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Guarino Guarini and the design of staircases in italian treatises

Guarino Guarini y el proyecto de escaleras en los tratados italianos

Ornella Zerlenga (*), Vincenzo Cirillo (**)

ABSTRACT

This present study investigates the models of staircase proposed by Guarino Guarini (1624-1683) in *Architettura Civile* (1737). Through the reading of the texts and with the support of the few illustrations contained in the treatise, several graphic models have been elaborated, highlighting the geometric configuration and spatial features of the presented types. These models are then compared with those proposed by other Italian treatises, including those of Serlio and Palladio. Here the methods of geometric representation used by Guarini to draw the staircases are significant, as is his criticism of the Spanish mathematician Juan Caramuel y Lobkowitz (1606-1682) and his *Architectura Civil Recta y Obliqua* (1678-1679), which Guarini analysed in terms of spatial configuration and decoration of the staircase.

Keywords: Guarino Guarini; Italian Treatises; staircase; descriptive geometry; projective geometry; 3D modeling.

RESUMEN

Este estudio investiga los modelos de escalera propuestos por Guarino Guarini (1624-1683) en su Tratado Architettura Civile (1737). A través de la lectura de los textos y de las pocas ilustraciones contenidas en el Tratado, se han elaborado varios modelos gráficos, destacando la configuración geométrica y las características espaciales de los tipos presentados. Estos modelos se comparan luego con los propuestos por otros tratados italianos, incluidos los de Serlio y Palladio. Aquí son significativos los métodos de representación geométrica utilizados por Guarini para dibujar las escaleras, así como su crítica al matemático español Juan Caramuel y Lobkowitz (1606-1682) y su Architectura Civil Recta y Obliqua (1678-1679), que Guarini analizó en términos de configuración espacial y decoración de la escalera.

Palabras clave: Guarino Guarini; Tratados italianos; escalera; geometría descriptiva; geometría proyectiva; modelación 3D.

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1. INTRODUCTION

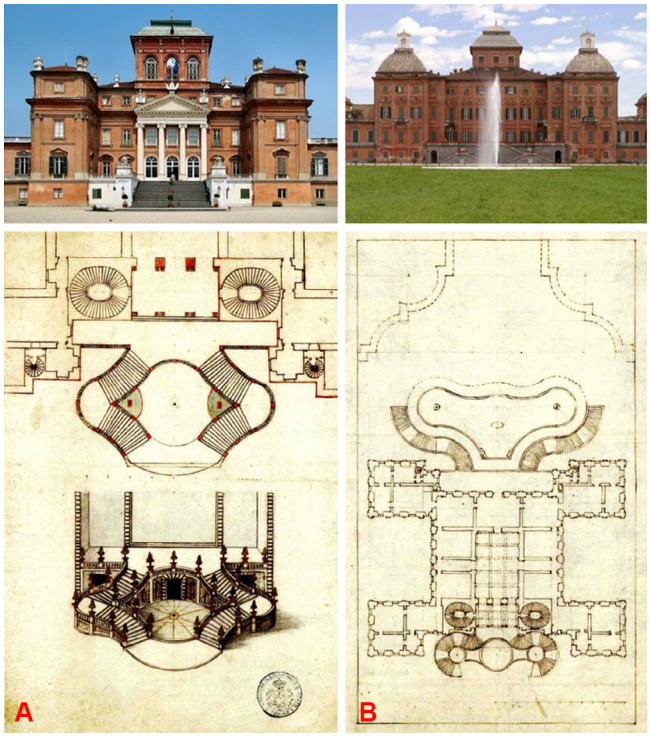

Figure 1. Projects for the staircase of Palazzo Racconigi by Guarini (1676), (a) *Archivio di Stato,* Azienda Savoia Carignano, cat. 43, Mazzo I, fasc. 6, n. 9 (Lange 36); (b) *Archivio di Stato,* Azienda Savoia Carignano, cat. 43, Mazzo I, fasc. 6, n. 6 (Lange 35).

The representation of the staircase is part of the more general theme of architectural drawing. Since ancient times, the designing of the staircase has been worthy of attention, due to both its useful function in overcoming the differences in floors as well as the not immediate mental visualization for articulated spatial solutions; consequently, its graphic representation is just as difficult. It has therefore been interesting to investigate this theme in the Italian treatises that, from the sixteenth to eighteenth centuries, both in literal and graphic form, welcomed the debate on the designing of staircases.

The topic was carried out through the analysis of the sources contained in the treatise of Guarino Guarini (1624-1683) (1) as well as those of Sebastiano Serlio (1475-1554) (2), Andrea Palladio (1508-1580) (3), Jacopo Barozzi da Vignola (1507-1573) (commented by Egnatio Danti, 1536-1586) (4), Vincenzo Scamozzi (1548-1616) (5), and Bernardo Antonio Vittone (1704-1770) (6).

Working through the similarities and differences, the ways of describing the staircase have been highlighted and the results placed in the historical-scientific contexts of reference in relation to the geometric coding of the methods of representation. Without any form of prejudice towards the common use of drawing as a conceptual conception of visual synthesis, aimed at creativity, knowledge and communication, the reading of the sources has confirmed, through the treatises, the existence of a critical choice of the most appropriate geometric methods of representation (although not yet scientifically codified) or exemptions from them to better describe the spatial qualities of a complex architectural element such as the staircase (7).

In this cultural context, the drawing of the staircase occupies a relevant place in the treatise by Guarino Guarini as well as in his work as an architect (for example the staircase projects for the palaces of Racconigi and Carignano; Figures 1-2). The types of staircases that Guarini presents are not new, but examples introduced by previous treatises writers. The contribution that Guarini makes to the history of geometrical representation methods is noteworthy. His rigorous mathematical training made him, simultaneously, both the successor of Girard Désargues (1591-1661) in anticipating the projection of Gaspard Monge (1746-1818) and the precursor of geometry for coding the double orthogonal projection (8).

This dual role leads him to debate on the correctness of the oblique decoration introduced by Juan Caramuel y Lobkowitz in his treaty *Architectura Civil Recta y Oblique* (9-11). At the same time, the adhesion to the parallel projection as an objective method for returning the reality allows him to geometrically govern the architectural representation as an integration of *Ichnografia* and *Ortografia*.

2. GEOMETRIC REPRESENTATION METHODS OF STAIRCASES IN ITALIAN TREATISES BETWEEN THE XVI AND XVIII CENTURIES

This section aims to examine the staircase models described by the Italian treatise writers from the sixteenth to eighteenth centuries. Starting from the staircase models proposed by the Italian treatise writers, the ways of visualising these *exempla* have been investigated, along with a scientific comparison in terms of the application of the geometric methods of representation (intuited and not yet fully coded) such as orthogonal projections, perspective and axonometry.

Figure 1. Projects for the staircase of Palazzo Racconigi by Guarini (1676), (a) *Archivio di Stato*, Azienda Savoia Carignano, cat. 43, Mazzo I, fasc. 6, n. 9 (Lange 36); (b) *Archivio di Stato*, Azienda Savoia Carignano, cat. 43, Mazzo I, fasc. 6, n. 6 (Lange 35).

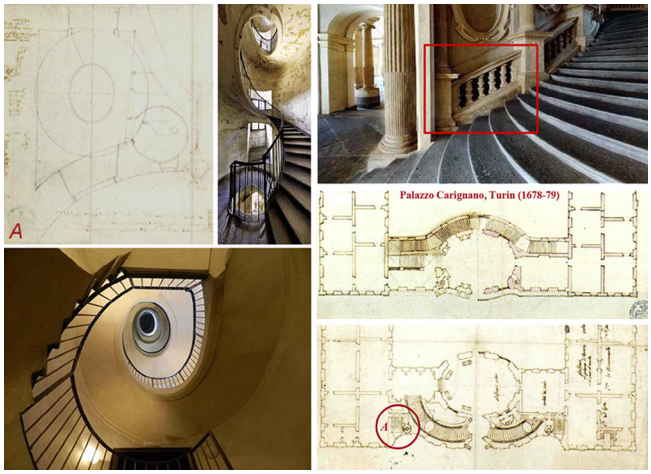

Figure 2. Design drawings for the staircases of Palazzo Carignano.

The mental visualisation of the staircase has always been a difficult operation, just like how graphical description and communication have never been a simple operation, revealing in the reading of these treaties a rather difficult application. In the above-mentioned treatises, the image of the proposed model is often associated to a detailed explanation in

writing to guide the reader both in the mental visualization of the spatial configuration as well as in the comprehension of the proposed models in both typological and constructive terms. In addition, to the choice of suitable geometric methods of representation, artifices and/or exemptions from the methods themselves are also used.

Whether wanting to intend the drawing as a tool to clarify intentions or use it to propose the latter to communicate with others, the graphic operation is never immediate, but requires numerous reviews to prepare a summary image that can be understood by the public who will use it. Therefore, the drawing becomes a conceptual means of visual synthesis aimed at communication or the process through which the transmission of information between author and recipient takes place through the exchange of messages elaborated according to shared graphic codes. The graphic signs (drawings and/or writings) constitute a powerful means of expression, so much so that their reading by the receiver can take place even in the absence of the one who transmits the message.

All this occurs in the treatises analysed. The graphic representation of the staircase presupposed an author (the treatise writer, who communicated his instructions) and a receiver (the architect, who accepted the message). Thus, the drawing, as an instrument of communication of the author, has represented an indispensable means for viewing the idea, just as the choice of geometric methods of representation was fundamental (12).

The study highlighted how the graphic representation methods of the staircase also differ according to the author, although all the treatise writers examined are part of those that constitute the scientific foundations of representation (*ichnographia*, *orthographia*, *scaenographia*) described by Vitruvius in the Book I of *De Architectura libri decem* (13). In this sense, the theme of the designing of the staircase leads to interesting developments in the production of treatises from the sixteenth to eighteenth centuries when space systems with increasingly complex geometries were introduced to the Italian and European scene (14-15). Therefore, the visual communication modes used by the treatises writers and examined here privilege a geometric representation according to the classic references of the Vitruvian tradition with the need to recall, though intuitively, to methods only subsequently codified and referable to the usual three methods of scientific representation in perspective (Serlio), axonometric (Danti in Vignola) and orthogonal projection (Palladio, Danti, Scamozzi, Guarini, Vittone).

Serlio described different staircase models in the *Second Book*, published in Paris in 1545, dedicated to perspective and scenography, which are part of his more general theoretical-practical work *Sette libri dell'architettura*. This treatise, addressed to a specialist public, propagated the Italian Mannerist language throughout Europe, offering a vast repertoire of design solutions and, above all, of images.

The iconographic apparatus through which Serlio presented the various staircases exclusively with straight-line, is described using a geometric-configurative matrix in the form of an orthogonal ordering lattice (Figure 3), while the curvilinear staircases, and in particular the circular ones, are only mentioned in the text and not drawn; for their construction, Serlio suggested adopting the same procedures described for the straight-shaped model. The ordering orthogonal lattice is functional to drawing the staircases models in perspective.

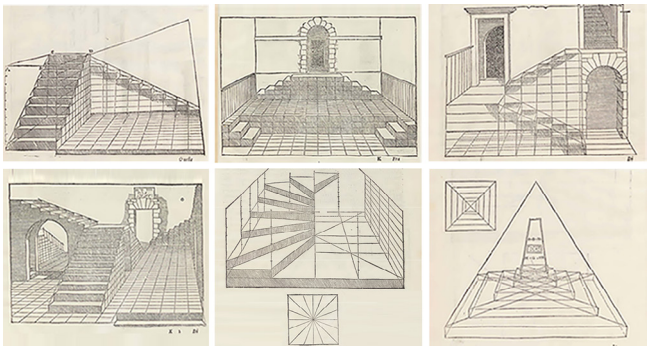

Figure 3. Serlio: geometric perspectives of different types of staircases. (2), pp. 52r, 53r, 54r, 55r, 56v, 57v.

Serlio stated that "fra le cose che hanno gran forza nelle dimostrazioni delle prospettive io trovo le scale molto bene, in quanto han più ritorni fanno l'effetto migliore" (among the things that have great strength in the demonstrations of perspectives, I find staircases to be the best, since in having more returns, they make the best effect) (2: 53v).

The various kinds of staircases proposed by Serlio (mainly external) are represented in perspective and, therefore, the drawings are drawn by Serlio "in scorcio" (foreshortened). The arrangement of the architectural space with respect to the representation frame is frontal, with points of view in relation to the staircase located both in the central and asymmetric direction; therefore, the perspective views are respectively defined "in profilo" (in profile) and "per fianco" (sideways). Beginning with the 'easier' types, the writer stated that "per l'ordinario un grado, è mezo piede in altezza, et un piede in larghezza, cioè il suo piano" (for the ordinary, a step is a half-foot in height and a foot in width, that is, on its surface) (2: 51v) and, therefore, referred to both the horizontal and vertical plane to an orthogonal lattice having the aforesaid measurements on its sides. The lattices and measurements allow to easily draw the proposed models, once the measurements of the staircase have been defined as multiples of these values. Moreover, the verbal description continually refers to the drawings, which show the lines of geometric construction: the sloping lines of the ramps, those "tirate all'Orizonte con linee occulte" (drawn to the horizon with occult lines) (2: 51v) and others, still called 'occult' and drawn as dashed lines (2: 53v).

The last two staircase models that Serlio described have a square plan and are represented in frontal and central perspectives. The typology refers to the "lumaca quadra" (square spiral) staircase (2: 55v) and to that which "da tutti i lati si monta" (ascends on all sides) (2: 57).

In the drawings, Serlio illustrates the geometric constructions that allow, starting from "linee di schiancio" (diagonals of the square) (2: 57), to represent the steps of the two staircase models according to a central perspective. This same construction, writes Serlio, can be adapted to make types "tonde,

et ancora di otto faccie, o di sei" (round, as well as those with eight faces, or six) (2: 57), but there are no drawings that correspond to this indication.

Andrea Palladio (1508-1580) dealt with staircases in Chapter XXVIII of Book I of the treatise *I quattro libri dell'architettura* (3: 60-67) (Figure 4). Architect, theorist, and builder, he represented the staircase models described above, not in perspective but rather by means of floor plans and cross-sections.

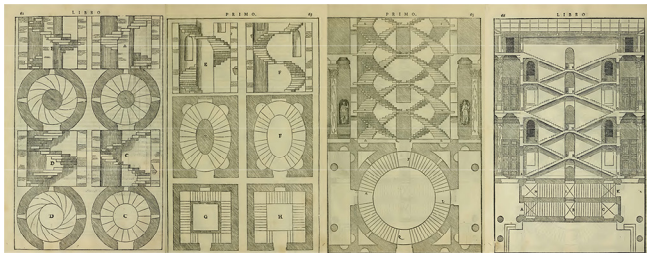

Figure 4. Palladio: staircase descriptive drawings in plan and cross-section. (3), pp. 62-63, 65-66.

The two distinct images (drawn in the same scale of representation) are not however recalled by straight canons in orthogonal projection but are arranged according to a reading in vertical succession that links the plan to the cross-section, and vice versa. As already noted above for the architectural drawing introduced by Serlio in his treatise, these drawings "reveal with great immediacy how the modern concept of relationship is acquired in the mutual reference of the prospectuses, exactly executed and completely devoid of perspective corrections to the relative plans" (16: 136). This principle is also adopted by Palladio in his drawings, which appear rich in graphic and aesthetic sensibility even if not without surprises. Observing the relationship between the floor-plan and cross-section, it is possible to verify how in reality the writer uses an artifice to better describe the difficult nature of the development of the proposed models in the space. The risers of the ramps do not correspond to the cross-section plane passing through the centre of the planimetric plan (circular or oval), but to a view only possible by removing the front half of the walls and leaving the entire helical development of the ramps in place.

Similarly, this artifice is also used to illustrate the complex quadruple 'spiral staircase' of Chambord in France as well as the double one with a straight planimetric layout, where the continuous articulation of the independent ramps is made visible by eliminating the opacity of the perimeter walls (in the first case) and in front (in the second), while the canonical cross-section plan is respected only for the side areas.

In his commentaries on the treatise *Le due regole della prospettiva pratica* (1583) of Vignola, Danti recalled the theme of the staircase "à lumaca doppia" (double spiral) (Figure 5), also citing that of the aforementioned castle of Chambord (4: 144). The 'double spiral' can also be applied to an oval planimetric profile, which Danti does not draw, considering it more difficult because in the oval profile the lines 'go to different points' unlike the circular ones, which go to the 'point and center of the middle'. The two circular models are represented in floor-plans and cross-sections, drawn in the same scale of representation and according to the usual vertical arrangement that places the elevation-cross-section above the plan. However, from the examination of the drawings, it is easy to note the inversion of the sense of reading of the plan with respect to the elevation and how these drawings allude to a spatial view of the interior made possible by the removal of the perimeter walls.

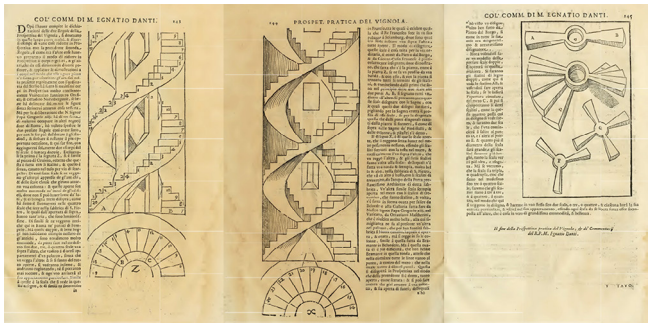

Figure 5. Egnatio Danti in Vignola: drawings of circular staircases and construction details in axonometry. (4), pp. 143-145.

The discussion of the last example described by Danti is interesting due to the historical-cultural context linked to the history of geometric methods of representation: the circular double, triple and quadruple staircases, which the writer considered as a set of unified elements whose assembly configured the staircase. Danti drew the staircase obtained so and the standardized elements with two, three and four steps in oblique military cavalier axonometry, whose top view represents the measurement and spatial composition of the elements. This unusual way of representation places these drawings in the chapter of the parallel projection, anticipating one of the most interesting works on the theme, *Lo inganno de gl'occhi* by Piero Accolti (1578-1627), published in Florence in 1625 (17).

The staircase models proposed by Scamozzi (5) (Figure 6) in Roman palms, foreshadow complex spatial articulations in the succession of ramps and landings; the choice to represent these 'forms' in floor plans and cross-sections does not facilitate communication. Scamozzi, while recurring in the written text to detailed explanations with references to the drawings, in the latter, he introduced some graphic artifices to overcome the absence of an allusive image of the three-dimensionality of the system. In representing the plan of the ramps, Scamozzi overlapped the vaulted intrados of the ramps and used graphic symbols to indicate the common dismount of the ramps to favour the mental visualisation of the spatial path. In general, the reading of the spatial configuration of the 'main staircases' introduced by Scamozzi in his treatise is not immediate and requires a considerable effort to understand both the decoding of the graphic signs as well as the spatial visualisation, since the planimetric drawings do not adequately correspond to the altimetric cross-sections, with only a discrete mention of the span of access to the staircase on the ground floor.

In the treatise by Vittone, *Istruzioni diverse concernenti l'officio dell'Architetto Civile* (1766), the author dedicated a section paragraph (eight pages of written text) to the theme of staircases, in which he described seventeen examples of theoretical and built models, then recalled in separate tables (ten) which, in a large format and according to the now more consolidated technical representation in floor plan and

cross-section, present the types described. The comparison with Guarini is particularly interesting in relation to the graphic representation by Vittone for the "gran Scala del famoso Castello di Caprarola" (grand staircase of the famous Castello di Caprarola) (6: 152), shown in Figure 7. Despite the interest of Vittone being mainly directed to the morphological and perceptive aspects of the spatial peculiarities of this staircase, the drawing that he published seemed to be correctly executed in terms of the orthogonal projections with respect to that of Guarini. Furthermore, the architectural drawing in plan and cross-section drawn by Vittone shows the skilful graphic techniques which make it possible to restore, through the application of chiaroscuro, the complex plastic dimension of the staircase, almost as if a modern photorealistic effect.

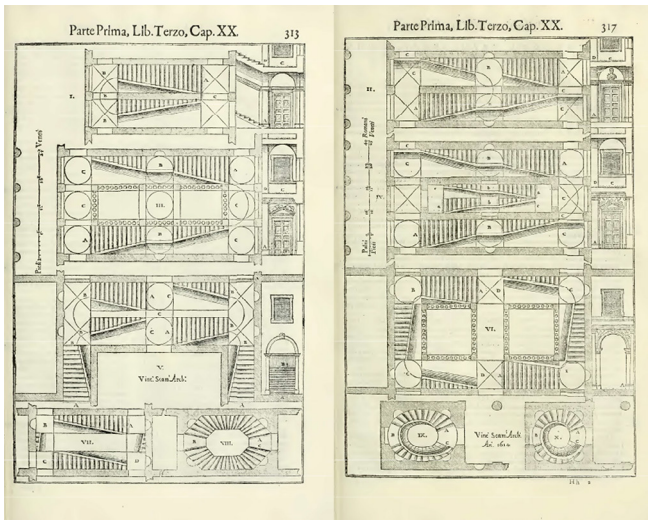

Figure 6. Scamozzi: plans and cross-sections of ten types of staircases. (5), pp. 313, 317.

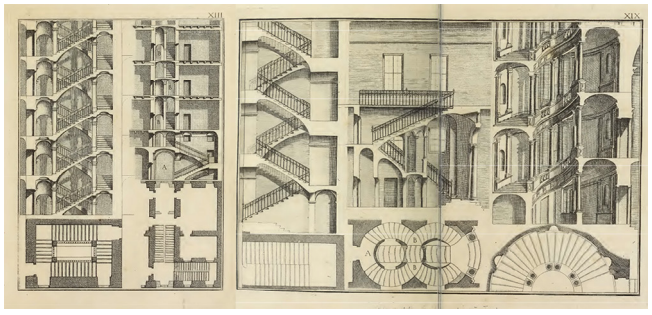

Figure 7. Vittone: plans and cross-sections of some staircase models. (6), plates XIII, XIX.

2.1. "The most difficult parts" in a buildings

In this section, the proposed reading starts from a review of the different models proposed by Italian treatises and their description through the configuration with pillar or shaft; geometric configuration of the planimetric layout (straight, curvilinear, square, rectangular, circular, ovate, polygonal), as well as the number of ramps and stairs (from one to four or double, triple, quadruple). This made it possible to verify how the different staircase models, in addition to presenting themselves as the outcome of a lively theoretical experimentation (and, therefore, of ideational expression), are also the result of construction techniques coeval with the historical period of reference, which have made their construction possible. The technique has always been a functional component of the form and, in its deepest meaning, determines the modalities of a real and material existence of the model itself. Therefore, the analysis of the 'structural' configuration seemed to be essential for the formal analysis; so much so that the introduction in more recent times of more advanced technological and constructive systems has allowed the creative imagination to configure increasingly efficient models of staircase (18: 38-51).

In the Renaissance and Mannerist treatises, the staircase still appears as an element linked only to the functional reasons of the act of 'going up'. Only through the successive and numerous conceptual and formal experiments of the Baroque period (due also to the codification of new architectural types linked to the noble residence), is it possible to see the elevation of this element at the fulcrum of the architectural project, in which the shape of the space plan becomes one of the most peculiar and representative characteristics of the home.

An analysis of the architectural treatises examined here shows a wide variety of staircase models: from the more traditional to more innovative ones (19), from the simplest spatial solutions to the most complex. This entails a growing difficulty not only of mental visualization but also of the correct visualisation of these spaces. In this sense, the architectural systems of the staircase models investigated were catalogued by the treatise writers, distinguished by typological form, and analysed graphically in relation to the geometric matrix by analogies and differences. In this operation, the modelling, and the digital visualization of the models (here used for the first time by the writers in almost all the types presented) took on a particular importance, which allowed to better describe the peculiar spatial connotation as well as graphically represent the architectural models introduced by the treatise writers in the written form. Thus, the graphic representation has once again confirmed the historical role of the conceptual means of visual synthesis, aimed at creativity, knowledge, and communication.

In Book II of his treatise on architecture, Serlio (1475-1554) describes different staircase models, from the simplest to the most complex. As illustrated in the previous section, the description concerns more the geometric representation method rather than the typological specificities of the staircases presented, all with a rectilinear development. The proposed staircases (Figure 3) serve one or two floors and have orthogonal or parallel ramps between them. The orthogonal reticulate (which Serlio uses to draw the stairs in perspective) is functional to proportionate the measurements of the stairs as, for the 'easier' types, the writer stated that "ordinary, a step is half a foot in height, and a foot in width" (2: 51v). These staircases, depending on their spatial articulation, can have arches passing under the ramp or lead to underground floors. The last two models that Serlio describes are the one defined as "lumaca quadra" (spiral) staircase (2: 55v) and to that which 'from all the sides are assembled' (2: 57r) and that Serlio proposes as a 'staircase for courts, altars, and similar things.

On the other hand, in the Treatise by Palladio, the rectilinear staircases differ in the number and arrangement of the ramps, being "spread out in two branches, or square, which turn into four branches" (3: 61), but also due to the presence of resting landings in the corners (called *requie* by Palladio)

which, absent in circular staircases, appear in this model as well as the 'ovate' staircase, with the latter presenting a greater number of steps along the longitudinal axis.

The architectural treatment of Palladio presents a taxonomic approach in describing the different structural characteristics and typological elements that make up a staircase (Figure 4). He listed the staircases in relation to the geometric shape of the planimetric basin, combining them in curvilinear, of which 'round' (referred to by the writer as "*à Lumaca*" or "*à Chiocciola*" (snail or spiral) and 'oval', and rectilinear (called "diritte", that is straight). The verbal descriptions of these models are accompanied by two full-page graphic tables, which contain eight scale drawings, all referenced in the text.

Both the curvilinear and straight staircases are grouped by static behaviour depending on whether they have cantilever ramps ("scala à Lumaca vacua nel mezzo", spiral staircase empty in the middle; "scala ovata senza Colonna", ovate staircase without columns; "scala diritta senza muro", straight staircase without walls) or supported by load-bearing elements in a central position (respectively 'spiral staircase' or 'ovate staircase with a column in the middle', 'straight staircase with a wall inside').

For the 'spiral' staircases, Palladio distinguished two other types: with twisted or straight steps or with the profile of the circular step (i.e. portions of circumferences that revolve around the common center of the staircase) or straight.

The last staircase model presented by Andrea Palladio is that of the staircase built by King Francis I in the Château of Chambord in France. This is a 'spiral staircase' made up by "quattro Scale, le quali hanno quattro entrate, cioè ciascuna la sua, e ascendono una sopra l'altra, di modo che facendosi nel mezzo della fabrica; ponno servire a quattro appartamenti, senza che quelli, che in uno habitano, vadano per la scala dell'altro: e per essere vacua nel mezo; tutti si veggono l'un l'altro salire, e scendere, senza che si diano un minimo impedimento" (four staircases, which have four entrances, that is, each its own, and they ascend one above the other, so that making them middle of the building, they can serve four apartments without those who live in one, need go up the staircase of another; and because they are empty in the middle, everyone can see the others without bothering each other in the least) (3: 64).

On this configurative criterion, Palladio proposed one last staircase model, which he called 'Double Staircase' and which, set on a rectangular system, consists of two parallel ramps with an independent development.

The 'double spiral' staircase and that of the castle of Chambord (4: 144) are taken Danti in his commentaries on Vignola's *Le due regole della prospettiva pratica* (1583). Two circular models were presented (Figure 5), though, as Danti explains, this 'double spiral' staircase model can also be applied to an oval planimetric profile. In the first model, called 'open', the ramps rest on a central pilaster system, which allows the staircase to be flooded with 'light'. Danti compared this staircase to that of the well of Orvieto, stating that it has not caved into the tufa and that instead of the ramp, there are the steps. In the second, the staircase is open in the middle and cantilevered, with the steps being 'stuck with the head in the wall and placed one above the other, one on top of the other, with the same steps making up the staircase' (4: 144). In conclusion, Danti describes a circular staircase model with double, triple and quadruple ramps obtained in succession from the assembly of the unified elements.

In the Chapter XX Scamozzi discusses *De' siti, e forme convenevoli a varie maniere di Scale private ad uso de' tempi nostri, e alcune introdotte dall'Autore* (5: 312), and affirmed that the "maniere delle Scale sono molte, e differenti, mà secondo il parer nostro si possono ridurre in dieci maniere, ò forme" (the manners of staircases are differents, but in our opinion they can be reduced to ten ways) (5: 312).

In line with tradition, from a formal point of view, Scamozzi confirmed the already known planimetric systems with curvilinear matrix (circular and ovate) and rectilinear (rectangular, square, polygonal) (Figure 6). In particular, the polygonal form is defined by the treatise "*à mandorla*" (almond) and referred to by these as a way realized in the staircase of the "stellata" in Prague (5: 314-315), known today as *Star Summer Palace*. Similarly, from a structural point of view, the staircases can be supported by pillars and columns, by 'full walls' or be 'suspended in the air' or cantilevered.

The choice of the site where the staircase is located assumes particular importance for Scamozzi, since most of them mainly serve noble houses. He distinguished the 'main staircases' from the 'secret' ones or those that "turn out very well within the apartments of rooms" (5: 314). Consequently, from a typological point of view, Scamozzi introduced several ways of 'main staircases', some of them 'invented by us' (5: 314), in which the ramps are articulated according to a symmetrical bilateral system, generating models of double staircases with one or two 'wells' (the previous 'empty'), often destined to house a 'secret staircase' in the void.

In the large section consisting of eight pages of written text dedicated to the topic of staircases, Vittone describes with a wealth of detail seventeen examples of theoretical and built models (Figure 7). From a morphological point of view, the proposed solutions appear to be highly articulated due to the presence of more ramps that are enveloped in the space based on planimetric plans with a straight, curvilinear matrix (also with a concave-convex direction) and, above all, mixtilinear.

3. GUARINI'S SCIENTIFIC AND CULTURAL TRAINING AND MODES OF REPRESENTATION

During his lifetime, Guarino Guarini loved to be called a 'mathematician' since this was his true vocation. His studied was oriented towards scientific subjects and architecture. This formation led Guarini to interpret architecture as part of mathematics. Furthermore, his interest in scientific subjects (mathematics and geometry) led him to publish in 1671 a treatise entitled *Euclides Adauctus et Methodicus Mathematica Universalis* (20), which assembled several ancient texts on theorems, problems, and geometric constructions.

The treatise *Architettura Civile* was published after his death in two versions: the first (Guarini 1686) (21) was a partial collection of plates with illustrations with a portion of the treatises, while the second (Guarini 1737) (1) was a complete edition with the text and the remaining plates. The 1737 *Ar-*

chitettura Civile, examined here, is divided into five treatises, articulated in chapters that are followed by 'Observations'. This hierarchical division denotes a rigorous treatment as well as a mathematical demonstration. Moreover, the issues addressed often share (or criticize) the theoretical assumptions of ancient treatise writers (Vitruvius) and more contemporary ones (Vignola, Serlio, Palladio).

The staircase design is developed by Guarini in Treatises II (*Della Ichnografia*) and III (*Della Ortografia elevata*). In Treatise II, Chapter VII, Observation IX (*Del modo in generale di disegnare le piante,* The general way of drawing plans), Guarini addresses in detail the description of plans of staircases. He distinguishes 'three types of staircases' and refers to the verbal description of the models proposed to the figures contained in *Plate VII* of the treatise (1: 68-70) (Figure 8).

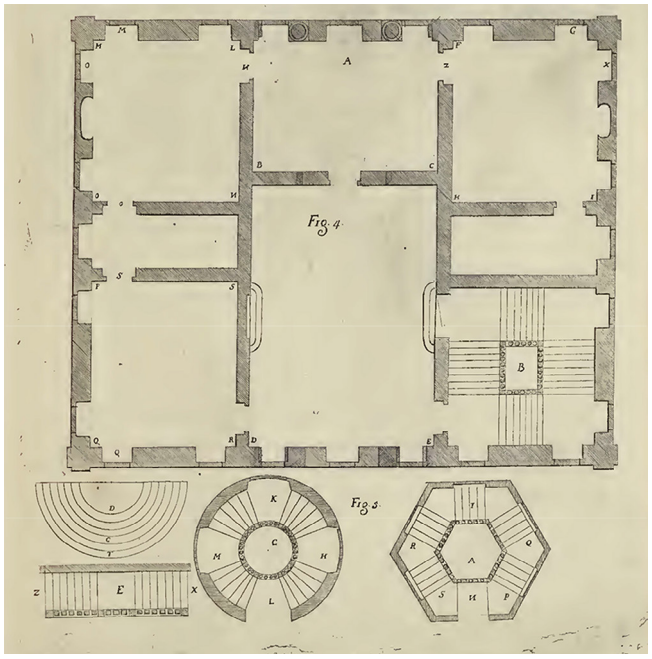

Figure 8. Guarini: plans of 'three types of staircases'. (1), Plate VII.

In *Treatise III*, *Chapter XXV*, *Observation VI*, Guarini describes a circular staircase (similar to the Scala Regia of the Palazzo Farnese di Caprarola) which is illustrated in *Lastra XVIII*. For this type of staircase, he believes that "le Scale a lumaca nell'esprimerle in disegno tengono la stessa difficoltà, che le piante oblique, e qualche cosa di più per essere non solamente oblique, ma anche ascendenti" (the spiral staircases expressed in drawing hold the same difficulty as oblique plans, and something more due to their being not only oblique, but also ascending) (1: 180).

Guarini describes in detail the geometric construction "per fare sopra questa pianta la Ortografia" (to make the orthography on this plan) (1: 180). Step by step, he defines the points that "ci determineranno il piano di ciascun gradino, ed avremo il taglio della Scala verso il muro esteriore; l'avremo di più verso l'anima, o vogliam dire tromba della Scala medesima, se nell'operare osserveremo le medesime regole" (will determine the plane of each step, and we will have the section of the stair towards the exterior wall; we will also have more towards the 'soul', or if you will, the shaft of the stair itself, if in working we observe the same rules) (1: 180). However, it should be noted that the arrangement of the plan below the cross-section appears in a reversed position and that the cross-section itself is likewise conceived (as for Palladio and Danti) without the front perimeter walls in order to visualize the complete development of the cylindrical helix in the space (Figure 9).

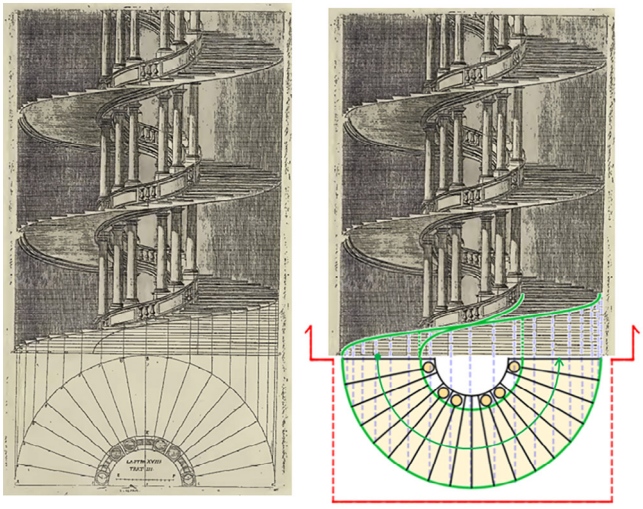

Figure 9. Guarino Guarini: circular staircases drawing of Palazzo Farnese di Caprarola. (1), *Lastra XVIII*.

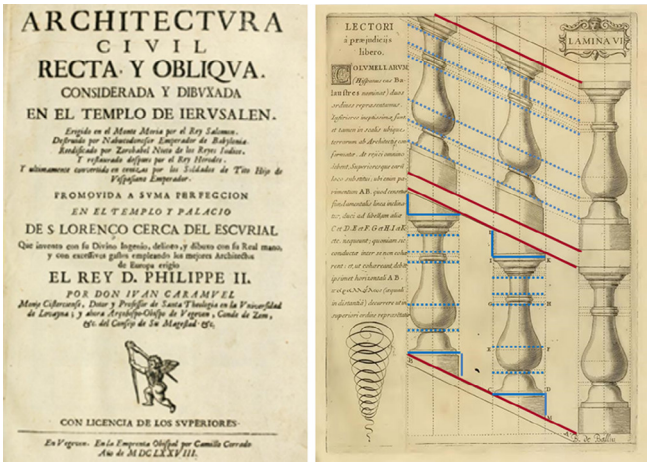

Figure 10. Caramuel y Lobkowitz: comparison between the straight and oblique decoration in staircases. (8), *Lamina VI*.

In relation to the history of geometric representation, the *querelle* between Guarini and the contemporary treatise writer Juan Caramuel y Lobkowitz (1606-1682) is particularly interesting. Caramuel, in his treatise entitled *Architectura Civil Recta y Obliqua* (1678) (8), said that the decoration in architecture –and in staircases– must be oblique for all the elements generated on oblique directions. Guarini, instead, thinks that the use of oblique architecture is not suitable since its use produces many deformations; he therefore prefers to use straight architecture. The problem of using straight architecture is that it requires a triangular-shaped connecting element to the oblique direction (Figure 10).

On this theme, in *Treatise III*, *Chapter XXV*, Guarini discusses the 'ornaments of the staircase's walls', describing the "convenienti documenti per sollevarne le ortografie" (documents suitable for raising the orthography). Starting from the title of *Observation I*, Guarini demonstrates a firm position

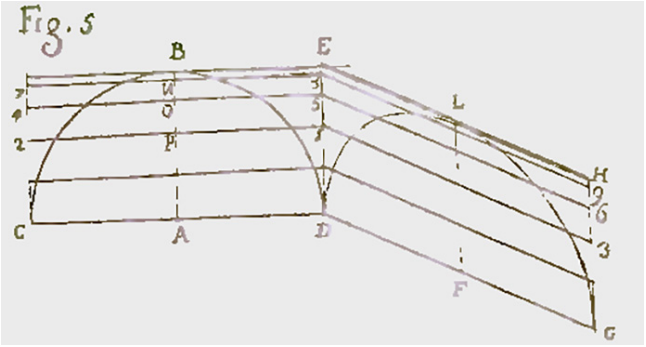

Figure 11. Guarini's *Figure 5* accompanying *Treatise III* (1) *Lastra XV*.

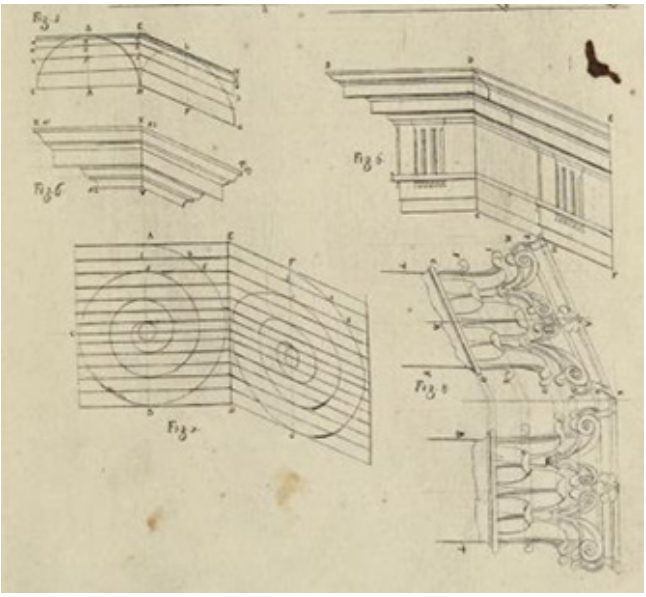

Figure 12. Guarini's figures accompanying *Observations III*, *IV* and *V* of *Treatise III*. (1) *Lastra XV*.

on this matter: "Per adornare le Scale non si deve adoperare l'architettura obbliqua" (to adorn staircases oblique architecture must not be used) (1: 178). In support of this, Guarini refers to the assertion in *Chapter XXIII*, in *Architettura obbliqua*, placing himself in contrast with the mathematician Juan Caramuel y Lobkowitz. In *Observation I* of *Chapter XXIII*, Guarini asserts that "l'Architettura obbliqua consiste servata la quantità de lati nell' obbliquare gli Angoli" (oblique Architecture consists in conserving the number of the sides in making the angles oblique) (1: 169). Referring to the *Figure 5* that accompanies the text, Guarini demonstrates: "il quadrato EDBA sarà obbliquato, se servata la quantità de' lati BA, AE, ED, DB, a cui faranno equali i lati DE, EL, LF, FD, si cangieranno gli Angoli, perchè là ove nel quadrato EADB gli Angoli sono retti, nel quadrato LEFD sono obbliqui e due sono acuti, cioè E, ed F, e due sono ottusi, che sono L, e D" (the square EDBA will be made oblique when, the number of sides BA, AE, ED, DB being conserved, to which sides DE, EL, LF FD are made equal, the angles are changed, because where the angles are right in the square EADB, they are oblique in square LEFD, and two are acute, that is, E and F, and two are obtuse, which are L and D).

In reference to Guarini's *Figure 5*, shown in our Figure 11 it appears evident that the geometric construction performed by Guarini is based on the projective criterion of the homological affinity with respect to which he demonstrates the ways to make cornices, vaults, and capitals oblique in *Observations III*, *IV* and *V* respectively (1: 170-171) (Figure 12).

The reason why Guarini devotes ample space to the treatment of oblique architecture is revealed in *Chapter XXIII*: "è un'Architettura, che si adopera non solamente a diminuire, ovvero accrescere le cornici proporzionatamente, e qualsisia dato disegno, ma serve anche all'Architettura delle Scale e a' suoi Volti" (this is an architecture that is used not only to decrease or to increase the cornices proportionally, and any given drawing whatsoever, but it also serves for the architecture of staircases and its vaults) (1: 169). In relation to the solution introduced by Caramuel and outlined in *Lamina VI* of his treatise, in Chapter XXV, Observation I, Guarini states that the Spanish treatise writer "corregge un difetto con un'altro maggiore, e per levare un'errore, n'ammette molti. Che finalmente è molto meglio ammettere una semplice, e sola obbliquità, che fa la Cornice sopra il Capitello, che lascia il Triangolo, o Romboide, mentre l'Abaco và a livello, e la Cornice colla Scala ascende, che spargere il male aspetto della predetta figura per tutto l'ordine, e farlo obbliquo…" (corrects a defect with another greater one, and to remove one error, admits many. Finally, it is much better to admit the simple and sole obliquity that the cornice makes over the capital, which leaves the triangle or rhombus, when the abacus goes straight, and the cornice with the stair ascends, than spread the bad appearance of the aforementioned figure throughout the entire order and make it oblique…) (1: 178).

Thus, in *Chapter XXV*, *Observation III*, Guarini describes the: "Maniera di ornar le Scale colle Cornici sagliente senza adoperare gli ordini. Il primo modo è a fascie, ed a risquadri… che siano Romboidi; Il secondo è cogli Atlanti, o Cariatidi in vece di Colonne; Il terzo con ovati, o tondi a medaglie legate insieme, ed attaccate alla Cornice" (Manner of decorating staircases with sloped cornices without using the orders: The first way is in bands and panels, which would be rhombs; The second is with atlases or caryatids instead of columns; The third is with oval or round medallions connected together and attached to the cornice…) (1: 179).

Finally, in *Observation IV*, he demonstrates how use the orders in cornices that ascend with the staircases: "curvandosi un poco s'adatta sopra il capitello, e si porta a livello sopra esso: d'onde di nuovo si spicca per ascendere allo stesso modo sopra la colonna più alta" (curving a bit adapts itself over the capital, and becomes straight over it, after, it slopes upwards once again in the same way above the next higher column) (1: 179).

3.1. Guarini's 'Three Kinds of Staircase'

In the *Treatise II*, *Chapter VII*, *Observation IX*, *Del modo in generale di disegnare le piante* (the general way to draw plans), Guarini addresses in detail the description of the plan of staircases. Introducing the topic, he writes: "le Scale sono le più difficili parti, che abbia la Casa di allogare, massime che Vitruvio non ne diede regola, se non delle loro salite" (staircases are the most difficult parts to arrange in a house, the governing of which Vitruvius does not provide any rules except those regarding their ascents) (1: 68).

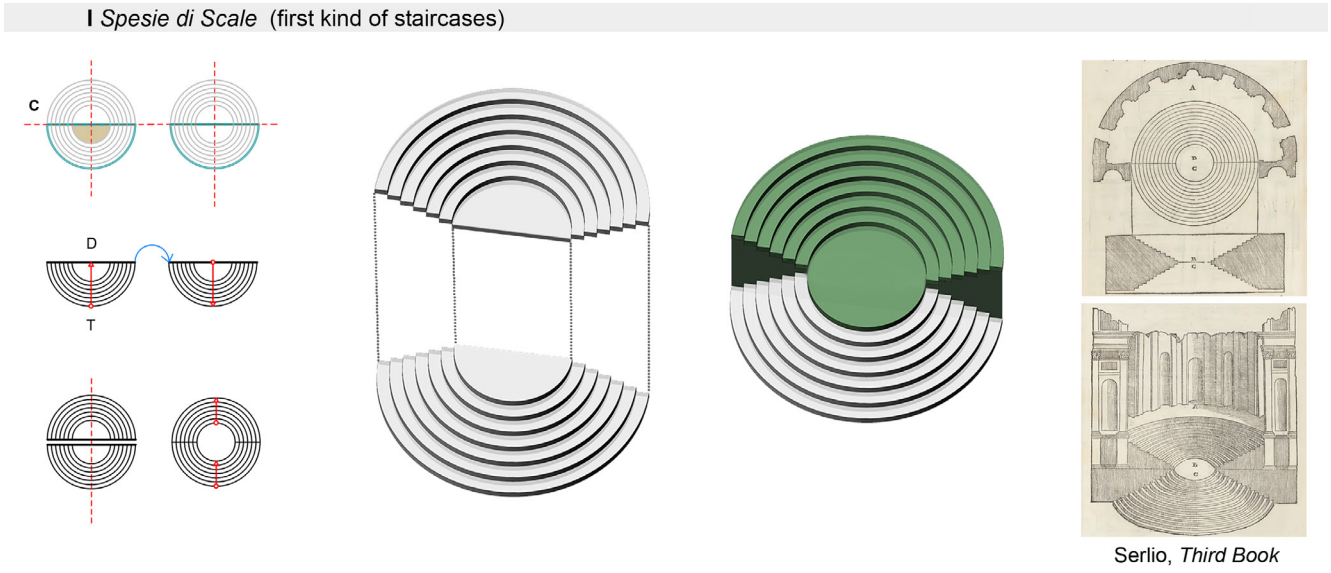

Figure 13. 3D modelling and visualisation of the first type of staircase by Guarini and comparison with the descriptive drawings by Serlio (2) (drawing by Vincenzo Cirillo).

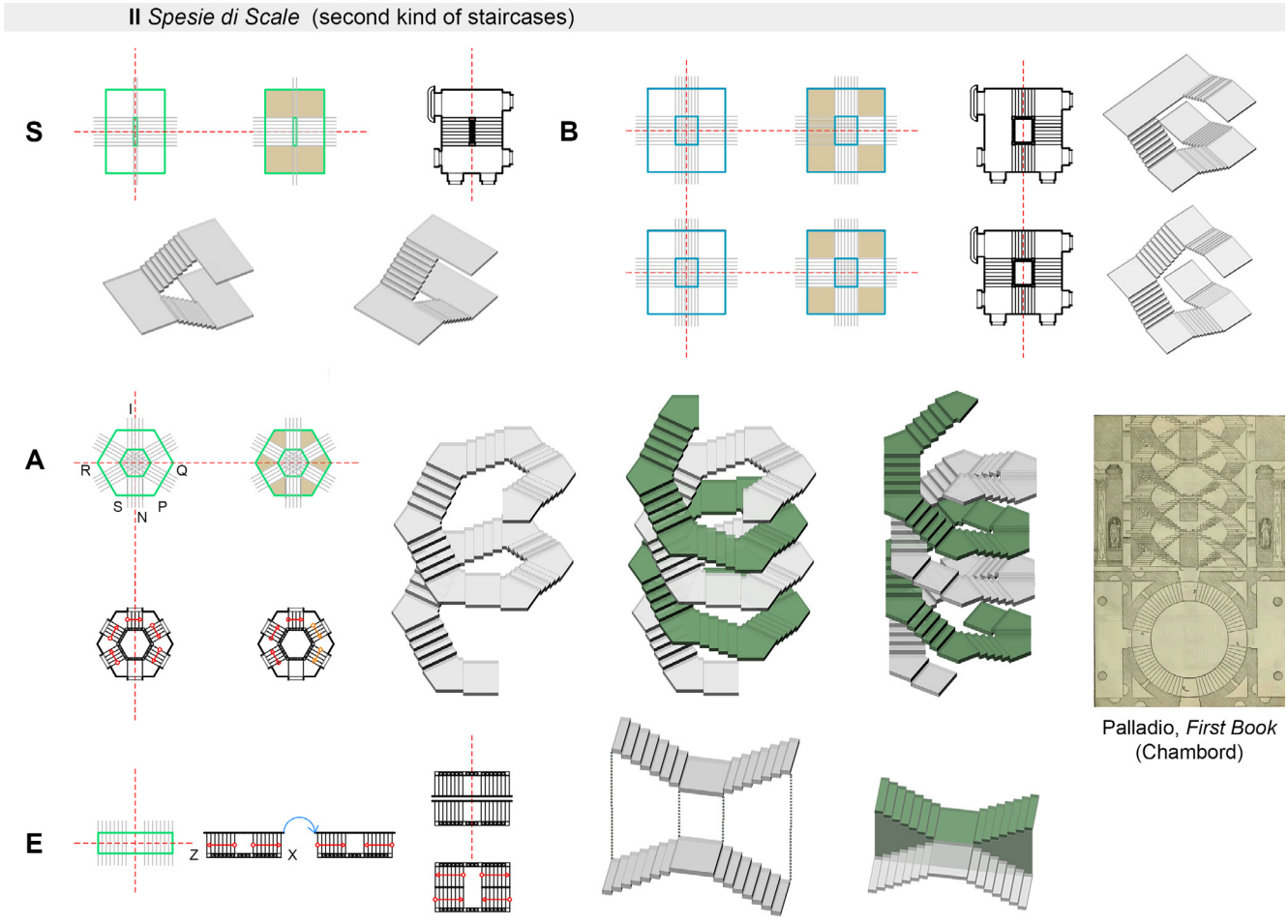

Figure 14. 3D modelling and visualisation of the second type of staircase (drawing by Vincenzo Cirillo).

The literal description of the types is as usual accompanied by figures in the plates at the end of the volume (Figure 8).

The first example of staircase corresponds to those that "nell'ascendere si diminuiscono, ed hanno i gradi sempre più corti, o si accrescono" (in rising grow smaller, and have steps that are increasingly shorter or that grow) (1: 68), depending on the staircase ascent direction in respect to the configuration of the same (Figure 13).

For this type of staircase, continues Guarini, it is also possible to realise doubles, which first ascend and then descend, with the first having convex and round steps, and the other concave. For this first type of staircase, Guarini

cites the circular staircase in Rome in the Pope's Belvedere Garden, a remarkable example already published by Serlio in *Book III*, *Delle Antichità,* of his treatise, illustrated in plan, section and perspective (which Serlio calls "dritto"). Guarini draws only a part in the orthogonal projection (plan) since it was graphically represented by Serlio. In *Book III*, Serlio describes the plan and the section of the staircase cited by Guarini: "il Belvedere in capo del giardino del Papa, oltra le loggie, che qui adietro ho dimostrato, perche'l sito và sempre salendo, vie è una scala molto bella, per la quale si saglie a un piano, che ha forma di teatro: la pianta della quale è qui sotto dimostrata, e anco ci ho posto il profilo, per essere meglio inteso, sì come per i caratteri corrispondenti si puo vedere. Qui non ho tenuto conto delle misure, volendo solamente dimostrare la inventione della scala, e del mezo cerchio, come egli stia. Questo mezo cerchio viene ad essere molto rilevato dal primo giardino verso il palazzo papale, e dietro detto mezo cerchio si trova un piano molto grande con belli appartamenti, e ameni Giardini" (in Belvedere at the end of the Pope's garden, beyond the loggia which I have shown above, because the site is rises continuously, there is a very beautiful staircase, by which one ascends to a site which has the shape of a theater; the plan of this is shown below, and I have also given the profile in order to be better understood, as can be seen by the corresponding characters. Here I did not take the measures into account, wanting only to demonstrate the invention of the stair and how the half-circle is placed. This half-circle comes to be very noticeable from the first garden towards the papal palace, and behind this half-circle is a very large floor with beautiful apartments and pleasant gardens (2: 119).

The second type described by Guarini corresponds to staircases "a rami, o bracci, che ascendono con gradini equidistanti, e paralleli, e sempre eguali" (with branches or arms that ascent with steps that are equidistant, parallel, and always the same) (1: 68). Guarini divides this type into three models according to the number of branches, the shape of the footprint in plan (rectilinear, square, hexagonal) and the typology (i.e., there is a stairwell, and whether the vaults rise along with the stair or are flat). Moreover, he attributes the hexagonal type to the model published by Palladio in his treatise, namely "la Scala di Sciamburg in Francia fatto dal re Francesco" (the staircase in Chambord built by King Francis I (1: 105-106) (Figure 14).

The two-branch staircase (Figure 11, Figure 5, E by Guarini) can be divided into three additional solutions depending on the direction to go up of the ramps ascend from the center or the extremes or, where coupled, return opposite verses. The four-branch staircase presents a square system, while that of five or six branches is hexagonal. These staircases can be "piene in mezzo, o vote, o a tromba, cioè con le volte che ascendono come le Scale, o con le volte a livello" (full in the middle, or empty, *a tromba*, that is, with the vaults that ascending as the staircases, or with the vaults at level). Moreover, if the elevation of the ramps on staircase A is higher, it is possible to obtain the model published by Palladio in his treatise, that is, the double staircase of Chambord. Concluding, the third type of staircase could be "tonda, oppure ovata" (round, or oval) (Figure 15). Guarini asserts that they can be made "colla colonna in mezzo piena, altre vacue, e sospese" (with the column in middle sometimes full, sometimes empty and suspended) as well as "trombe salienti, o a volta a livello" (a well that rises, or with level vault). Additionally, depending on the direction of the ascending ramps, he describes four types, of which the last one has double ramps like the staircase in Chambord. Finally, *Observation IX* ends with eleven detailed distributive and functional recommendations for staircase construction.

4. CONCLUSIONS

The contribution offered here on the theme of the ways to represent staircases in Italian architectural treatises from the sixteenth to the eighteenth century aims to demonstrate how it is included in the more general history of architectural drawing, although specifically documenting two central nodes. The first is expressive of a critical reading of the different ways of representation through which the staircase has been analysed. This diversity highlights how representation is never neutral but is related by its cultural and scientific contexts.

The second relates to the world of digital innovation and, the modern concept of modelling, where this practice allows to give shape to complex and/or never represented design ideas. In the analysis of the sources referred to here, the verbal description of the staircase models often presented by Guarino Guarini does not correspond to the graphical representation or the same is insufficient to describe the peculiarities, resulting in a greater difficulty in imagining the spatial configuration of the same by the reader.

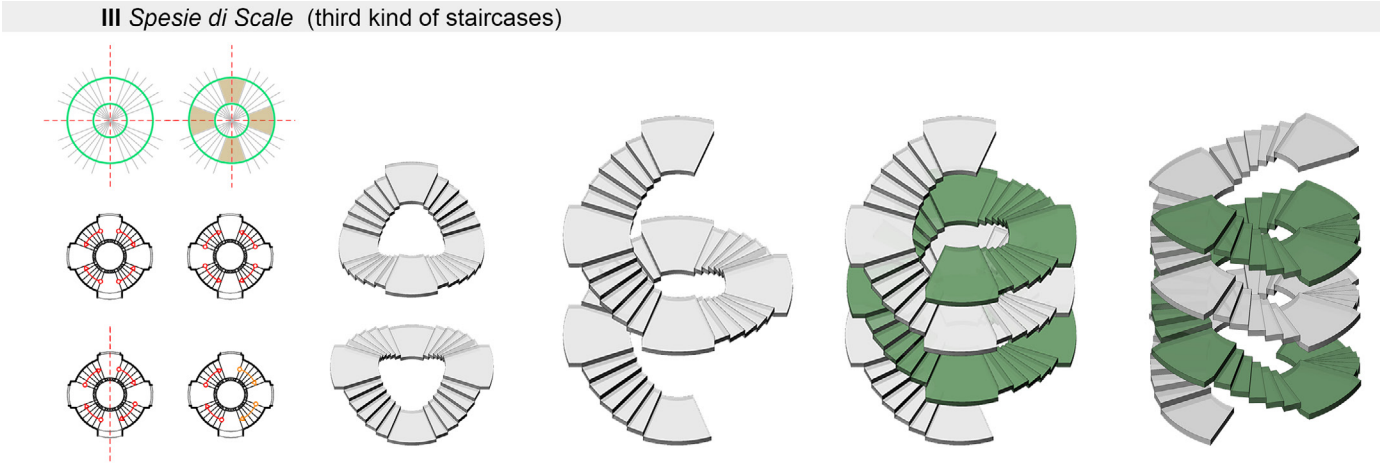

Figure 15. 3D modelling and visualisation of the third type of staircase (drawing by Vincenzo Cirillo).

The 3D modelling elaborated and the subsequent visualization through adequate axonometric or perspective views, here conducted by the writer for the first time, has been useful for the critical representation of the spatial characteristics of the three kinds of staircase illustrated by Guarini, favouring a more immediate understanding to the specialists of the sector and not only. Thus, the study aims to demonstrate that visualization gives a significant result, while also playing a powerful strategic role: giving voice to creativity, knowledge, and communication.

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