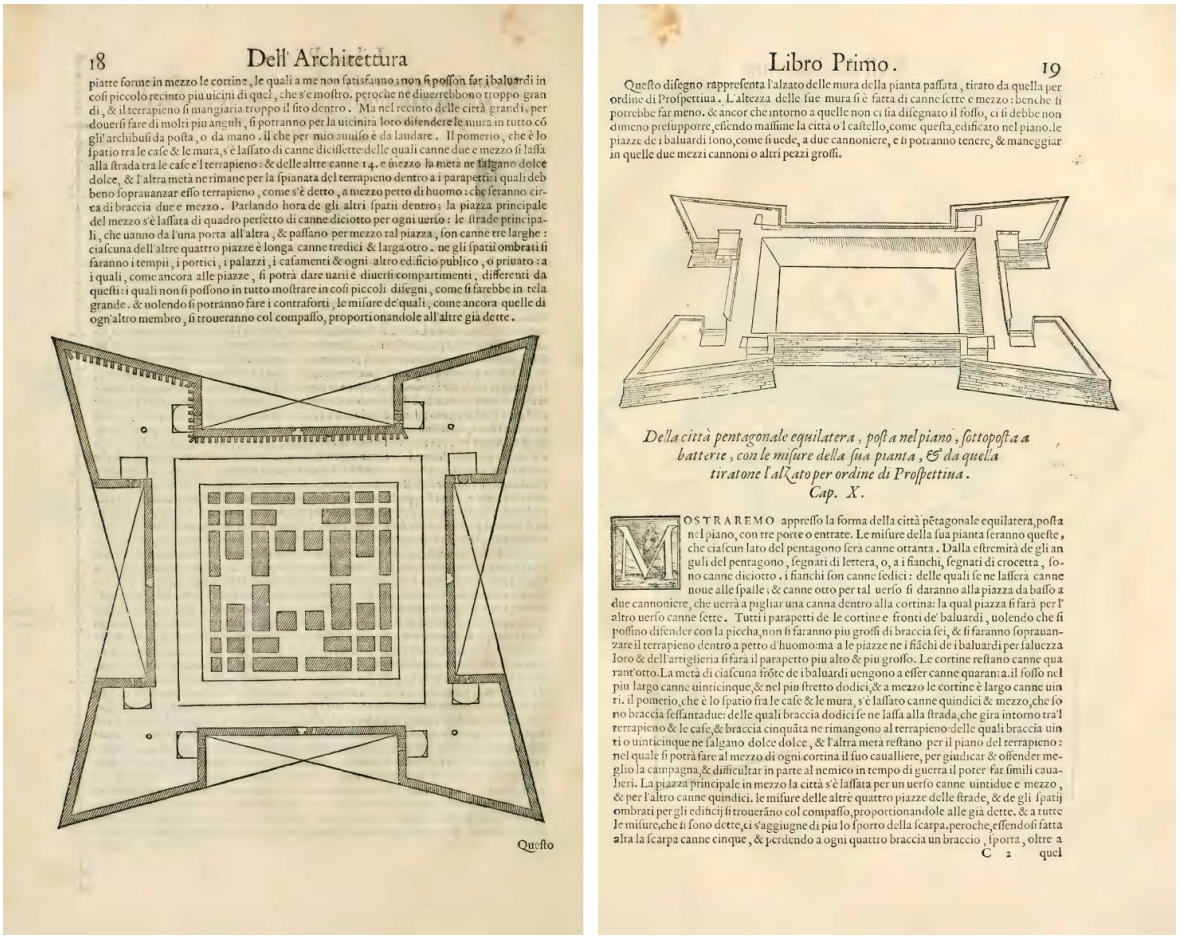

Figure 5. Design model for a square fortification. Plan and a bird's-eye perspective view. Source: Cataneo, *L'architettura,* 18-19.

Within this cultural context, however, Cataneo emerged as an exponent of perspective, devoting Book Eight to illustrating simple perspectival applications, accompanied by shading.

The drawings of cities defended by polygonal walls and bastions depict, in sequence, the plan and the perspective elevation (Figure 5), the latter rendered with a projection centre situated some distance from both the picture plane and the ground level, to create a bird's-eye view not unlike a military axonometric projection. This is all the more evident in the plans of more complex cities, where the need to ensure the measurability of all elements in the elevations seems to take precedence over the evocative quality of the perspective, resulting in representations similar to military axonometric projections (Figure 6).

When Cataneo presents models of religious architecture, however, the plan is accompanied by a perspective section, with the projection centre at human eye level, to enhance the perceptual effect of the interiors. (Figure 7).

GEOMETRIC THINKING AND THE EARLY SIGNS OF DESCRIPTIVE GEOMETRY

In the sixteenth century, double orthographic projection and scaled drawing—with the resulting selection of content based on the scale itself—seemed by then to be established achievements in the representation of architectural designs, serving the purposes of communication and construction.

The seventeenth century was permeated by the *esprit de géométrie*, fueled by discoveries and studies in mathematics—and, in particular, in pure geometry—where geometry came to occupy a prominent position within the philosophical method through the theories of Galileo, Bacon, Descartes, Malebranche, and Desargues. Within

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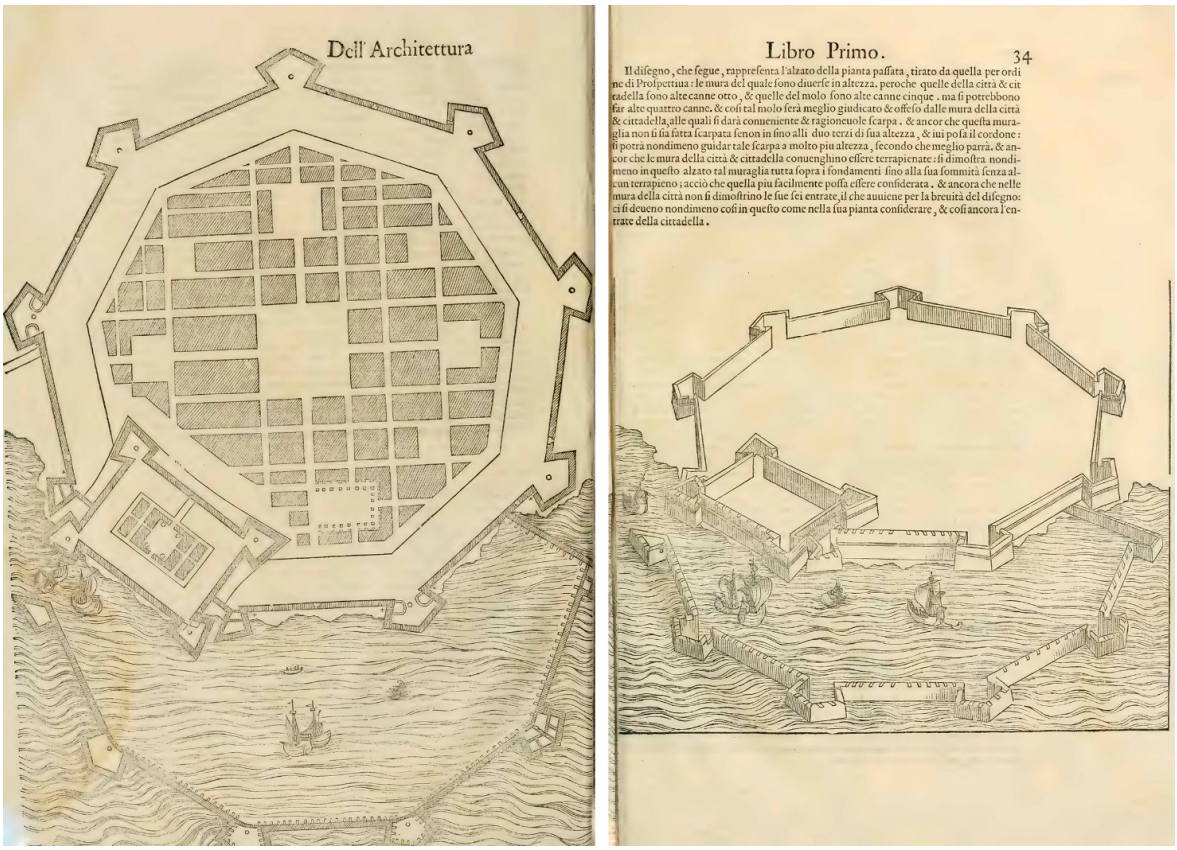

Figure 6. Design model for a nine-sided fortification with a rectangular citadel. Plan and pseudo-military axonometry. Source: Cataneo, *L'architettura,* 33-34.

this scientific context, the work of Guarino Guarini—architect, philosopher, and mathematician—emerged as a precursor to modern descriptive geometry.[36]

The breadth and complementary nature of Guarini's intellectual interests require that his writings be read in parallel, especially about his essential contribution to the representation science and the scope of his design work in civil and military architecture.[37]

The connections between architecture and geometry are evident from the very beginning of *Architettura Civile*, published posthumously by Bernardo Vittone in 1737, in which Guarini states that "Architecture, as a discipline that employs measurements in all its operations, depends on Geometry and must be familiar with at least its basic elements".[38] In *Placita Philosophica,* "geometry teaches us to arrange the numbers of the intellect through a certain kind of reasoning, which allows us to discover other truths: it teaches us to arrange measures and order them in such a way that, from one, through the reasoning, others may be found".[39] Guarini's architecture, based on the combination of simple geometric figures, arrives at extremely complex outcomes thanks to a profound knowledge of geometry that enables him to address both the problems of intersections between surfaces and solids—inherent

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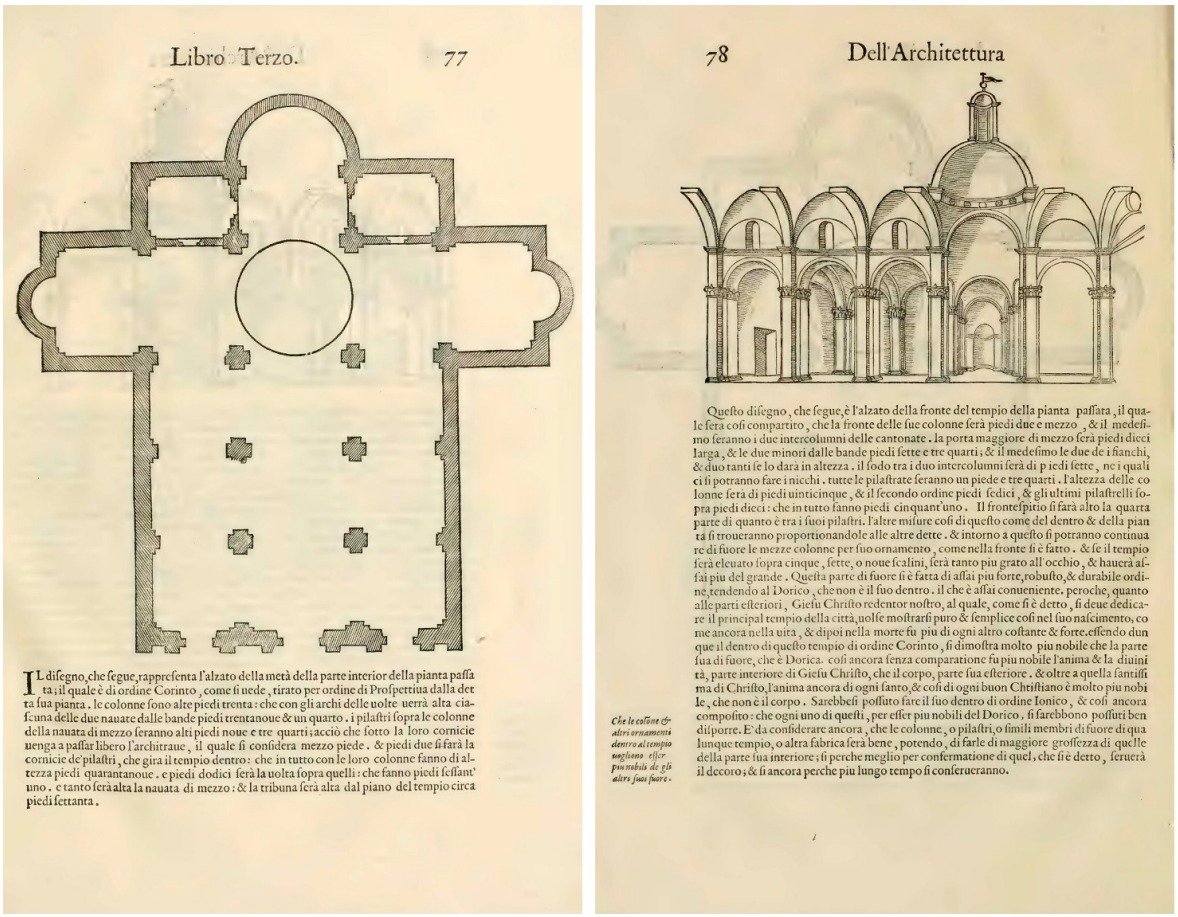

Figure 7. Design model for a church with a longitudinal layout. Plan and human-eye perspective view. Source: Cataneo, *L'architettura,* 77-78.

to the conceptual sphere of the design process—and their accurate representation, which becomes the means for their realization.

In *Architettura Civile* and *Euclides adauctus*, Guarini develops a graphic system to teach how to draw the developments of the solids that make up stone vaulting structures. While in the former work, problems concerning the intersections between the solids that generate composite vaults and the development of the intrados and extrados surfaces are reduced to a description of procedures and results, in the latter, they are rigorously proven (Figure 8). A parallel reading of the two works highlights Guarini's preeminent position in the systematic development of orthographic projections. In *Euclides*, in fact, Guarini frames a series of results and methods of technical-practical origin—known to architects and builders[40]—within a treatise on pure geometry (Figure 9).

Euclides, in turn, is constantly referenced—in connection with the calculation of surfaces and volumes of vaulted systems—in *Modo di misurare le fabriche*, especially the *Tractatus XXIV* focused

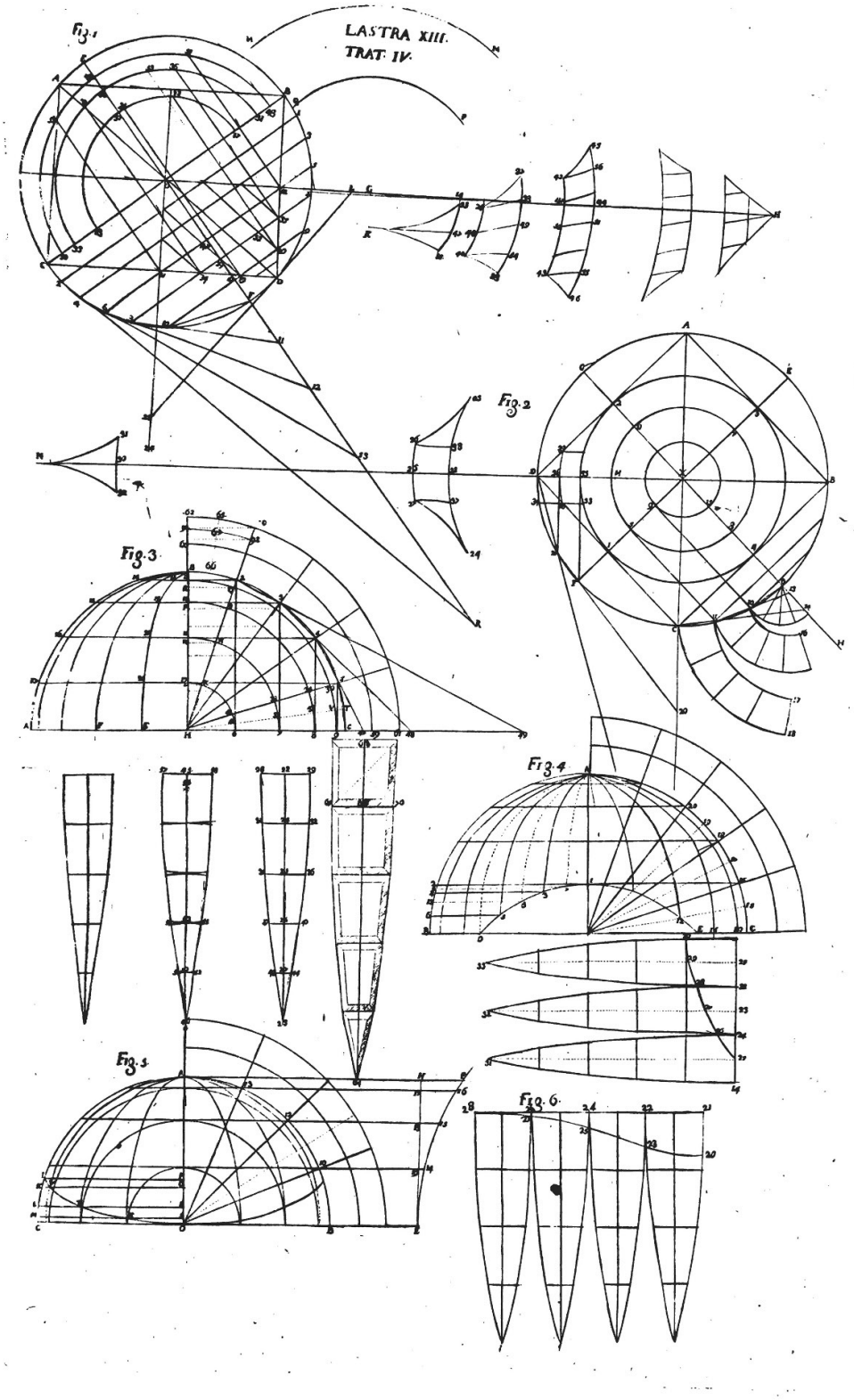

Figure 8. Development on a plane of a spherical surface as a model for a dome vault stereotomy. Source: Guarini, *Architettura Civile,* XLI.

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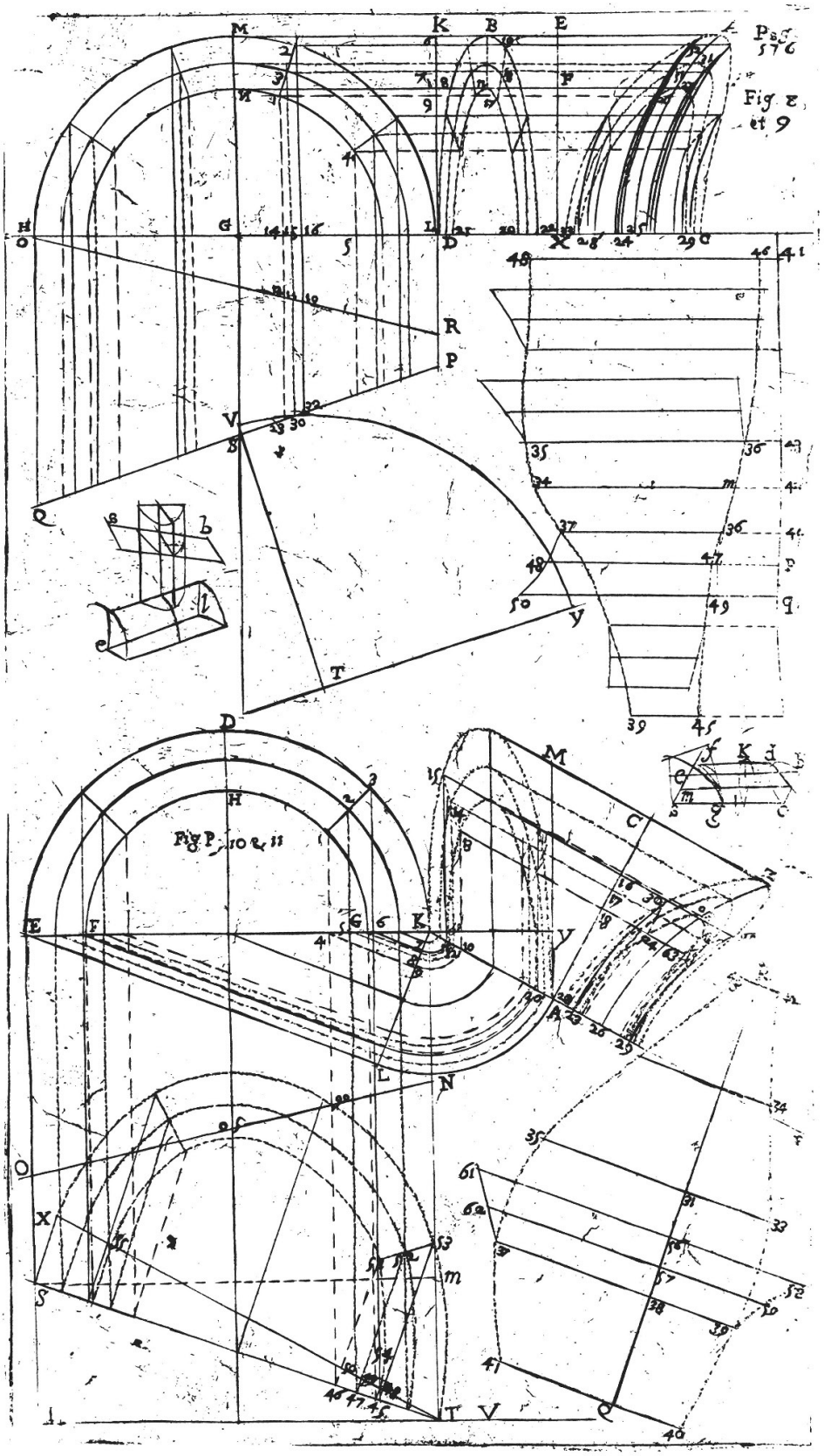

Figure 9. Intersection between solids and surfaces. Source: Guarini, *Euclides adauctus,* 639.

on the conics, in the *Tractatus XXXI* on the surfaces calculations, and in the *Tractatus XXXII* linked to stereotomy through the explanation of intersections between solids, between solids and planes, and their developments on a plane.

In *Architettura Civile*, the author draws on Vitruvius's concepts of icnography, orthography, and scenography—the latter understood as perspective—and adds shading.

About the perspective method for representing architecture, Guarini takes a position similar to Alberti's: "Perspective, provided it deceives the eye and makes the surface of the object appear, achieves its purpose, [...] Architecture, however, cannot achieve its purpose of pleasing the eye except through true symmetries, since this is its ultimate goal—not to deceive the eye".[41] Similarly, he includes a reference to perspective and its usefulness in scenography in *De Stereographia*, in Tractatus XXVI of the Euclides, highlighting that it can be traced back to a single projective mechanism, but without delving further into the subject.

The importance attributed to the orthographic projective method is evident in the organization of the presentation of architectural models across three treatises—On Ichnography (plan), On Elevated Orthography (elevation and section), and On Projected Orthography (surfaces' development)—out of the five that make up the volume, departing from the largely typological approach of previous and contemporary treatises. By stating that "The ability to draw floor plans perfectly and to produce the documents of iconography depends on orthography, and orthography depends on the former"[42]—more than a century before Monge's theories—Guarini seems to establish that connection between the projections at the basis of the double orthographic projection.

More specifically, he defines the distinction between two types of orthography: elevated orthography, which is used to represent elevations (extrinsic orthography) and sections (intrinsic orthography), and depressed orthography, or projected orthography,[43] applied to stereotomy through projections onto the plane of the surfaces of rotation and double curvature of the vaults.

The projective method is then described in detail and illustrated with drawings, in which he presents both ideal designs intended to explain the method itself and vault shapes through which he addresses the construction challenges involved in cutting the stone blocks that compose them. The design of buildings in Treatise III, dedicated to elevated orthography, serves as a demonstration and illustration of the scientific method of representation (Figure 10). However, it has been noted that little emphasis is placed on projection at this stage, in which mathematical methods are a means of realizing an architectural program[44] (Figure 11).

Of greater interest in this regard is Treatise IV, On Projected Orthography, in which Guarini discusses the cutting of stones based on contemporary French practices, delving deeper, as Nino Carboneri notes, into the mathematical endeavour, through the precursors of descriptive geometry, always in relation to a concrete application in architecture.[45]

In *Architettura Civile*, concerning the theory of Mongian projections, the concept of a projection centre at infinity is absent—a concept far from Guarini's philosophical positions—and there is no explicit explanation of the one-to-one correspondence between object and representation established through operations of projection and section. According to Bianchini, this latter limitation is overcome in *Euclides*: in Treatise XXVI, Guarini specifies that "the projection arises from the intersection of the surface—or set of surfaces—orthogonal to the projection plane, which completely envelop the object to be projected"[46] thereby clarifying that process of projection and section, that is, which allows for the establishment of a rigorous one-to-one correspondence between the real object and its 2D graphic model[47] though there is no mention of the spatial relationship

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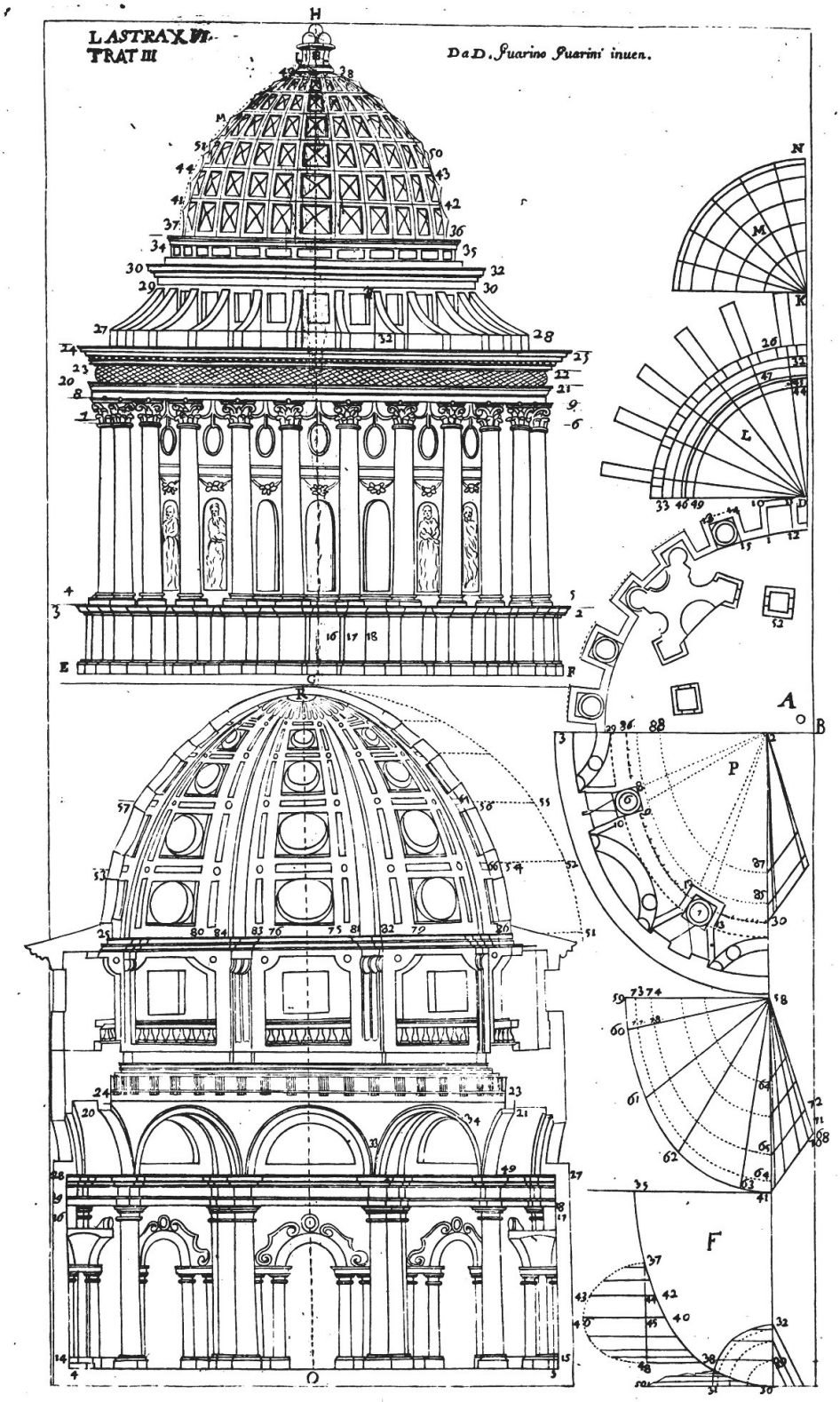

Figure 10. Way for tracing the elevation above the plan. Source: Guarini, *Architettura Civile*, XVI.

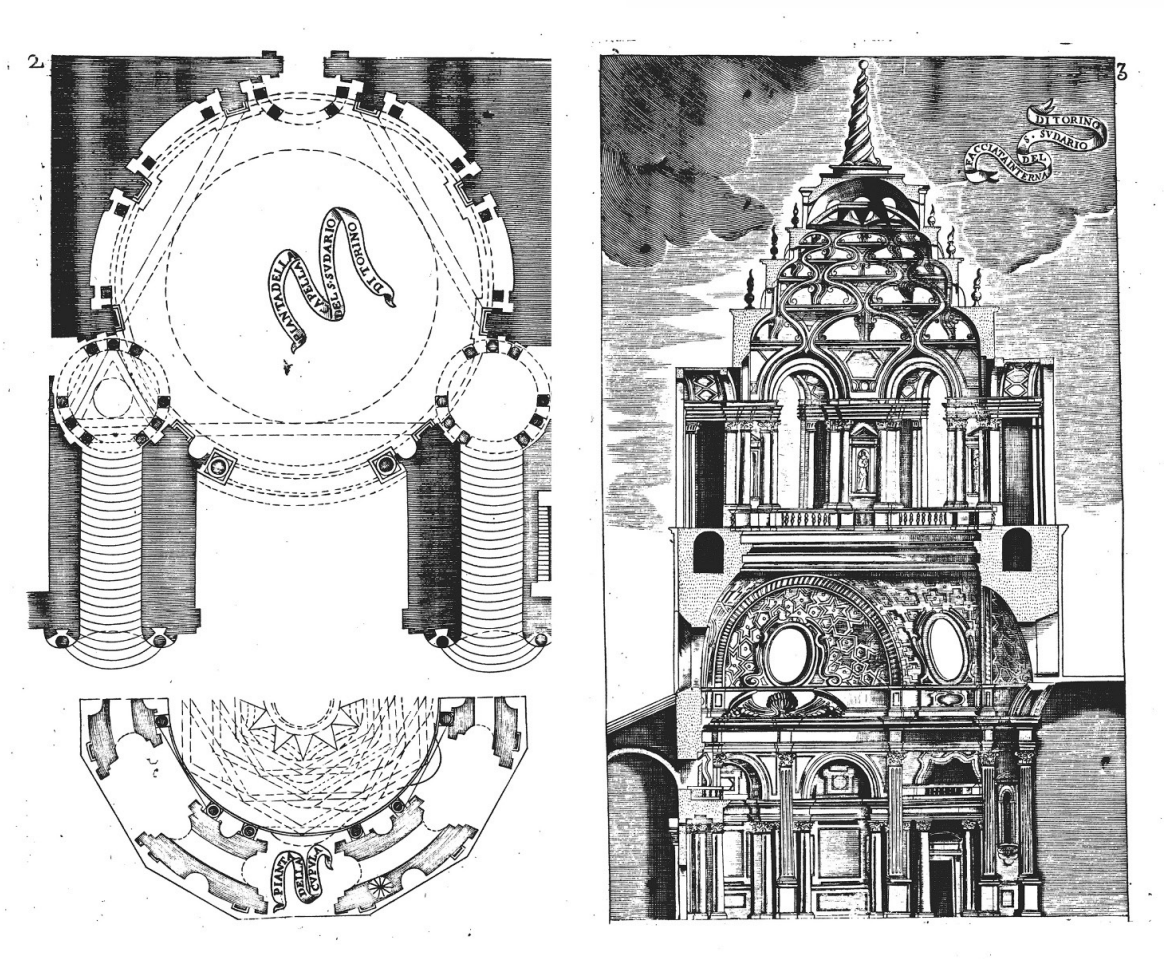

Figure 11. Design drawing of the Holy Shroud Chapel, ground plan, vault plan, and section. Source: Guarini, *Architettura Civile*, 2-3.

between the object and the projection planes, nor of the resulting instructions for reconstructing the object in space based on its projections.[48]

In the field of military architecture, Guarini authored the *Trattato di fortificatione* in 1676, an educational manual dedicated to his pupil, Ludovico Giulio, Prince of Carignano. In the volume, Guarini describes the construction techniques for Italian-, French-, and Dutch-style bastions, adding some of his own inventions. As we have seen, modern fortifications are characterized as a system[49]—through the interplay of architecture, geometry, and ballistics—which Guarini interprets by linking consecutive geometric constructions to define the fortification's shape.[50] The importance of planimetric and altimetric profiles within military architecture leads to geometric constructions and schematic representations in plan and section of citadels, bastion systems, and external defensive

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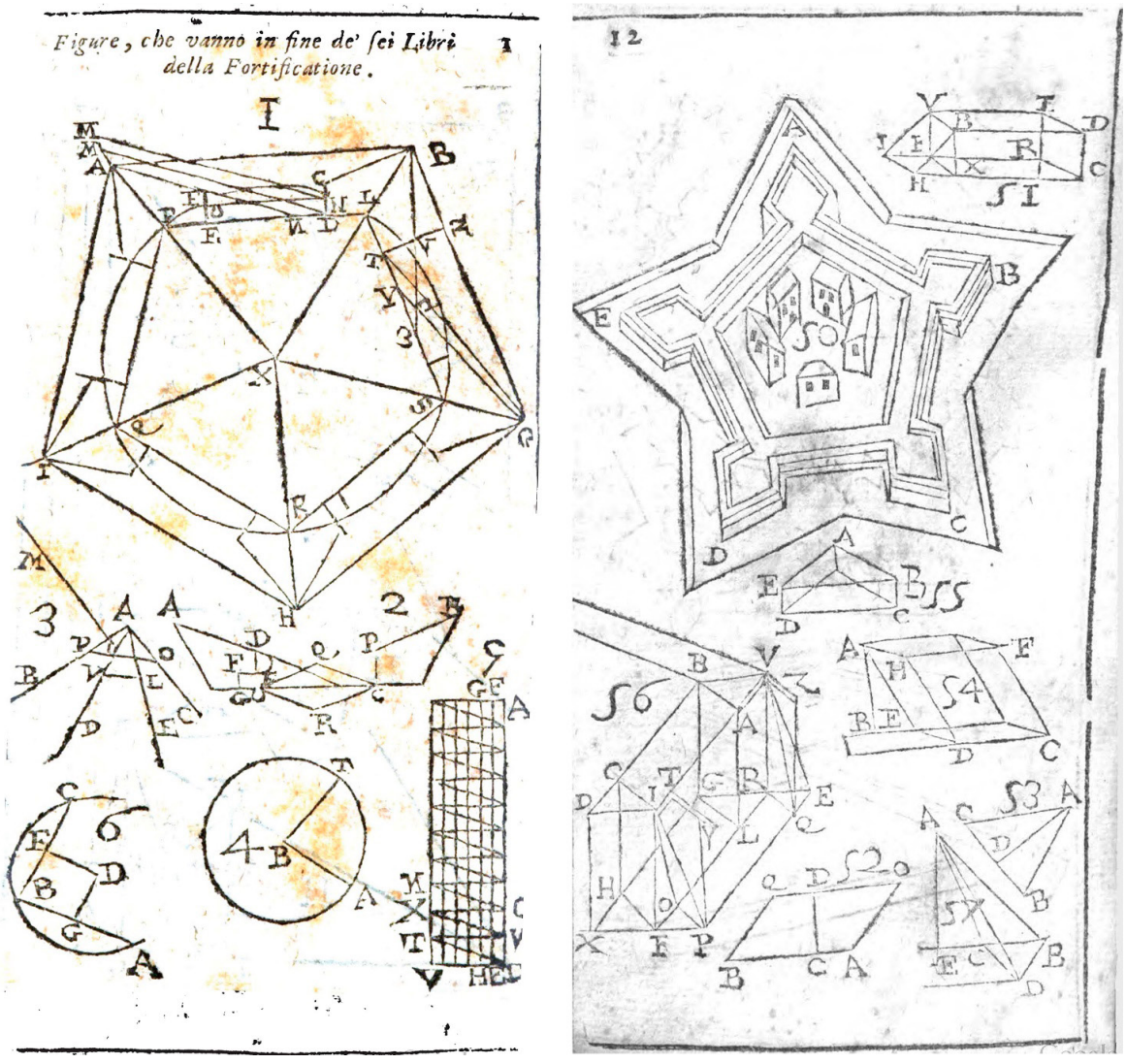

Figure 12. Geometric construction of a regular fortification plan and military axonometry. Source: Guarini, *Trattato di fortificatione*, I, XII.

works, whose principal dimensions are specified in the text—particularly those defining the range of firearms—while the precision of the geometric tracings determines the others; the projective correlation achieved through drawings at the same scale and juxtaposed in the plates, as seen in *Architettura civile*, is absent here. Military axonometric projections also appear, and Guarini briefly illustrates the method of their construction to demonstrate the structure's three-dimensional nature, starting from the plan and tracing the heights from the vertices (Figure 12).

CONCLUSION

The design drawings in 16th- and 17th-century architectural treatises reflect the characteristics of contemporary figurative thought, highlighting connections to the artistic and geometric realms, where methods of graphic representation are scientifically defined. The contribution of these treatises to the representation science lies not only in the application of projective methods—some of which had not yet been scientifically formalized—but also in innovative representational solutions, driven by the need to convey models and examples to other designers and builders effectively.

While orthographic projections, in their technical form as applied to architecture, are clearly the most suitable method for formalizing design concepts, the perspective method—the subject of 15th-century theories—is regarded as a tool for constructing architectural scenes and for the 3D visualization of artifacts. The use of shadows is recommended in both types of projections. The emerging literature in the field of fortification highlights the need for 3D drawings to be measurable, leading to the use of military axonometry for the ballistic verification of design models. Further exploration of military treatises will form the basis for future developments in the research presented here.

Notes and References

1 Recht, *Il disegno d'architettura. Origine e funzioni*, 139-140. Translation by the author.

2 Among the numerous editions of the treatise, which dates back to the Augustan age in the 1st century BC, the following are worth noting: Vitruvio, *De Architectura*; Vitruvio, *I dieci libri dell'architettura*.

3 The *De re aedificatoria,* written in Latin during Alberti's stay at the court of Niccolò V in Rome, and presumably finished around the 1450s, was published in 1485. Among the most common translations, with the Italian text alongside: Alberti, *De re aedificatoria*; Alberti, *L'Architettura, [De re aedificatoria].*

4 The treatise of Antonio Averlino, detto il Filarete, was written in the 1460s. The critical edition of the treatise is Averlino, *Trattato di architettura.*

5 The treatise of Francesco di Giorgio Martini, comprising manuscripts collected in various codices, dealing with civil and military architecture, its date of composition is uncertain: it appears that the work was begun in the 1470s, around the time the artist entered the court of Urbino, and completed within two decades. The codices were brought together and published for the first time in 1841 in: Promis and Saluzzo, eds., *Trattato di architettura civile e militare di Francesco di Giorgio Martini*. Moreover, they were the subject of the critical edition in 1967, edited by da Corrado Maltese: di Giorgio Martini, *Trattati di Architettura, Ingegneria e Arte Militare.*

6 The Treatise on Painting was written in 1435–36; the critical edition of Cecil Grayson in1980. Alberti, *De Pictura.*

7 della Francesca, *De prospectiva pingendi*.

8 da Vinci, "Frammenti sull'architettura", 277-317.

9 Taton, "Le grandi tappe della matematizzazione delle tecniche grafiche: dalle origini a Durer, a Desargues, a Monge", 19-24.

10 De Rosa, Sgrosso and Giordano, *La geometria nell'Immagine. Storia dei metodi di rappresentazione*.

11 de Rubertis, *Il disegno dell'architettura*.

12 Ackerman, *Architettura e disegno. La rappresentazione da Vitruvio a Gehry*.

13 Kemp, *La scienza dell'arte*.

14 Alberti, *L'Architettura, [De re aedificatoria]*, Book II, 98. Translation by the author.

15 Alberti, *L'Architettura, [De re aedificatoria]*, Book II, 98. Translation by the author.

16 de Rubertis, *Il disegno dell'architettura,* 91.

17 Di Teodoro, *Raffaello, Baldassar Castiglione e la Lettera a Leone X, note 129, 227.*

18 "Lettera a Leone X", 459-484.

19 "Lettera a Leone X", 480. Translation by the author.

20 "Lettera a Leone X", 480-481. Translation by the author.

21 The books that make up Serlio's body of work were published over a period of thirty-eight years. It consists, in order, of: Book IV on architectural orders (1537), Book III on ancient Roman building (1540), Book I on geometry (1545), Book I on perspective (1545), Book V on temples and churches (1547), Extraordinario libro on portals (1551), Book VI on private houses (manuscript 1552, published posthumously 1994), Book VII on palaces and villas (posthumous 1575). Fulvio Irace's 1978 critical edition, which brings together Serlio's books, is: Serlio, *I sette libri dell'architettura*.

22 De Fusco, *Il Codice dell'Architettura. Antologia di Trattatisti,* 406-407.

23 Irace, "Presentazione", in Serlio, *I sette libri dell'architettura, 10.*

24 Serlio, *Regole generali di Architettura*, 3. Translation by the author.

25 De Fusco, *Il Codice dell'Architettura. Antologia di Trattatisti,* 422.

26 Spallone and Vitali, "Rectangular Ratios in the Design of Villas from Serlio's Manuscript for Book VII of Architecture", 293–328.

27 Serlio, *Il primo libro d'Architettura*, 20-21.

28 Palladio, *I quattro libri dell'architettura*.

29 Although Palladio was not the sole creator of the plates, it seems reasonable to suggest that he acted as supervisor of the treatise's illustrations. Zich, "I quattro libri dell'architettura di Andrea Palladio: una proposta di analisi geometrica delle illustrazioni", 231-232

30 For more on the graphic layout choices in Palladio's treatise, see: Sdegno, "'Nel luogo che mi è venuto meglio': note sulla grafica dei Quattro libri", 299-320.

31 For an in-depth examination of the issue, see Wittkower, *Principi architettonici nell'età dell'Umanesimo*, 99-146.

32 Cataneo, *I quattro primi libri di architettura*.

33 Cataneo, *L'architettura*.

34 Sgrosso, "Rinascimento e Barocco".

35 Scolari, "L'idea di modello".

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[36] Bianca Tavassi La Greca points out that the presence in Guarini's work of a solid mathematical foundation, his familiarity with the works of Desargues, and his study of descriptive geometry have been noted by critics, who have designated Guarini as the "precursor of Monge." Guarini, *Architettura Civile*, edited by Nino Carboneri and Bianca Tavassi La Greca, note 3, 10-11.

[37] Guarini, *Euclides adauctus et methodicus, matematicaque universalis;* Guarini, *Modo di misurare le fabriche*; Guarini, *Trattato di fortificatione;* 1676, Guarini, *Architettura Civile*.

[38] Guarini, *Architettura Civile*, edited by Nino Carboneri and Bianca Tavassi La Greca, 11. Translation by the author.

[39] Guarini, *Placita philosophica,* 179. Translation by the author.

[40] Docci, Migliari, and Bianchini, "Le 'vite parallele' di Girard Desargues e Guarino Guarini, fondatori della moderna scienza della rappresentazione", 9-13.

[41] Guarini, *Architettura Civile*, edited by Nino Carboneri and Bianca Tavassi La Greca, 20. Translation by the author.

[42] Guarini, *Architettura Civile*, edited by Nino Carboneri and Bianca Tavassi La Greca, 96. Translation by the author.

[43] Guarini, *Architettura Civile*, edited by Nino Carboneri and Bianca Tavassi La Greca, 113. Translation by the author.

[44] Guarini, *Architettura Civile*, edited by Nino Carboneri and Bianca Tavassi La Greca, 288.

[45] Guarini, *Architettura Civile*, edited by Nino Carboneri and Bianca Tavassi La Greca, XXXV.

[46] The quotation from Guarini's text is taken from: Bianchini, *La scienza della rappresentazione nella concezione di Guarino Guarini*, 23. Translation by the author.

[47] Bianchini, *La scienza della rappresentazione nella concezione di Guarino Guarini*, 23.

[48] Bianchini, *La scienza della rappresentazione nella concezione di Guarino Guarini*, 28-29.

[49] Fara, *Il sistema e la città. Architettura fortificata dell'Europa moderna dai trattati alle realizzazioni 1464-1794*.

[50] Spallone, Roberta, "The 'Regular Fortress' by Guarini and the Citadel of Turin".

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