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Vitruvian Proportions in the Design of the Architectural Orders of the Basilica of San Lorenzo

Introduction

The literature regarding the proportions of the Basilica of San Lorenzo is quite significant, however, the vast majority of the analyses – from the older ones of Wittkower¹, Sanpaolesi², Bartoli³, Battisti *et al.*⁴, De Angelis d'Ossat⁵ and Gurrieri and Brandinelli⁶, to the more recent ones of Saalman⁷, Bruschi⁸ and especially Cohen⁹ – focus mainly on the proportional relationships to be found in the overall design of the basilica, in its plan and sections, and how this larger “grid” generated the design of the basilica. While this study does not attempt to investigate the whole body of the church, it will try to find explanations to some of the still unanswered questions regarding the internal architectural order and ornamentation, especially in the Old Sacristy and in the transept. An analysis of the proportions of the architectural order proper, as in the numerical relationships between its various members based on the rules codified in architectural treaties, in particular Vitruvius's *De architectura* (first century BC), is still due, despite the various morphological studies on the sculptural qualities of capitals and friezes, from Saalman's *Filippo Brunelleschi: Capital Studies*¹⁰ to Cohen's *Ugly Little Angels*¹¹; an exception being Morolli's *L'ordine brunelleschiano*¹² and, albeit very briefly, Saalman's *Filippo Brunelleschi*¹³. Bruschi *et al.* affirm that the influence that the treatise of Vitruvius had on Brunelleschi's (1377-1446) design is a topic that deserves further investigation, while at the same time underscoring that Brunelleschi was knowledgeable in at least some parts of Vitruvius's treatise¹⁴. An idea that Bruschi reiterates, suggesting that, albeit hard to prove, Brunelleschi had at least some knowledge of Latin, and his friendships within the literary circles of Florence could have allowed him to read parts of Vitruvius¹⁵. The treatise would have given Brunelleschi indications on the architectural order, and some passages might have given him suggestions on how to understand ancient architecture¹⁶. Onians rejects the idea the Brunelleschi was inspired primarily by Roman monuments¹⁷, and hypothesizes that his “sense of Classical order” might have come partly from Vitruvius¹⁸. In his *Rimeditando sulle fonti brunelleschiane*, Ruschi even brings forth the idea that it was the *De architectura* that allowed Brunelleschi to use the “vocabulary” of “ancient” architecture in order to bring back the formal language of Roman architecture¹⁹. Manuscripts of

the *De architectura* had been circulating in Italy at least since the fourteenth century²⁰: in Florence, Boccaccio's copy was in the monastic library of Santo Spirito and the one of Niccolò Acciaiuoli was placed in the Certosa di Galluzzo²¹, even though its use as a reference text for architectural purposes is hard to demonstrate, but not entirely unlikely²², especially considering that signs of Vitruvian doctrine have been noted in paintings by Cimabue and others²³. Even on the occasion of the discovery of the Vitruvian manuscript at St. Gallen around 1415-1416, Poggio Bracciolini did not mention the discovery in his letters, and Cencio de' Rustici mentions it, but not as a new finding²⁴, signs that the manuscript was certainly available²⁵. Undeniably, these manuscripts were all but easy to read and systematically organized²⁶, also due to the mixture of Greek and Latin often used by Vitruvius, so well summed up in the words of Leon Battista Alberti: “he speaks in a way that Latins would say that he wants to appear Greek, and the Greeks would guess that he spoke Latin”²⁷. However, we are not presently dealing with still obscure issues such as the *scamilli impares* or the *eccheia*, that relied heavily on now lost drawings at the end of the book, and an exegesis of the Vitruvian text, as welcome as it would be, would hardly fit in the space of this analysis.

In light of this, a study that looks at the decorative apparatus put into place by Brunelleschi and his followers, not so much in the “metrical” terms of *braccia*, but rather in terms of “module”, taken as the width of the pilasters or the diameter of the columns is very much called for. This article will proceed to demonstrate that apparently inexplicable design choices, such as the entablature in the Old Sacristy and the extremely elongated “Gothic” crossing pillars in the transept, were in fact deliberate choices and part of a precise program that aimed at bringing back classical architecture which was founded on the theoretical base provided by Vitruvius. I do not have the presumption to demonstrate beyond any incontrovertible doubt that Brunelleschi and his followers used the *De architectura* as the main source of inspiration, but rather that it might have had a more prominent role than what was believed until now, at least as concerns the development of the architectural order, as I will demonstrate in the Old Sacristy as well as in the transept.

The Gothic style of central Europe was

never really adopted in Florence²⁸, as it always maintained a specific style, and most importantly, more closely resembled classical architecture than its French or German counterparts. The Romanesque buildings of Florence, such as San Miniato al Monte, the Santi Apostoli and in particular the Baptistery had been studied by Filippo Brunelleschi, buildings that in the opinion of Manetti (1423-1497), his biographer, still had “something reflecting the splendour of the ancient buildings of Rome”²⁹, underlining once again their closer relationship to classical rather than Gothic architecture. Moreover, Manetti writes in his *Vita di Filippo Brunelleschi*, that Brunelleschi travelled to Rome where he “saw the way the ancients used to build and their symmetries; and he seemed to recognize a certain order of members and bones”³⁰. A first-hand knowledge of the Roman Imperial monuments that he probably acquired during his visits to Rome before 1417-1420, as some elements in his early architecture can be considered of Roman origin, such as the arches within the order and the particularly developed drip in the cornice, while at the same time the noticeable differences with proper Roman classical architecture can lead to think that Brunelleschi was not striving to carefully imitate existing Roman monuments but rather to incorporate in his architecture the design principles that governed those buildings³¹, an idea already expressed by Argan³², Luporini³³ and Bruschi³⁴. Vasari (1511-1574) as well insists on how “[with] Filippo Brunelleschi architecture rediscovered the measures and proportions of the ancients, both in the round columns, as well as in the square pillars and in the cornerstones both rusticated and smooth, and he then distinguished every order and showed the differences between them”³⁵. The fact that his sources were not necessarily the monuments of Imperial Rome that he saw and studied can suggest that Brunelleschi had literary sources as a reference, such as Vitruvius’s *De architectura*, other than the Romanesque and Gothic monuments of Florence and Northern Italy.

At the same time, the medieval roots of Brunelleschi’s architecture cannot be overlooked, as exhaustively explained by Klotz³⁶ and, more recently, Cohen³⁷. Even the architectural order and the round arches he used, despite being part of the classical architectural language, can be found in the Romanesque Florentine buildings such as the Baptistery. In the Old Sacristy of San Lorenzo, he exclusively used pilasters, as can be found in the major Florentine churches such as Santa Trinita, Santa Croce and Santa Maria del Fiore. As Thoenes puts it, even in the most Gothic of pillars, the subdivision in base, shaft and capitals never completely disappeared, however, the constant presence of a tripartite entablature governed by proportional ratios was

an innovation of Brunelleschi³⁸. Moreover, even Tuscan Gothic architecture bears almost more similarities with protoRenaissance architecture than with the Gothic. Roberto Pane points out how the difference between the pointed arches in the nave of the cathedral of Santa Maria del Fiore and hypothetical semicircular arches would only be a few square meters³⁹, and a similar remark is made by Cohen when he says that Santa Trinita’s proportions are very similar to the ones of San Lorenzo, and that substituting the Gothic ornaments with Renaissance ones would make it look much like San Lorenzo⁴⁰.

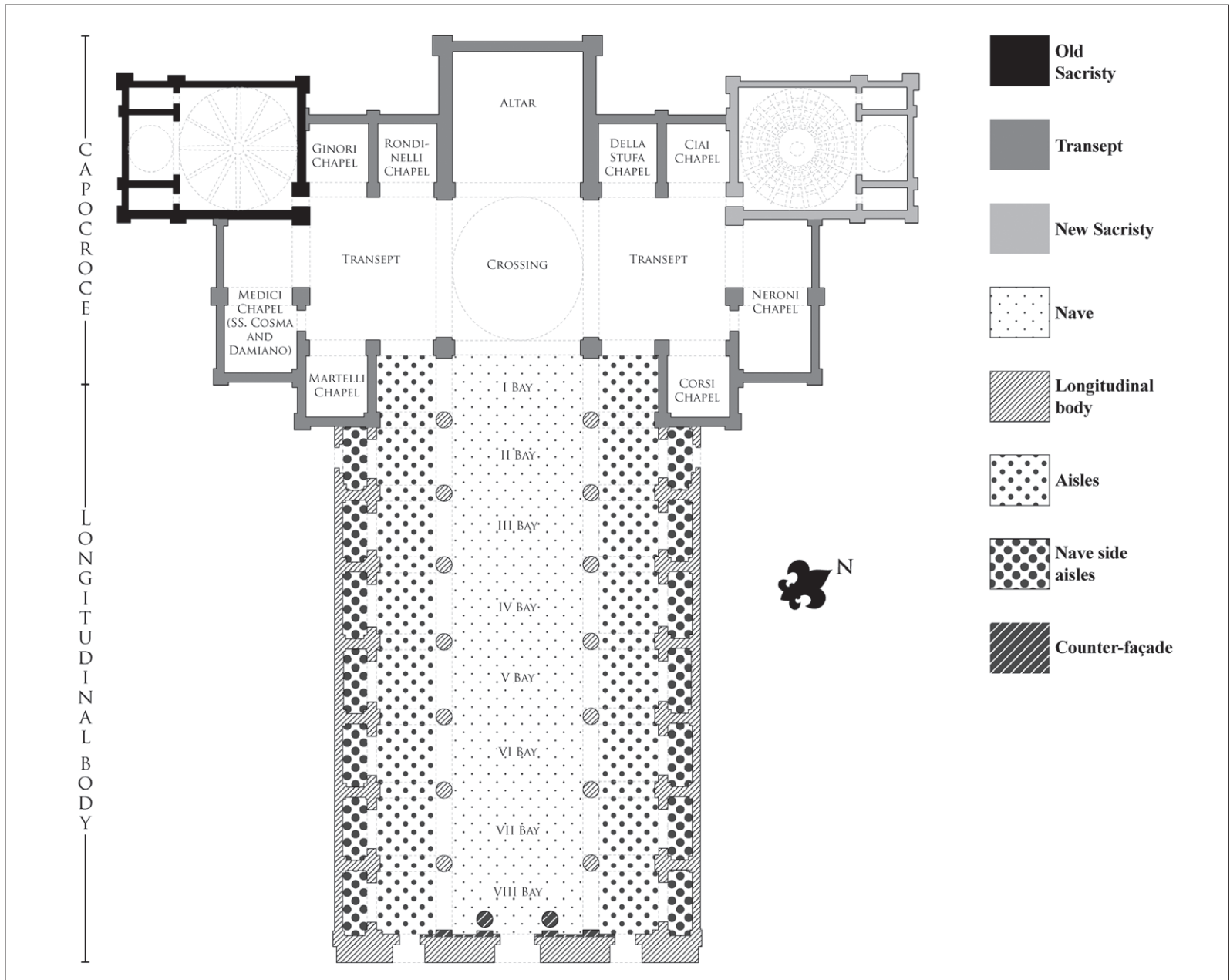
The result is a mixture of classical and medieval architectural language that characterizes Brunelleschi’s style and identity and that can only be fully understood if “read” through the lenses of the modular system that governed the classical orders, the *rata pars* that Vitruvius mentions in the first chapter of the third book when he defines the *proportio* which “est ratae partis membrorum in omni opere totiusque commodulatio”⁴¹ (consists in taking a fixed module, in each case, both for the parts of a building and for the whole)⁴².

The proportional systems in the Basilica of San Lorenzo

Vitruvius distinguishes between two types of modules: the *embatér* (μ), an expression of the geometrical, quantitative aspect of the project (i.e. the physical size of the diameter of the column, which often came in standard sizes from quarries)⁴³, and the *rata pars*, a more abstract, mathematical system to develop the project and derive proportions, not forcibly linked to an *a priori* dimension, but rather developed *a posteriori*⁴⁴.

There are thus two proportional grids to be taken into consideration in the analysis of the architectural order of the Basilica of San Lorenzo: the first is the module/*rata pars*, which is an abstract and mathematical unit that defines the proportional ratios between the various parts of the building. The module is generally defined as the diameter of the column at the bottom, or in the case of San Lorenzo, as the width of the pilasters at the bottom, measured above the *imoscapo*. It needs to be pointed out that Vitruvius does not offer a precise definition of where to take the measurement of the module/*embatér*, a problem that is still present in Alberti’s *De re aedificatoria*⁴⁵. In order to maintain continuity with previous works, in particular Cohen’s survey, all the measurements of the module are intended to be taken above the bottom *scapus* of columns and pilasters.

All the dimensions (height, width, depth and thickness) of the ornaments of a building derive from that module, from mouldings to elements and portions, usually through arithmetical ratios expressed in small fractions.



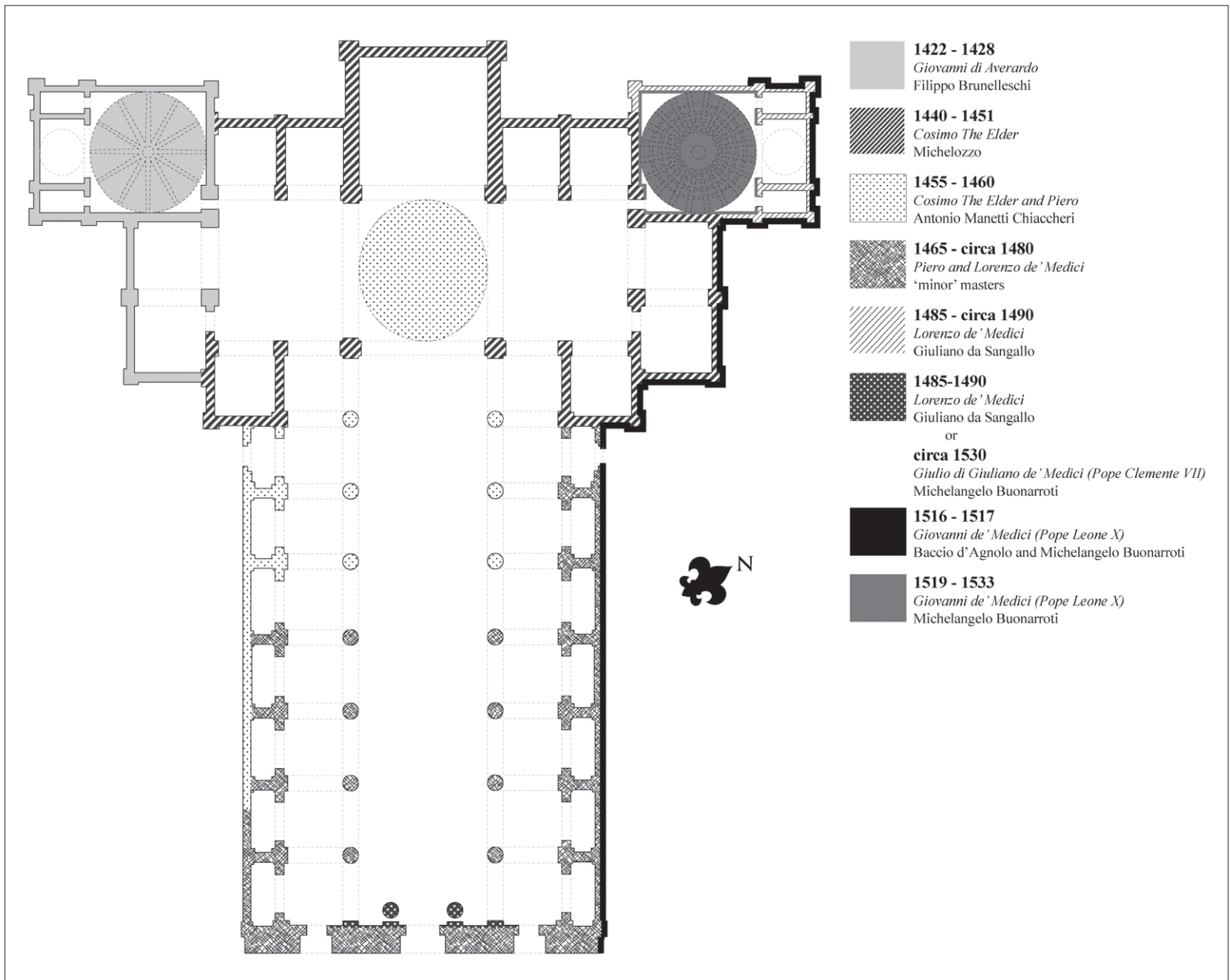
1. Plan of the Basilica of San Lorenzo, Florence.

The second proportional system, the other method of organizing the project, is the one related to the physical measurement in place at the time of the construction, the Florentine *braccio*, corresponding to 58.36 cm.

Regardless as to whether the main proportional grid of the general layout of the basilica was set up by Brunelleschi or his predecessor Matteo Dolfini (d. 1421)⁴⁶, it is clear that there is an intentional program behind both the dimensions in terms of physical *braccia* and the proportions of the classical orders expressed in modules. I agree with the latest hypothesis advanced by Cohen, that the main proportional grid that generates and governs the structure of the basilica in its entirety is based on the Boethian number progression and the Root-two rectangle⁴⁷. At the same time, this accounts for the overall design of the plan of the basilica, whereas the decorative apparatus and the architectural orders contained inside might have had a different development,

while at the same time fitting within the large construction grid. Vitruvius, in the third book of the *De architectura*, explains how it is possible, not only to determine the proportions of an architectural order by starting from the module, the diameter of the column, as a datum, but also to determine the physical dimension of the module through mathematical operations starting from an existing space (III, III, 7). The same process can thus be applied to an existing proportional framework, based on the Root-two rectangle – established either by Brunelleschi or Dolfini – to then determine a secondary proportional system based on the module as it concerns the architectural order and the ornamentation.

This article will focus on this secondary proportional system and analyze the Corinthian order of Brunelleschi in the same terms as any architectural order was conceived and examined in ancient and then Renaissance treaties, i.e. by taking the module – in this case the width



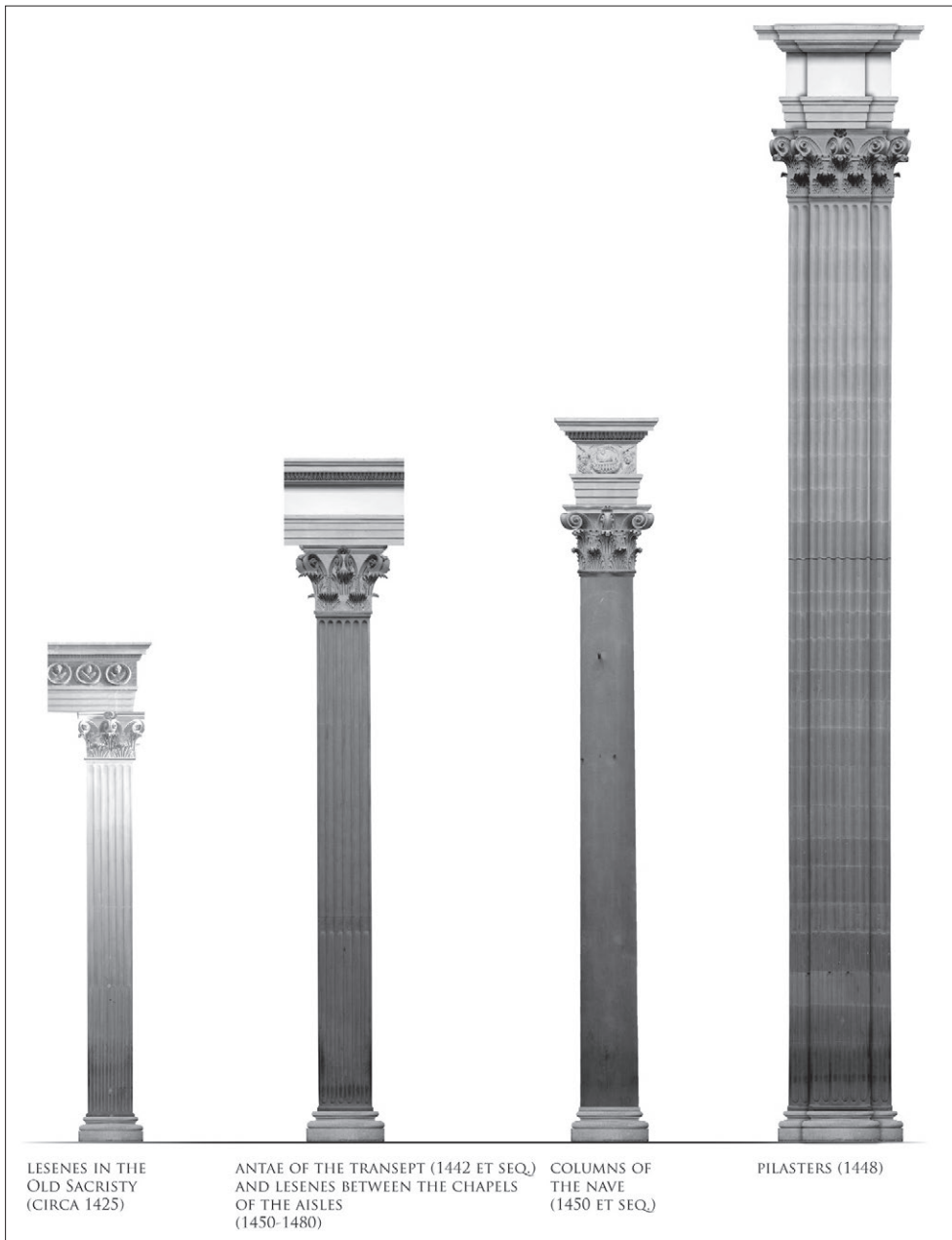
2. Chronology of the Basilica of San Lorenzo, Florence.

of pilasters and columns measured above the bottom *scapus* – as the unit of measurement. Given the peculiar historical moment in which the new plan for the Basilica of San Lorenzo was conceived, and Brunelleschi's roots in medieval architecture, the rules and proportions of the classical order that we find in Vitruvius's treatise *De architectura* and in classical monuments are only partially followed, which further confirms the use of this mixed proportional system, between the Middle Ages and the Renaissance.

The Corinthian order

Vitruvius considered the Corinthian to be the most elegant order as “[c]olumnae corinthiae praeter capitula omnes symmetrias habent uti ionicae, sed capitulorum altitudines efficiunt eas pro rata excelsiores et graciliores” (IV, I, 1; “Corinthian columns have all their proportions like the Ionic, with the exception of their capitals. The height of the capitals renders them

proportionately higher and more slender”, p. 203). In the same chapter, he pursues to explain the origins of the Corinthian capital, an element that, despite being most likely legendary, is of importance as it gives an explanation on why it was used in an order with slender proportions, inspired by the female body: “A girl, a native of Corinth, already of age to be married, was attacked by disease and died. After her funeral, the goblets which delighted her when living, were put together in a basket by her nurse, carried to the monument, and placed on the top. That they might remain longer, exposed as they were to the weather, she covered the basket with a tile. As it happened the basket was placed upon the root of an acanthus. Meanwhile about spring time, the root of the acanthus, being pressed down in the middle by the weight, put forth leaves and shoots. The shoots grew up the sides of the basket, and, being pressed down at the angles by the force of the weight of the tile,



3. Comparison of the architectural orders in the Basilica of San Lorenzo, Florence.

4. Florence, Basilica of San Lorenzo, view of the Old Sacristy looking at the scarsella on the south-west wall.

were compelled to form the curves of volutes at the extreme parts” (p. 209).

The architect Callimachus passed by the tomb and inspired by the sight, established a new architectural order based on it.

Brunelleschi follows the general rules of the Corinthian order in his architecture, but he applies notable modifications, both in terms of morphology and proportions, as he draws inspiration not only from the classical treatise of Vitruvius and the monuments of Rome, but also from the vernacular architecture of Florence, that somehow maintained part of the classical canon but imbued with peculiar characteristics, such as the omission of the pedestal.

The Old Sacristy

Together with part of the transept and the chapel of Cosma and Damiano, the Old Sacristy is the only part of the Basilica that Brunelleschi certainly authored (fig. 2), at least as concerns its interior



vertical distribution and ornamentation⁴⁸, except for the Donatello (1386-1466) sculptures that were added at a later time⁴⁹.

The module is the width of the pilasters at the bottom and measures 64 cm, that converted into *braccia* is one and one-ninth (fig. 5 for all the measurements).

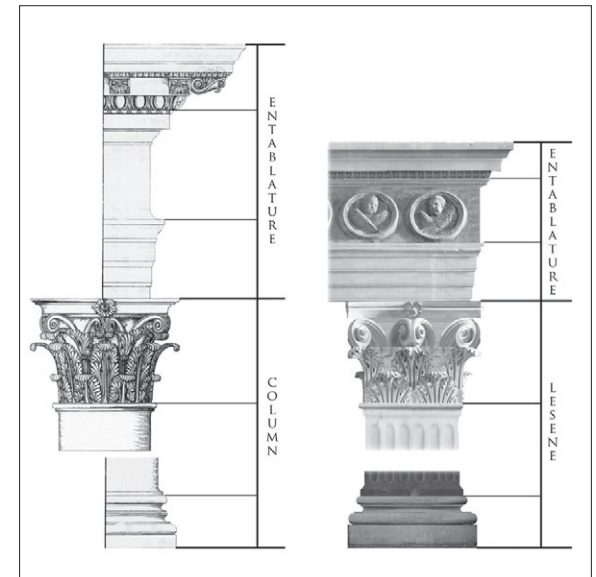
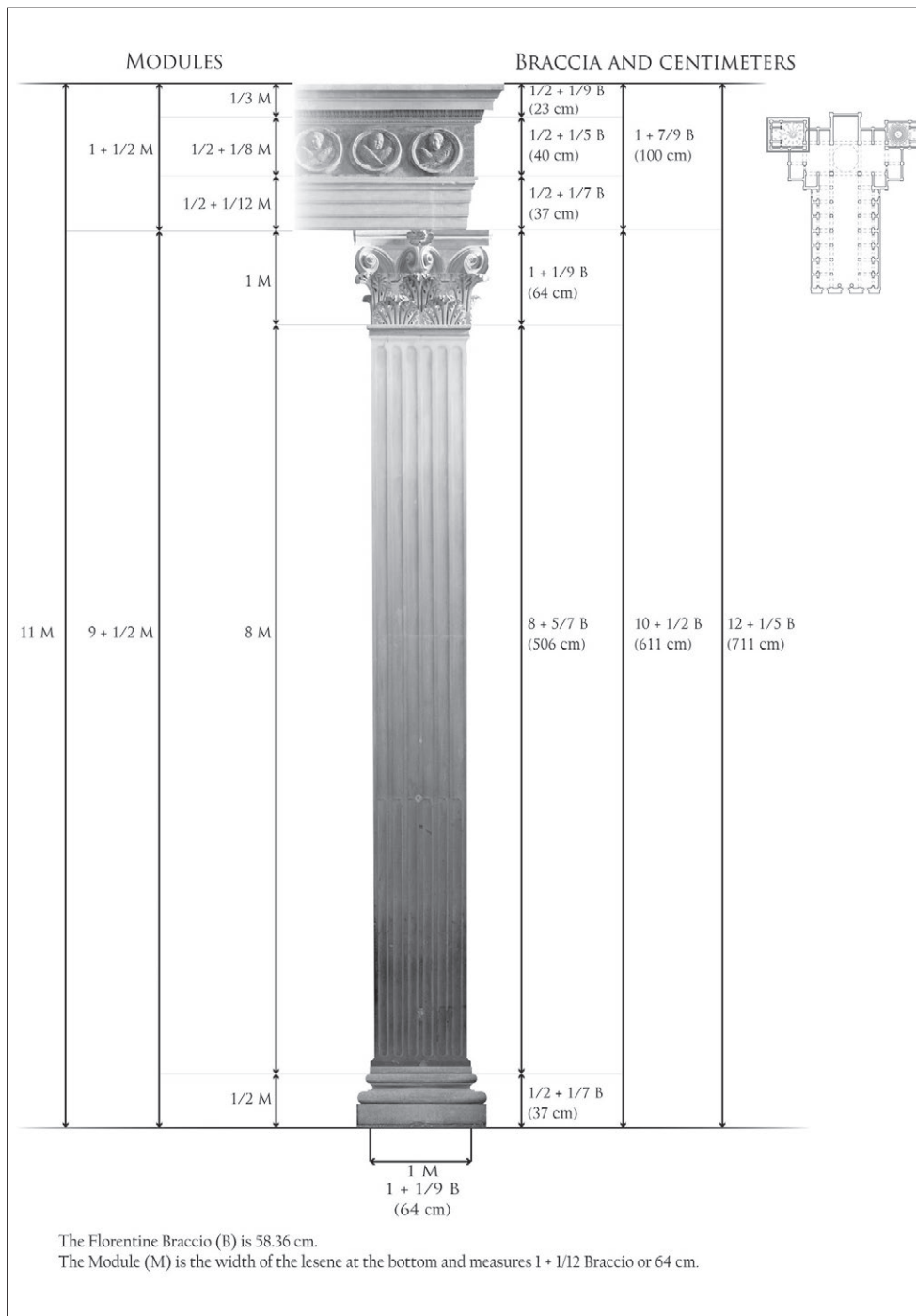
The capital is one module and the total height of the pilaster, including the base, shaft and capital is nine and a half modules. The entablature is one and a half module, divided into a third of a module high cornice, a five-eighths high frieze and a similarly tall architrave.

The total height of the architectural order is eleven modules, the pilaster is nine and a half modules plus one and a half module of entablature and the entablature is one-sixth of the height of the pilaster.

The base in the Old Sacristy, as well as in the rest of the basilica is half a module.

I. I CAPITALS

The Corinthian order designed by Brunelleschi resembles the prescriptions of Vitruvius (fig. 6), however it must be noted that even in the pilasters inside the Baptistery we can observe a similarly proportionate Corinthian, at least as concerns base, shaft and capital. The general ratios of the Corinthian given in the



I.2 SHAFTS

The shaft, eight modules tall (fig. 5), is within the measures set by Vitruvius, since he advises to use the same proportions for the Corinthian order as set for the Ionic, either eight or nine modules (IV, I, 8). The numbers of fluting on the shaft is a detail, already pointed out by Bruschi *et al.*⁵¹, that again can point back to Vitruvius. In classical architecture the number of flutes is always odd, and while an even number of flutes can be observed in the Baptistery, in the numbers of six and eight, the six flutes can stem from a wrong interpretation of Vitruvius, who prescribes twenty-four flutes in the shaft of a column (III, V, 14), which translated to the four sides of a pillar would give six flutes for each side.

I.3 BASES

The base Brunelleschi uses is Attic and “ita tum lata et longa erit columnae crassitudinis unius et dimidia” (III, V, 1; “the thickness with the plinth amounts to half the thickness of the column”, p. 185), which means that the height of the base should be half a module. Brunelleschi follows this rule, as the base of the Corinthian order in the Old Sacristy measures just slightly more than half a module. However, still in tune with Vitruvius “Altitudo eius, si atticurges erit, ita dividatur, ut superior pars tertia parte sit crassitudinis columnae, reliquum plintho relinquatur” (III, V, 2; “The height, if it is to be an Attic base, is to be thus divided: that the upper part is to be one-third of the thickness of the column, and the remainder left to the plinth”, p. 185). The plinth, that Vitruvius advises to be one-sixth of a module, is bigger in Brunelleschi’s version, being one-fourth and dividing the base exactly in half for the plinth and half for the other mouldings. This subdivision is reminiscent of the bulkier plinths of the medieval tradition that can be observed in several monuments of Florence.

5. Measurements of the architectural order in the Old Sacristy of the Basilica of San Lorenzo, Florence.

6. Comparison between the Corinthian order as in Vitruvius’s *De architectura* (C. Amati, *Dell’architettura di Marco Vitruvio Pollione libri dieci, Milan 1829, I, plates XVI and XVI A. Elaborated by the author*) and the pilasters in the Old Sacristy of the Basilica of San Lorenzo, Florence.

De architectura are that “quod ionicum capitulum altitudo tertia pars est crassitudinis columnae, corinthium tota crassitudo scapi” (IV, I, 1; “the height of the Ionic capital is one third of the thickness of the column, that of the Corinthian is the whole diameter of the shaft”, p. 203). The height of the capital should thus be one module, and this is followed by Brunelleschi, as the Corinthian capitals in the Old Sacristy are one *braccio* and one ninth tall (64 cm; fig. 6). This shows a clear intent of the architect to follow the classical tradition by using the proportions in order to “bring back to light the good architecture”⁵⁰ and at the same time to create a new style that would take into account the Florentine tradition as well, as opposed to the foreign Gothic.

7. Florence, Basilica of San Lorenzo, the capital and entablature of the corner pilaster towards the *scarsella* in the Old Sacristy.

8. Florence, Basilica of San Lorenzo, the frieze adorned with reliefs of gridirons and angel heads visible on the outside wall of the chapel of the Saints Cosma and Damiano.



1.4 THE ENTABLATURE AND DONATELLO'S DECORATION

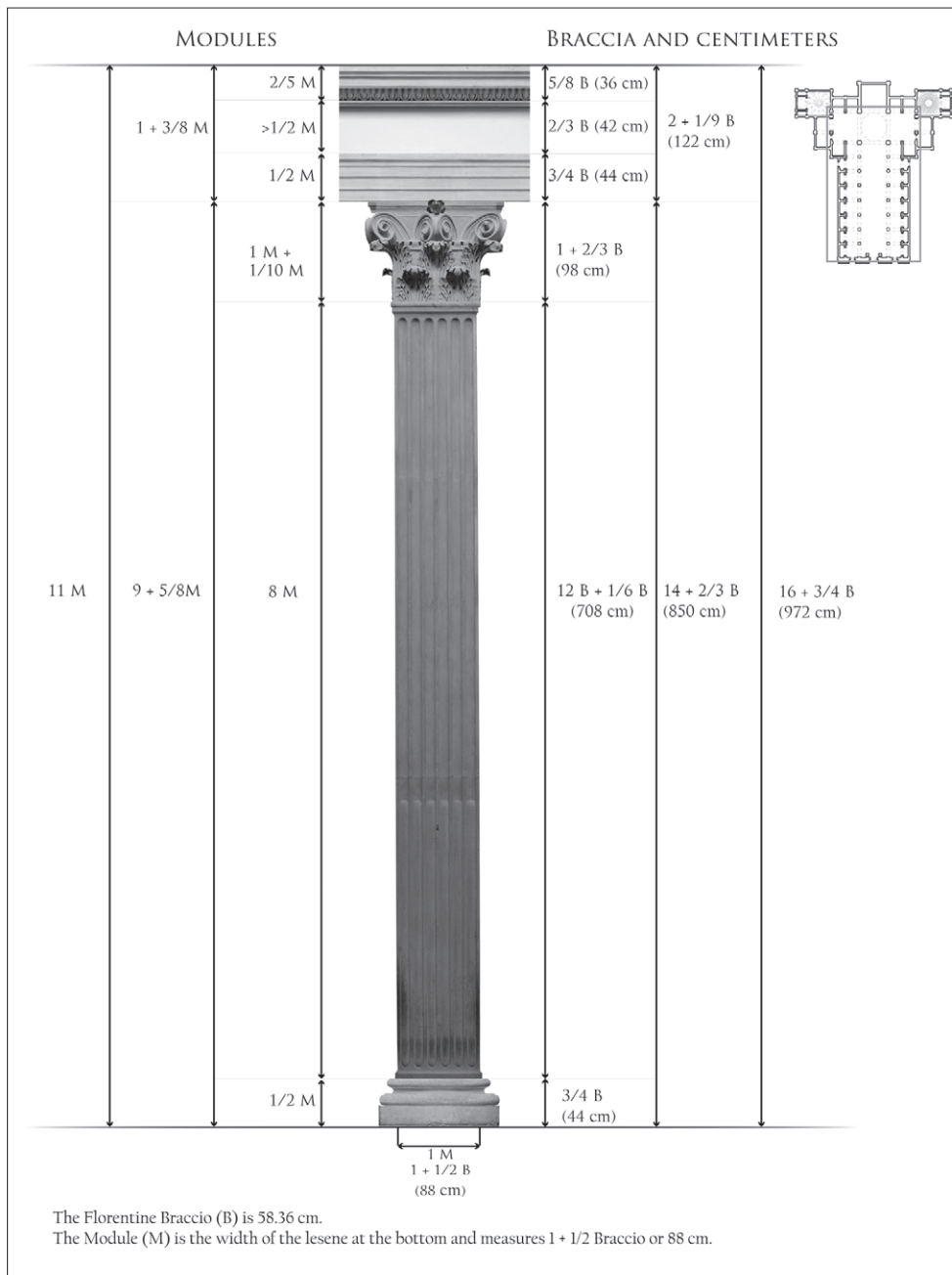
The major divergences from the classical Corinthian order can be observed in the entablature. Brunelleschi follows what Vitruvius prescribes for the height of the architrave for columns between twelve and fifteen Roman feet (between six and seven *braccia* and two-thirds): “epistylia sit altitudo dimidia crassitudinis imae columnae” (III, V, 8; “the height of the architrave should be half the thickness of the column at the bottom”, p. 191) i.e. half a module. However, where in the Vitruvian text we find the architrave divided into three dimensionally increasing fascias (III, V, 10), Brunelleschi places three equally tall fascias. The frieze is canonically taller than the architrave, despite not following exactly Vitruvius's rule that would see a sculpted frieze one-fourth taller than the architrave, whereas the frieze in the Old Sacristy is just about one-sixth taller.

This reduced increase can be explained by the fact that originally the frieze of the Old Sacristy might have not been adorned with the present reliefs, added by Donatello only in the 1430s⁵². At the same time, it might not have been entirely without decoration, which would explain why its height is not less than the architrave, as the classical tradition would prescribe for an undecorated frieze. Moreover, a similar decoration with cherubs' heads is present in the frieze of the Baptistery⁵³. The amount of decoration completed as part of the original design of the Old Sacristy is hard to determine, as well as Donatello's presence. The

main decorative work tends to be placed after Giovanni di Bicci's (1360-1429) death in 1429, and excluding Donatello's trip to Rome of 1432-1433 and Cosimo de' Medici's (1389-1464) exile in the subsequent year, the decoration of the Old Sacristy might date back between 1429 and 1432 or 1434 and 1443, date of Donatello's departure for Padua⁵⁴. In a deliberation from 1434 regarding the construction of the chapels in the transept, it is mentioned that the frieze has to be made like the other chapels “constructed or under construction”, specifying not to use pictorial decoration save on the altar, and thus referring to the Medici chapel, indicating that the reference to the white frieze does not come from the Old Sacristy, which might have already displayed some decoration in the frieze⁵⁵. Further proof is the presence, on the frieze of the outside entablature that connects the Old Sacristy to the church, of terracotta reliefs of angel heads and gridiron (fig. 8), that, while hard to prove as a work of Brunelleschi himself, is at least consistent with his design⁵⁶.

Moreover, Brunelleschi was known for not making drawings of the ornament of his buildings available, as noted by Manetti: “he only took care to explain how to erect the main walls, and the correspondence between some members, without showing ornaments or how to design capitals or architraves, friezes, cornices, etc.”⁵⁷, which means that there is the possibility that the original plans did contain some kind of decoration for the frieze, albeit less prominent than the colored cherubs, or possibly exclusively display the circular frames painted in white, or with a hemispherical cavity, similarly to the roundels in the pendentives and on the walls that will later host Donatello's reliefs⁵⁸, and to the roundels on the portico of the Innocenti⁵⁹.

The cornice is the part that changes the most compared to the classical tradition: the line of dentils that Vitruvius places above the frieze is eliminated *in toto*, as well as the modillions, and the corona that should be as tall as the middle fascia of the architrave is notably reduced, bringing the total height of the entablature to just one sixth of the height of the pilaster,



the dentils, and the shrinking of the cornice in general can be explained by the fact that this entablature, and the whole order, is placed in an interior space, and is therefore not meant to support a roof. Vitruvius himself says that “sic in ionicis denticuli ex proieturis asserum habent imitationem” (IV, II, 5; “in the case of Ionic dentils, they also imitate the projection of the ordinary rafters”, p. 217) – the ordinary rafters being the small beams supporting the tiles of the roof – and that “quod non potest in veritate fieri, id non putaverunt in imaginibus factum posse certam rationem habere” (IV, II, 5; “what cannot happen in reality cannot [they thought] be correctly treated in the imitation”, p. 217). Putting into place ordinary rafters without a roof to support “cannot happen in reality”, for “reality” intended the original, ancient wooden architecture, and thus there is no valid reason for the ordinary rafters to be translated into their “imitation”, the stone version – i.e. the dentils. The same reasoning is valid for other parts of the cornice, as “unaquaeque res et locum et genus et ordinem proprium tuetur” (IV, II, 2; “each scantling preserves its proper place and style and arrangement”, p. 213), and thus they must have a reason for existing and being placed in a certain position, and that is why some parts are omitted from the entablature.

I.5 OLD SACRISTY – CONCLUSIONS

To summarize, by reading the Old Sacristy’s decorative apparatus with the Vitruvian module language, we can account for almost all of Brunelleschi’s choices. Starting from the bottom: the base respects the canonical height, save for the slightly taller plinth, the shaft is exactly what Vitruvius prescribes, as well as the capital (dimensionally speaking). The entablature presents noticeable differences, but they can be explained again by reading Vitruvius’s text and following the general indications he gives regarding entablatures designed for interior spaces. Moreover, if Brunelleschi really followed the *De architectura* in the design of the Old Sacristy’s decorative apparatus, it could lead to the conclusion that the decoration in the frieze was not intended to be as prominent as it is, nor left white as in the transept, but simpler and more geometrical rather than sculptural.

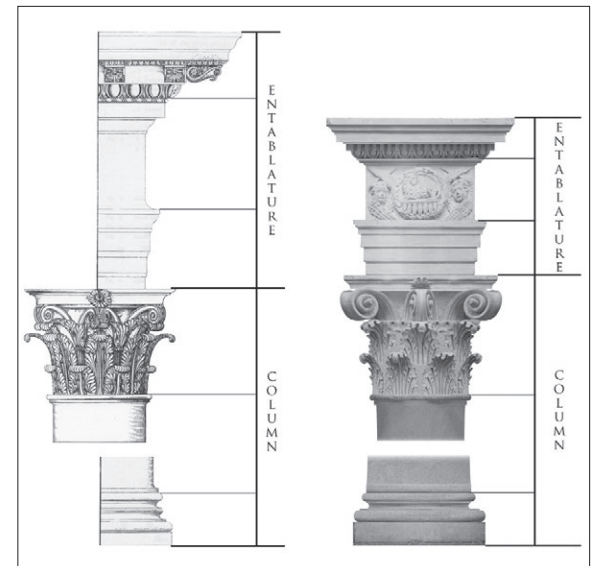
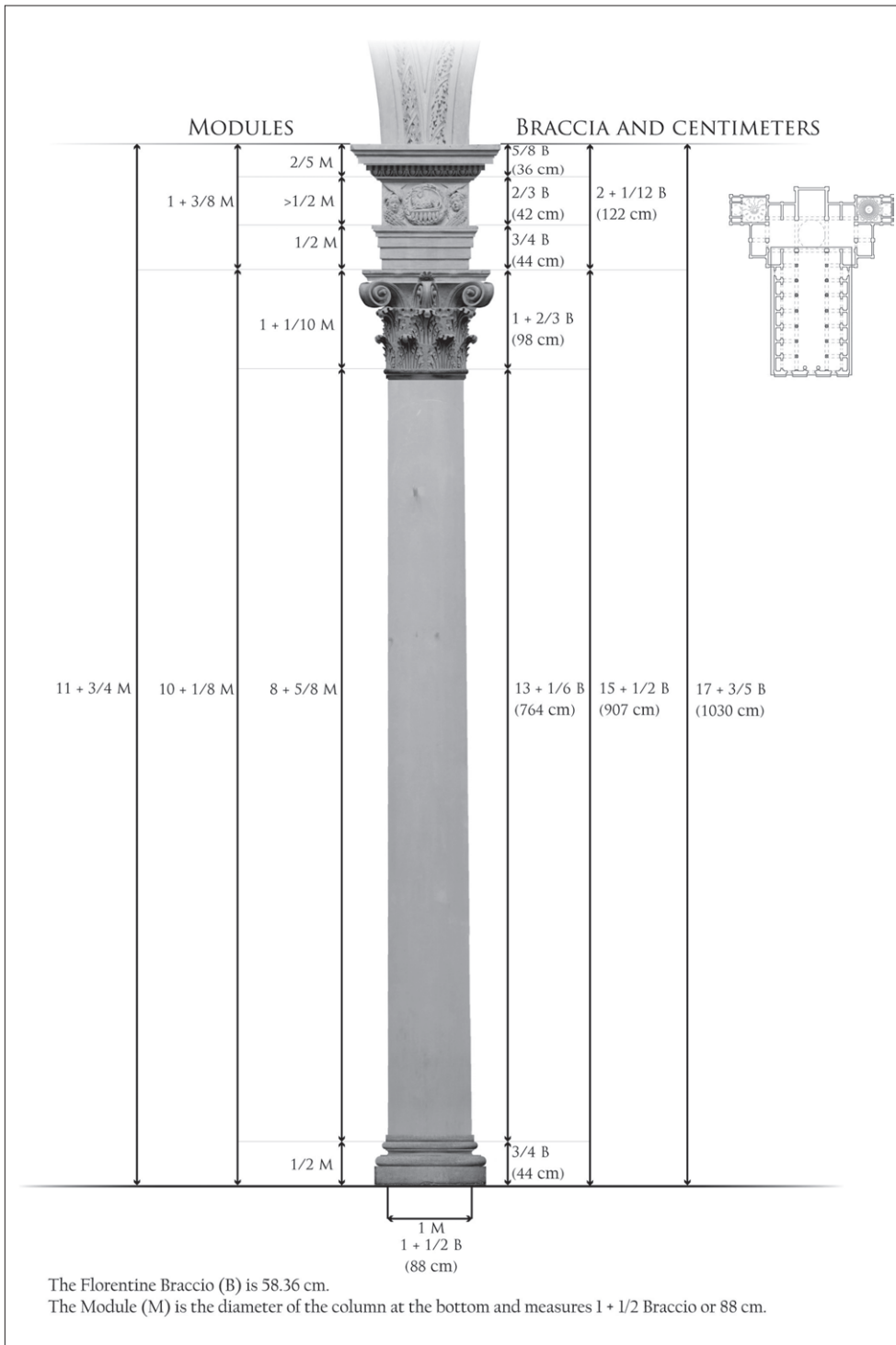
Antae, pilasters and columns of the transept, naves and aisles

The Old Sacristy and part of the transept, the Chapel of Cosma and Damiano, are the only parts of the church that were probably built under the direction of Brunelleschi himself. The rest of the transept, the nave and the aisles were constructed later and finished after Brunelleschi’s death in 1446⁶¹ (fig. 2). These parts took a different direction from what was

9. Measurements of the pilasters in the transept and in the nave’s side aisles of the Basilica of San Lorenzo, Florence.

whereas the classical proportions usually have a ratio of one to five.

The reasons of this compressed version of the entablature are to be found in the wooden origins of the architectural order, as well as in the precedents of Florentine Romanesque architecture. The Baptistery and other Florentine examples give much more importance to the architrave than their classic counterparts, making it the second more prominent member of the entablature, followed by a slightly taller frieze, whereas the Vitruvian Corinthian entablature would expect the cornice to be the more developed member. However, in the medieval precedents the drip is never identifiable, such as in the Baptistery and in San Miniato al Monte, whereas it is clearly outlined in Brunelleschi’s cornice with a listel and a fascia, which can lead to think that his inspiration came from classical sources⁶⁰. In particular, the absence of



twelve *braccia* instead of, respectively, one half and almost nine *braccia*.

The capitals are one module and one-tenth, so they are taller than the ones in the Old Sacristy, both in metrical terms and in modules.

The entablature is slightly more than one module, composed of an architrave and a frieze of half a module each, and a cornice two-fifths of a module tall. Despite metrically taller than the entablature in the Old Sacristy, in terms of modules it results as being even shorter.

This brings the height of the pilasters in the transept and in the side aisles of the nave to a total of nine modules and five-eighths, and the height of the total order to eleven modules, the same as the pilasters in the Old Sacristy.

All the pilasters in the transept and in the side aisles of the nave sit on three steps, which are not counted in the aforementioned measurements, as they are not part of the architectural order. The columns in the nave, however, sit directly on the floor and thus their proportions change accordingly. They retain all the same measurements as the pilasters in the transept and in the side aisles of the nave: base, capital, architrave, frieze and cornice, but their shaft is elongated to compensate for the absence of the underlying steps. The shaft thus goes from twelve *braccia* and one-sixth to thirteen *braccia* and one-sixth, which means from eight modules to eight modules and five-eighths and brings the total height of the order to eleven modules and three-fourths.

The capital is bigger than the ones in the Old Sacristy (fig. 6), both dimensionally and in terms of modules. This increase makes them more similar to the ones from the Roman Imperial period than the ones described by Vitruvius who includes the abacus in the measurement of the total height of the capital (fig. 11), leading to a taller and slender capital. Moreover, these capitals are placed on top of taller pilasters and columns than the ones in the Old Sacristy, so the viewer sees them from a distance of around eight meters

10. Measurements of the columns in the nave of the Basilica of San Lorenzo, Florence.

11. Comparison between the Corinthian order as in Vitruvius's *De architectura* (C. Amati, *Dell'architettura di Marco Vitruvio Pollione libri dieci, Milan 1829, I, plates XVI and XVI A. Elaborated by the author*) and the columns in the nave of San Lorenzo, Florence.

the vision of the architect, while retaining part of the style that Brunelleschi set at the beginning of the construction.

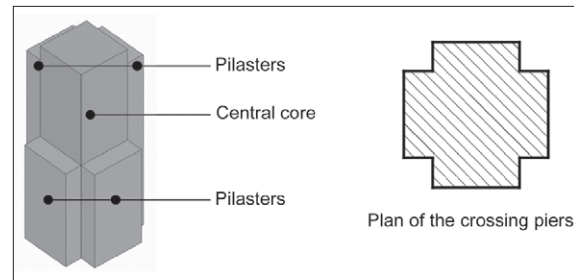
The module of the pilasters in the transept and in the nave side aisles, as measured at the bottom of the shaft, is 88 cm or one braccio and a half (figs 9 and 10 for all the measurements). It is important to note that the module being bigger, greater dimensions expressed in *braccia*, might – and will – maintain the same dimensions in modules as we have seen in the Old Sacristy.

The base is half a module and the shaft eight modules, maintaining the same modular dimensions as the ones in the Old Sacristy, despite being respectively three-fourths and

12. Florence, Basilica of San Lorenzo, the south side of the crossing seen from the nave looking towards the altar.

13. Schematic representation and plan of the crossing piers in the Basilica of San Lorenzo, Florence.

14. Florence, Basilica of San Lorenzo, the north-east crossing pier; looking towards the altar and showing the joint between two pilasters.



instead of the five and a half meters of the Old Sacristy. This leads to a natural optical reduction due to the perspective, corrected with an increase of the height of the capitals. Furthermore, the pilasters and columns are placed in a greater and more open space than the Old Sacristy, and thus their dimensions have been commensurate to the environment. This kind of optical adjustment was well known to ancient Greek and Roman architects, and Vitruvius himself writes that “quod oculus fallit, ratiocinatione est exequendum” (III, III, 11; “what the eye cheats us of, must be made up by calculation”, p. 179) and: “Venustates enim persequitur visus, cuius si non blandimur voluptati proportione et modulorum adiectionibus, uti quod fallitur temperatione adaugeatur, vastus et invenustus conspicientibus remittetur aspectus” (III, III, 13; “For the sight follows gracious contours; and unless we flatter its pleasure, by proportionate alterations of the modules [so that by adjustment there is added the amount to which it suffers illusion], an uncouth and ungracious aspect will be presented to the spectators”, pp. 179-181).

This is not the only instance of optical corrections applied by Brunelleschi, as Marvin Trachtenberg’s punctual study of construction methods in the Old Sacristy revealed, the dimensions of flutes and fillets were altered in order to give more visibility to the sliver piers⁶².

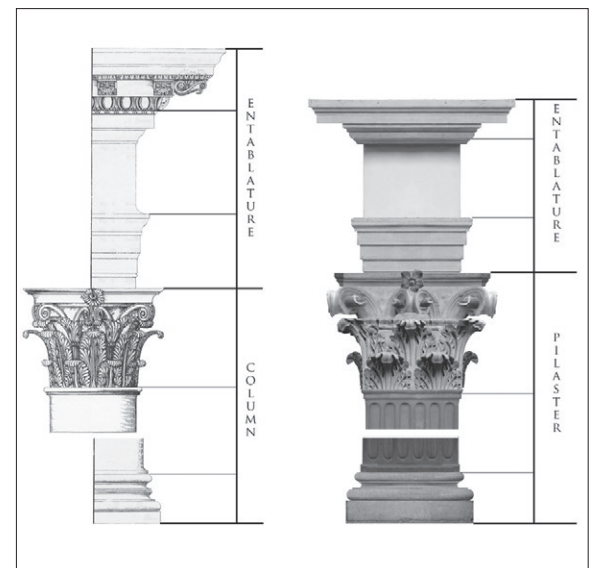
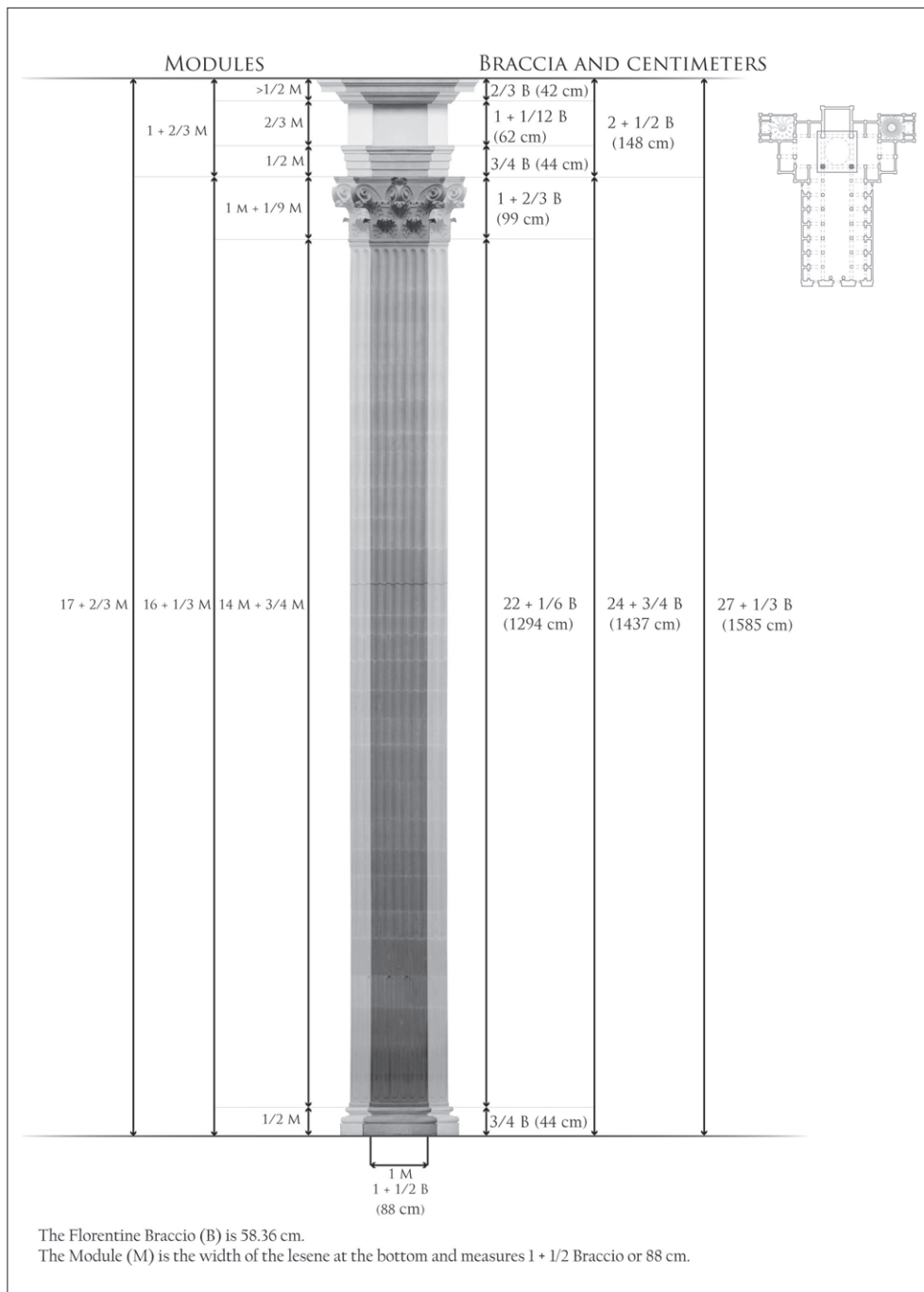
The entablature, already considerably shorter than the classical one in the Old Sacristy, is here further reduced. The metrical dimensions increase, but considering the module, now bigger, both the architrave and the frieze are shorter, whereas the cornice is slightly taller. The reasons for a shorter entablature are the same as for the Old Sacristy, since the transept and the nave are both interior spaces, even if larger than the Old Sacristy. At the same time, the capital was probably the most important part of the architectural order for this first generation of architect-humanists, a symbol of the “rebirth” of architecture, unlike the classic tradition, where entablature and capital both had the same importance.

Crossing piers

The crossing piers are placed at the crossing between the transept and the nave, under the dome. They are made of four pilasters placed against a central ‘invisible’ core, a one module large square (fig. 13). Considering the module as one of these pilasters, its dimension does not change from what we saw in the pilasters in the transept and in the nave side aisles, as it is one and a half *braccia* (fig. 9).

I.6 CROSSING PIERS AS FOUR PILASTERS

The shaft is fourteen modules and three-fourths high; the capital one module and one-ninth and the



could be dictated by the aforementioned optical corrections, as this entablature is placed further away from the observer.

However, the shaft is extremely elongated, spanning more than fourteen modules and giving it an incredibly slim appearance, unlike any other order in the church, and diverging notably from any classical proportions. Cohen considers the crossing piers the “only evidence of Gothic influence in this otherwise thoroughly early Renaissance basilica”⁶³ and, judging by the elongated shaft of a single pilaster they do indeed resemble Gothic pillars, rather than a classical Corinthian pilaster. Bruschi *et al.* as well, consider in their survey the crossing piers as composed of four separate pilasters, and measured as such, confirming their Gothic proportions.

It is to be noted that the two westernmost piers, the ones closer to the altar, are placed on three steps, similarly to the pilasters of the transept and side aisles, and they are subject to the same process of reduction of the height of the shaft, whereas all the other elements maintain the same dimensions. For the purpose of the current analysis, the difference in height is not specifically examined, for it leads to the same conclusions.

1.7 CROSSIG PIERS AS CROSS SHAPED PILLARS

If we take as a module not the single pilaster one *braccio* and a half wide, but the whole width of the crossing pier, considering also the two pilasters on the sides that protrude for half a *braccio*, the module becomes two and a half *braccia*, and thus the ratios are considerably different (fig. 17 for all the measurements).

The most unorthodox ratio, the one of the shaft, goes from a “Gothic” fourteen modules and three-fourths (fig. 15) to a more classical eight modules and seven-eighths, very close to the nine modules of the Vitruvian Corinthian shaft height, and bringing the total height of the order back to ten modules and seven-eighths, very close to the

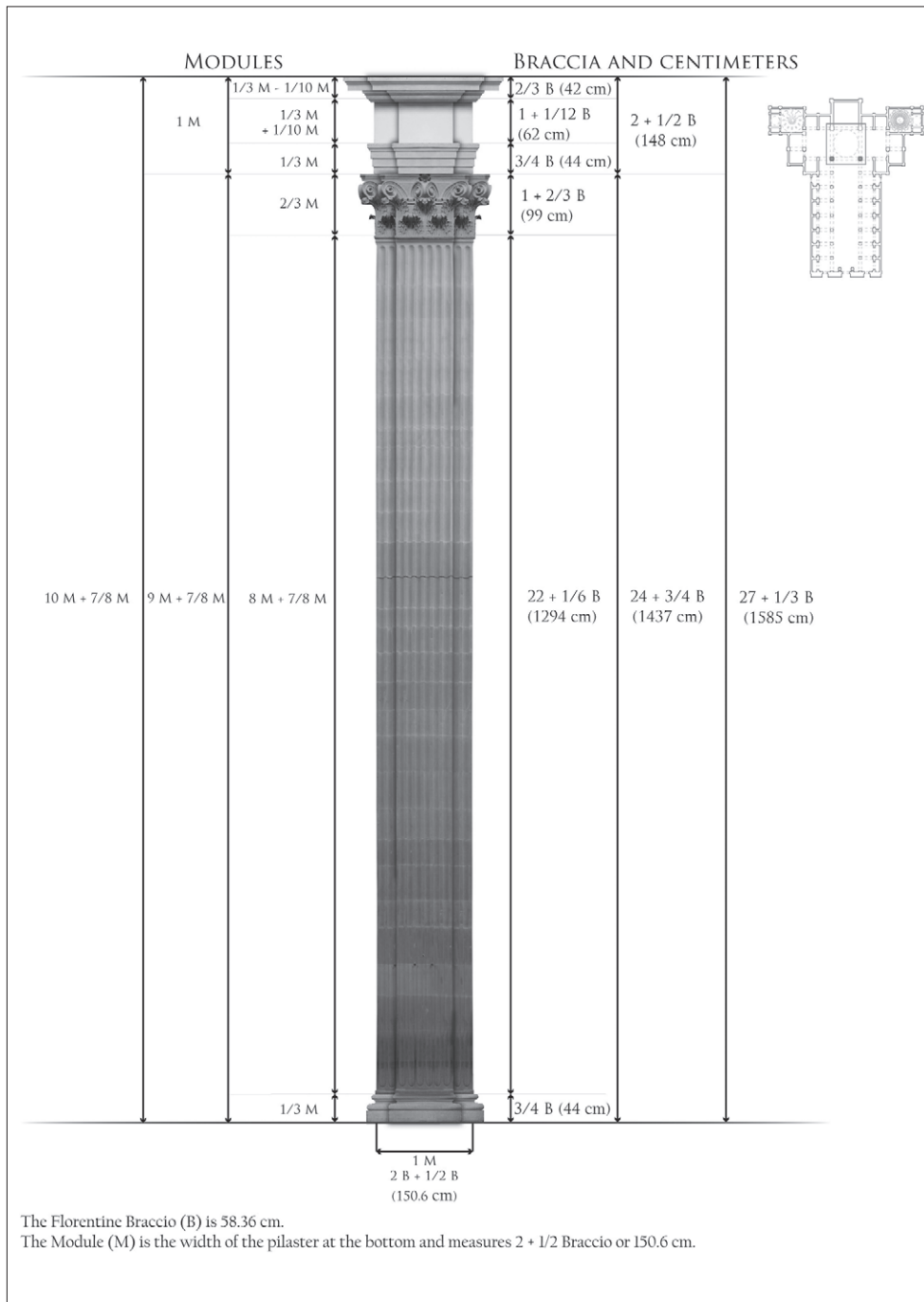
15. Measurements of the pilasters in the Basilica of San Lorenzo, Florence, forming the crossing piers, considering the module as the width of a single pilaster.

16. Comparison between the Corinthian order as in Vitruvius's *De architectura* (C. Amati, *Dell'architettura di Marco Vitruvio Pollione libri dieci*, Milan 1829, I, plates XVI and XVI A. Elaborated by the author) and the pilasters of the crossing piers in the Basilica of San Lorenzo, Florence.

entablature one module and two-thirds, divided into an architrave of half a module, a frieze of two-thirds of a module and a cornice of half a module. The total order height is seventeen modules and two-thirds (fig. 15 for all the measurements).

The base, as everywhere else in the church, is half a module tall.

Considering the module as the width of a single pilaster, one *braccio* and a half, the ratios between the various members of the pillars do not vary considerably compared to the pilasters in the transept and in the nave side aisles (fig. 9): the capital has the same height, and the entablature, despite being a compressed version – it is still placed in an interior, so the explanation given for the entablature in the Old Sacristy and the rest of the transept still stands –, shows just a dimensional increase with a taller frieze, which



17. Measurements of the crossing piers in the Basilica of San Lorenzo, Florence, considering the module as the whole width of the piers.

eleven modules that we can observe everywhere else in the church (figs 5, 9 and 10). While this interpretation brings back the total height of the order to a more canonical dimension, the ratios of the base, capital and entablature become even more divergent from the classical tradition than before: the base becomes one third of a module, the capital two-thirds, and the entablature just one module, despite the dimensional increase that it received. Although these dimensions are notably smaller than what Vitruvius would prescribe, it is interesting to notice how all the members are expressed as simple and commonly used fractions: one-third for the base, two-thirds for the capital and one for the entablature; evidencing that these proportions were not entirely incidental, but rather deliberate, as in a classical reinterpretation of the Gothic compound pier.

In fact, Cohen finds a flaw in the San Lorenzo proportional system exactly in the area of the crossing piers where the distance between plinths goes from nineteen *braccia* to eighteen *braccia*. He attributes the placing of the two *braccia* “core” of the piers to the original Dolfini design⁶⁴, but the addition of the pilasters on each side brings the total width of the plinth to three *braccia*. This disruption may well be interpreted as a mistake, probably due to the hiatus in the construction of the basilica, and the numerous changes that happened during the edification of the transept⁶⁵. Bruschi as well, considers the piers an “irregularity” made necessary in order to adhere to the square modular plan of the basilica. He affirms that the solution put into place by Brunelleschi to link the minor and major orders between the transept and the nave is the same employed in San Miniato and, by Brunelleschi himself, at the Innocenti: the top of the arch of the minor order is tangent to the bottom of the architrave of the major order⁶⁶. This solution does indeed decide the height of the piers, but it still leaves some leeway as concerns the proportioning of their members. The increase in the width of the piers might thus be interpreted as an adjustment made in order to bring the overall proportions of the piers to more classical ratios, despite the fact that the general plan of the basilica was already set. The pilasters on the crossing piers are in fact the only ones in the church (if we exclude the counter-façade that will only be built at a later date) that protrude for the thickness of two flutes rather than one.

The changes in the architectural taste during the long history of the basilica are noticeable in many aspects⁶⁷ and it is not unreasonable to believe that some adjustments were made to bring the style of the basilica closer to the taste of the time, as the crossing piers were probably erected during Cosimo de’ Medici’s patronage between 1442 and 1450⁶⁸. Santo Spirito’s crossing piers, in fact, show slightly less ‘Gothic’ proportions compared to San Lorenzo’s. Bruschi hypothesizes a taller order in Brunelleschi’s original design⁶⁹, so it is not to be excluded that Santo Spirito’s crossing piers had the same fate of San Lorenzo’s and had been subject to a ‘de-gothicization’ at a later date. Cosimo already refused the design of Brunelleschi for his family palace on Via Larga, and the trend that followed was closer to more classically accurate forms and more aligned to the teachings of Leon Battista Alberti, rather than the “gothicisms” of the early Renaissance, a trend that will be followed by Cosimo’s son Piero⁷⁰.

Conclusion

It is essential to contextualize the reference measurement system that architects used in their buildings, as it would otherwise be

impossible to read and understand some of their decisions and design choices. In the case of San Lorenzo, this is of particular significance as it is often regarded as the first example of Renaissance architecture⁷¹, and despite the fact that the authorship of the whole church is still under discussion⁷², we can reasonably presume that Vitruvius's *De architectura* was a reference text, if not for the general layout of the basilica, at least for the proportioning of its internal decorative apparatus and its architectural order. This hypothesis is supported by the fact that by using the Vitruvian module as a reference, dimensions such as the ones of the entablature of the Old Sacristy and the crossing pilasters, apparently inexplicable if measured in *braccia* and related to the rest of the framework of the whole church, acquire a *raison d'être* and also offer other interesting insights, such as the possibility of a different and simpler decoration in the frieze in the Old Sacristy, as well as an explanation for the "Gothic"

crossing piers in an otherwise typically early Renaissance proportioned basilica. It is undeniable that the architectural system put into place by Brunelleschi links every part to the other, and that they are "syntactically" part of a whole⁷³. Analyzing the architectural orders and their parts singularly, almost isolated from the larger proportional system, seems thus counter-intuitive. However, due to the numerous changes and vicissitudes of the construction of the church of San Lorenzo, and the modifications applied after – and without – the supervision of Brunelleschi, it is reasonable to also read and interpret them as elements with their own proportional system.

More than one century later, Vasari, in his *Le Vite* praises Brunelleschi saying that "he was a gift from heaven to give a new form to architecture, which had been lost for hundreds of years"⁷⁴, underlining once again how important this ancient knowledge was for the artists of the Renaissance.

APPENDIX

The measurements and all the photographs used in this study, unless otherwise stated, are from a survey conducted by the author in the Basilica of San Lorenzo between 2011 and 2012, for which I thank the Opera Medicea Laurenziana. Some of the dimensions that were impossible to obtain with direct measurements have been determined via photographic rectification of the images using the Siscam Archis 2D software. Rectified images are tilted photographs that are transformed in an orthogonal projection through a procedure called *rectification*: the position and dimensions of known vertical and horizontal elements are fed to the software, which geometrically and/or analytically determines the position and dimensions of the other objects on the same plane and gives a graphical restitution. In the case

of San Lorenzo this process had to be repeated multiple times for each part of the order, as the various parts are not necessarily on the same plane. Along my analysis, the measurements from Cohen's 2014 survey were integrated where deemed necessary.

All the measurements during the survey were originally taken in centimeters, then converted into *braccia*, considering a single *braccio* as 58.36 cm. All the *braccia* measurements are expressed as whole numbers and fractions, avoiding the use of decimals, as well as the subdivision in *soldi* and *denari* since not in use in fifteenth century Florence^a. For the purpose of this study, which analyzes the classical proportions of the ornamentation, all the *braccia* measures are finally converted into modules, considered as the width of the shaft of pilasters and diameter of columns,

and the analysis is thus carried out referencing primarily to this unit of measurement.

There is of course some degree of inaccuracy in the measurements, especially since it is necessary to convert all of them twice (first from centimeters into *braccia*, then from *braccia* into modules) and in both cases they need to be rounded up to the closest fraction. However, slight errors in the order of one to four centimeters do not hinder the overall proportional analysis, as they are not noticeable enough to contribute to a change in the fractional proportions, and thus lead to different conclusions.

a. Cohen, *Beyond Beauty...*, cit. [cf. note 9], p. 88. Bruschi, *Filippo Brunelleschi*, cit. [cf. note 8], p. 23, mentions the use of Florentine *soldi* as concerns the proportioning of Brunelleschi's crucifix in Santa Maria Novella, but he still uses fractions of *braccia* when discussing Brunelleschi's architecture.

1. R. Wittkower, *Brunelleschi and 'Proportion in Perspective'*, in "Journal of the Warburg and Courtauld Institutes", 16, 3/4, 1953, pp. 275-291.
2. P. Sanpaulesi, *Brunelleschi*, Milan 1962.
3. L. Bartoli, *La rete magica di Filippo Brunelleschi. Le seste, il braccio, le misure*, Florence 1977; Id., *L'unità di misura e il modulo proporzionale nell'architettura del Rinascimento*, in "Quaderni dell'Istituto di Elementi di Architettura e Rilievo dei Monumenti, Università degli Studi di Genova, Facoltà di Architettura", 6, 1971.
4. *Problemi brunelleschiani. Sagrestia Vecchia e San Lorenzo*, ed. by E. Battisti, Rome 1977.
5. G. De Angelis d'Ossat, *Brunelleschi e il problema delle proporzioni*, in *Filippo Brunelleschi, la sua opera e il suo tempo*, papers presented at a congress (Florence, 16-22 October 1977), ed. by F. Borsi, 2 vols., Florence 1980, I, pp. 217-238.
6. *La Sagrestia Vecchia di San Lorenzo*, ed. by F. Guerrieri, Florence 1986.
7. H. Saalman, *Filippo Brunelleschi. The Buildings*, University Park (PA) 1993.
8. A. Bruschi, *Filippo Brunelleschi*, Milan 2006.
9. M.A. Cohen, *Beyond Beauty. Reexamining Architectural Proportion through the Basilicas of San Lorenzo and Santo Spirito in Florence*, Venice 2013.
10. H. Saalman, *Filippo Brunelleschi: Capital Studies*, in "The Art Bulletin", 40, 2, 1958, pp. 113-137.
11. M.A. Cohen, *Ugly Little Angels: Deliberately Uneven Construction Quality in the Basilica of San Lorenzo in Florence*, in "Architectural Research Quarterly", 11, 3-4, 2007, pp. 276-289.
12. G. Morolli, *L'ordine brunelleschiano: morfologia e proporzioni*, in *San Lorenzo 393-1993. L'architettura. Le vicende della fabbrica*, exhibition catalog (Florence, Basilica of San Lorenzo, 25 September-12 December 1993), ed. by G. Morolli and P. Ruschi, Florence 1993, pp. 81-94. I am indebted to my late thesis director, Prof. Gabriele Morolli (1947-2013), who suggested the necessity to look at the measurements of the architectural order of the Basilica in light of Vitruvius's treatise.
13. Saalman, *Filippo Brunelleschi...*, cit. [cf. note 7], p. 208.
14. A. Bruschi et al., *Fonti del linguaggio brunelleschiano, appunti sulla componente romana*, in *Filippo Brunelleschi, la sua opera...*, cit. [cf. note 5], II, pp. 389-440 (p. 391).
15. Bruschi, *Filippo Brunelleschi*, cit. [cf. note 8], p. 11. See also p. 23.
16. *Ibid.*, p. 169, note 29. See also pp. 73, 113, 128 and elsewhere.
17. J. Onians, *Bearers of Meaning. The Classical Orders in Antiquity, the Middle Ages, and the Renaissance* Princeton, NJ, 1988, p. 130.
18. *Ibid.*, p. 133.
19. P. Ruschi, *Rimeditando sulle fonti brunelleschiane: dall'auctoritas romana alla rinascenza fiorentina*, in *San Lorenzo. A Florentine Church*, ed. by R.W. Gaston and L.A. Waldman, Florence 2017, pp. 279-292: p. 282. See also Bruschi, *Filippo Brunelleschi*, cit. [cf. note 8], pp. 66-69.
20. R. Kay, *Vitruvius and Dante's 'Imago Dei'*, in "Word & Image", 21, 3, 2005, pp. 252-260: p. 253.
21. G. Clarke, *Vitruvian Paradigms*, in "Papers of the British School at Rome", 70, 2002, pp. 319-346: p. 320.
22. *Ibid.*, p. 321.
23. Kay, *Vitruvius and Dante's ...*, cit. [cf. note 20], p. 255.
24. Clarke, *Vitruvian Paradigms*, cit. [cf. note 21], p. 320.
25. W. Verbaal, *The Vitruvian Middle Ages and Beyond*, in "Arethusa", 49, 2, 2016, pp. 215-225: p. 219.
26. I.D. Rowland, *From Vitruvian Scholarship to Vitruvian Practice*, in "Memoirs of the American Academy in Rome", 50, 2005, pp. 15-40: p. 19.
27. Leon Battista Alberti, *De re aedificatoria*, Florence, Nicolai Laurentii Alamani, 1485, p. 179: "sic enim loquebatur, ut Latini Graecorum videri voluisse, Graeci locutum Latine vaticenetur" [my translation].
28. Cohen, *Beyond Beauty...*, cit. [cf. note 9], p. 29.
29. Antonio Manetti, *Vita di Filippo Brunelleschi preceduta da La novella del Grasso*, ed. D. De Robertis and G. Tanturli, Milan 1976, p. 64: "qualche cosetta di riflesso dello splendore di quelli antichi edifici di Roma" [all translations are mine unless otherwise indicated].
30. *Ibid.*, p. 65: "vide'l modo del murare degli antichi e le loro simmetrie; e parvegli conoscere un certo ordine di membri e d'ossa".
31. S. Ray, *L'architettura di Brunelleschi e l'idea di "antico" nella cultura fiorentina del primo quattrocento*, in *Filippo Brunelleschi...*, cit. [cf. note 5], II, pp. 381-388: p. 386.
32. G.C. Argan, *The Architecture of Brunelleschi and the Origins of Perspective Theory in the Fifteenth Century*, in "Journal of the Warburg and Courtauld Institutes", 9, 1946, pp. 96-121.
33. E. Luporini, *Brunelleschi: forma e ragione*, Milan 1964.
34. Bruschi, *Filippo Brunelleschi*, cit. [cf. note 8], p. 53.
35. Giorgio Vasari, *Le Vite de' più eccellenti architetti, pittori, et scultori italiani, da Cimabue insino a' tempi nostri: nell'edizione per i tipi di Lorenzo Torrentino, Firenze 1550*, ed. by L. Bellosi and A. Rossi, Turin 1986, p. 236. "Filippo Brunelleschi la architettura ritrovò le misure e le proporzioni degli antichi così nelle colonne tonde come ne' pilastri quadri e nelle cantonate rustiche e pulite, et allora distinse ordine per ordine e fecisi vedere la differenza che era tra loro" [all translations are mine unless otherwise indicated].
36. H. Klotz, *Filippo Brunelleschi: The Early Works and the Medieval Tradition*, New York 1990.
37. Cohen, *Beyond Beauty...*, cit. [cf. note 9], p. 209.
38. C. Thoenes, "Spezie" e "ordine" di colonne nell'architettura del Brunelleschi, in *Filippo Brunelleschi, la sua opera...*, cit. [cf. note 5], II, pp. 459-469: p. 465.
39. R. Pane, *La sintassi del Brunelleschi fra il linguaggio dell'antico e l'eredità medioevale toscana*, *ibid.*, II, pp. 357-379: p. 362.
40. Cohen, *Beyond Beauty...*, cit. [cf. note 9], p. 29.
41. Vitruvius, *De architectura*, III, I, 1. All references to Vitruvius, *De architectura*, refer to book, chapter and section. Hereafter cited in the text.
42. Vitruvius, *On Architecture*, trans. by Frank Granger, 2 vols., Cambridge 1931, I, p. 159. Hereafter cited in the text.
43. L. Bosman, *Proportion and Building Material, or Theory versus Practice in the Determination of the Module*, in "Architectural Histories", 3, 1, 2015, pp. 1-10: p. 2.
44. G. Morolli, *La lingua delle colonne. Morfologia, proporzioni e semantica degli ordini architettonici*, Florence 2013, p. 41.
45. Bosman, *Proportion and Building Material...*, cit. [cf. note 43], p. 4.
46. Cohen, *Beyond Beauty...*, cit. [cf. note 9], p. 185.
47. *Ibid.*, p. 53.
48. *Ibid.*; Bruschi, *Filippo Brunelleschi*, cit. [cf. note 9], p. 113.
49. G. Morolli, *Donatello: immagini di architettura. Un classico cristiano tra Roma e Costantinopoli*, Florence 1987, p. 53; Bruschi, *Filippo Brunelleschi*, cit. [cf. note 8], pp. 102, 108.
50. Vasari, *Le Vite...*, cit. [cf. note 35], p. 299: "tornare a luce la buona architettura".
51. A. Bruschi, *Fonti del linguaggio brunelleschiano: appunti sulla componente romana*, in *Filippo Brunelleschi, la sua opera...*, cit. [cf. note 5], II, pp. 389-440: p. 403.
52. Morolli, *Donatello: immagini di architettura...*, cit. [cf. note 49], p. 53.
53. V. Hoffmann, *L'origine del sistema architettonico del Brunelleschi*, in *Filippo Brunelleschi, la sua opera...*, cit. [cf. note 5], II, pp. 447-458: p. 451.
54. J.T. Paoletti, *Donatello's Bronze Doors for the Old Sacristy of San Lorenzo*, in "Artibus et Historiae", 11, 21, 1990, p. 39.
55. E. Battisti, *Filippo Brunelleschi*, London 2012, p. 355.
56. Cohen, *Beyond Beauty...*, [cf. note 9], p. 156. See also Id., *Face to Face with the Angels. The Early Sculpted Friezes (ca. 1446-1450) of the Basilica of San Lorenzo*, in *San Lorenzo...*, cit. [cf. note 19], pp. 330-351: p. 343.
57. Manetti, *Vita di Filippo Brunelleschi...*, cit. [cf. note 29], p. 116: "attendeva solamente a fare fare le mura principali, e la rispondenza di qualche membro, senza ornamenti o modi di capitelli o d'architravi, fregi e cornice" ecc.
58. This hypothesis was formulated by Prof. Gabriele Morolli during a discussion we had circa 2012.
59. Bruschi, *Filippo Brunelleschi*, cit. [cf. note 8], p. 73.
60. Bruschi, *Fonti del linguaggio...*, cit. [cf. note 51], II, p. 399.
61. G. Morolli, *Non solo Brunelleschi: San Lorenzo nel Quattrocento*, in *San Lorenzo*, ed. Timothy Verdon, Florence 2007, pp. 59-109.
62. M. Trachtenberg, *Some Issues of Materiality and Façade in San Lorenzo, Brunelleschi, and Florentine Early Renaissance Architecture*, in *San Lorenzo...*, cit. [cf. note 19], pp. 293-319: p. 312.
63. Cohen, *Beyond Beauty...*, cit. [cf. note 9], p. 31.
64. *Ibid.*, p. 123.
65. Morolli, *Non solo Brunelleschi...*, cit. [cf. note 61].
66. Bruschi, *Filippo Brunelleschi*, cit. [cf. note 8], p. 115.
67. G. Aroni, *Gli ordini architettonici di San Lorenzo a Firenze, 1420-1490. Analisi morfologica e proporzionale tramite fotoraddrizzamento*, Milan-Udine 2016.
68. G. Morolli, *I due tempi del cantiere di Cosimo*, in *San Lorenzo 393-1993...*, cit. [cf. note 12], pp. 53-58: p. 55.
69. Bruschi, *Filippo Brunelleschi*, cit. [cf. note 8], p. 139.
70. Morolli, *Non solo Brunelleschi...*, cit. [cf. note 61], p. 68.
71. Wittkower, *Brunelleschi...*, cit. [cf. note 1], pp. 275-291.
72. Cohen, *Beyond Beauty...*, cit. [cf. note 9].
73. A. Bruschi, *L'antico, la tradizione il moderno. Da Arnolfo a Peruzzi, saggi sull'architettura del Rinascimento*, ed. by M. Ricci and P. Zampa, Milan 2004, p. 20.
74. Vasari, *Le Vite...*, cit. [cf. note 35], p. 292: "ci fu donato dal cielo per dar nuova forma alla architettura, già per centinaia d'anni smarrita".