# Beyond beauty : reexamining architectural proportion in the Basilicas of San Lorenzo and Santo Spirito in Florence

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## 3. Sets of Proportions in the Overall Basilica of San Lorenzo (including the Old Sacristy)

Unlike the nave arcades, which are composed of clearly defined, essentially two-dimensional repeating bays that are conducive to proportional analysis, the basilica as a whole at first appears to lack overall proportional order. The body of the basilica consists of a jumble of chapels of different shapes and sizes, two non-identical sacristies, and an assembly of zigzagging exterior walls that, taken together, are more suggestive of haphazard accretion than comprehensive design (see Figure 2-1). Indeed, Manetti's warning that "...to judge [this work] as Filippo's would be to judge falsely, because his greatness is not in it" would seem to imply that some problem of execution impeded realization of a single vision.[1] An overall basilica set of proportions comes to light, however, with a slight methodological modification.

### 3.1 Methodology

Since the most important dimensions of the overall basilica are not repetitious, we can no longer insist that to be considered intentional, a proportion must correspond to the measurements within statistically established tolerances. In the nave arcade bays, for example, a discrepancy of more than 2 cm between a proportional relationship under consideration and the actual measurements was cause for concern, because statistics established that masons built the nave arcade bays within that degree of accuracy (at least in the earlier phase of nave construction). With regard to the overall basilica, however, we have no way to determine how large a discrepancy between a particular proportion and the actual measurements warrants concern. Consequently, a different approach to the overall basilica is needed. In the analysis that follows, we will round off dimensional irregularities more freely than before in search of evidence of proportional logic resembling that of the nave arcade bay set of proportions. Consistent with the Part I methodology, historical explanations will be provided for the rounded-off dimensions, and virtually every centimeter will be accounted for in the end.

### 3.2 Proportional Building Blocks

This strategy of temporarily rounding off dimensions makes possible an important observation: while the basilica floor plan lacks *dimensional* modularity, it displays a notable degree of *conceptual* modularity, for the main cruciform spine consists of eight large *approximate* squares (Figure 3-1). The widest part of this spine, the transept, contains the key to unlocking the overall basilica set of proportions. Measured pilaster plinth to pilaster plinth, the transept is slightly trapezoidal, tapering from 65.46 br (3820.0 cm) along the top edge, to 65.01 br (3794.1 cm) along the bottom (see Figures 3-2; and Figure 2-1, SP 25 to SP 50, and SP 15 to SP 60). Transept distortions such as this could represent intentional “architectural refinements,” in this case perhaps motivated by acoustical concerns.[2] Of interest here is the smaller dimension, which exceeds 65 br by a negligible 7 mm. The number 65, when paired with 92, approximates the ratio 1:√2 within 0.08%.[3] Significantly, the length of the nave, measured pilaster plinth-to-pilaster plinth, extends 92.65 br (5407.3 cm) along the left arcade, and 92.71 br (5410.4 cm) along the right (see Figures 3-3; and Figure 2-1, FP 4 to FP 2, and FP 7 to FP 9). If we temporarily round off the transept width to a consistent 65 br, and the nave length to 92 br, these new numbers imply a closely approximated root-2 rectangle superimposed over the nave (Figure 3-4). Although the nave does not completely fill this rectangle, it would if the nave chapels had been made twice as deep as the present ones, as shown in a sketch of c.1480 by a follower and younger contemporary of Brunelleschi, Giuliano da Sangallo (Figure 3-5).[4]

According to Manetti, when Giovanni de’ Medici was unable to find patrons for more than eight private chapels, he directed Brunelleschi to remove all the nave chapels that he had envisioned and Brunelleschi complied “unwillingly, because it seemed to him a miserable thing….”[5] Comparing the floor plan scheme that Brunelleschi probably intended (see Figure 3-5, minus Sangallo’s hypothetical portico and second sacristy) with the one he was forced to accept (see Figure 3-5, minus the portico, second sacristy, and deep nave chapels), we can appreciate Brunelleschi’s unhappiness. Not only did the nave become spatially constricted, but the root-2 rectangle proportional framework became irrelevant (see Figure 3-4, minus the nave chapels). Manetti, for his part, appears to have been equally unhappy with the *present* nave chapels, added after 1457 (see Figure 3-4).[6] His lament that “…the body of the church, from the transept downward [i.e., the nave]…although beautiful, does not conform to the aforesaid transept,” implies that he, and therefore presumably Brunelleschi, would have preferred deeper and taller nave chapels identical in design to the transept chapels (see Figure 3-5).[7]

Returning now to the eight approximate squares in question (Figure 3-1), note that the dimensions that make them up, all measured plinth-to-plinth, converge around the whole number 19 (see Figure 3-6). The east-west spine of the basilica, which is composed of the high altar chapel, crossing square, and nave, varies in width from 18.88 br (1102.0 cm) to 18.96 br (1106.7 cm); the depth of the transept varies from 19.14 br (1117.1 cm) to 19.19 br (1119.8 cm); and the depth of the high altar chapel varies from 18.99 br (1108.3 cm) to 19.0 br (1108.8 cm).[8] For now let us round off all of these dimensions to 19 br even and describe the nave as 19 br wide, the transept as 19 br deep, and both the crossing square and high altar chapel as 19 br square. Thus, the total length of the basilica equals 130 br (calculated as the sum of the rounded-off high altar chapel depth, 19 br; transept depth, 19 br; and nave length, 92 br; but excluding the thicknesses of the crossing piers), or twice the transept width of 65 br. In plan, therefore, an overall proportional framework of two squares, each 65 br per side, is conceptually implied (Figure 3-7).

The four whole numbers derived thus far, 19, 65, 92 and 130, are closely interrelated through the mediation of three additional numbers, also found among the basilica dimensions, 27, 38, and 46.[9] The difference between 65 and 19 is 46 (65 - 19 = 46), or, half of 92 (92 ÷ 2 = 46). Twice 65, or, 130, minus 92, equals 38 (130 - 92 = 38), which is twice 19 (19 + 19 = 38). The difference between 92 and 65 is 27 (92 - 65 = 27), a number that, when paired with 19, produces yet another side/diagonal approximation pair, 19:27, this one accurate within 0.48%.[10] I will term these seven numbers the "65 Group" because they can all be derived from a square measuring 65 per side.[11]

## 3.3 Reconstruction of the Basilica Design Process

These basic geometrical and numerical building blocks imply that a logical, step-by-step design process can produce the overall basilica design that we see today. A detailed explication of that proposed reconstruction follows. While there is no way to know whether the designer of the overall basilica set of proportions proceeded exactly as proposed below, this attempt to retrace his design process suggests that the number of logical ways in which he could have arrived at the present design solution is finite, and that he must have encountered many, if not all, of the problems encountered in the reconstruction below. The following proposed reconstruction of the design process is continued by the proposed reconstruction of the basilica construction process, in Chapter 4 ("4. The Construction History of the Fifteenth-Century Basilica of San Lorenzo: A Proposed Narrative").

### Step 1: Compose Schematic Diagram

A proposed reconstruction of the design process that might have produced the present overall design of the Basilica of San Lorenzo begins with a two-square rectangle measuring 65 br by 130 br (Figure 3-7).

### Step 2: First Subdivision of Schematic Diagram

The two-square rectangle is then evenly subdivided into eighteen identical smaller squares (Figure 3-8).

Step 3: Second Subdivision of Schematic Diagram

Ten of these eighteen smaller squares are then subdivided into four squares each such that a cruciform area composed of eight un-subdivided squares remains between them (Figure 3-9). Comparing this diagram with the Sangallo plan, imagined shorn of all its appendages (Figure 3-5), we see that some of the smallest squares are destined to become chapels, others side aisle bays, and others, to be removed.

Step 4: Incorporate Dimensions from the 65 Group

When we attempt to assign dimensions selected from the 65 group to this diagram, we find that some of them are not commensurable with it. We can set the overall width and length equal to 65 br and 130 br without any problem (Figure 3-9), but if we want the future nave portion of the diagram to measure 92 br in length, we must stretch that portion slightly within the double square perimeter (Figure 3-10). We can then evenly redistribute the remaining 38 br into two horizontal bands of 19 br each, one corresponding to the depth of the transept and crossing square, and the other to the depth of the high altar chapel (Figure 3-10). In order to keep the crossing square truly square, not rectangular, we must also move the two vertical lines that delineate the central spine of the basilica closer together, from $21\frac{2}{3}$ br (Figure 3-9) to 19 br apart (Figure 3-10).

The preceding transformation leaves a 23 br wide vertical strip on each side of the central spine, where the transept chapels, side aisles, and nave chapels will go. Note that the sum of these widths is 46 br (23 + 23 = 46), one of the numbers of the 65 group. Also note that now the crossing square and high altar chapel areas both measure 19 br square, as we intended, but that the transept arms, which were square in our previous diagram (Figure 3-9), now measure 19 br x 23 br (Figure 3-10). The central portion of the nave, which in our previous diagram was composed of four squares (Figure 3-9), is now composed of four 19 br x 23 br rectangles (Figure 3-10). As for the future nave arcades, our diagram now contains an on-center intercolumniation of $11\frac{1}{2}$ br (Figure 3-10), which is $\frac{1}{6}$ br smaller than the $11\frac{2}{3}$ br that will be needed to establish the $9\frac{2}{3}$ br plinth to plinth distance, measured between 2 br square plinths, that is called for by the nave arcade bay set of proportions.

Step 5: Insert Column Plinths and Crossing Pier Cores

Next we insert the nave columns and the engaged square columns (or wrap-around pilasters), each of which stands on a 2 br-square square plinth. In this step we also insert the 2 br-square crossing pier cores (to which we will later attach the crossing pilasters). We begin by inserting the four crossing pier cores, and immediately confront the question of where exactly to place them. If we place them on center, the crossing square will no longer measure 19 br square between the cores but rather, 17 br square (for now ignoring the projections of the yet-to-be inserted crossing pilaster plinths). Therefore we will place these piers at the outside corners of the crossing square, such that they do not encroach into it (Figure 3-11, intersections of lines C, D, O, and P). Next we insert the nave columns, on their 2 br square plinths, such that they are evenly spaced and in alignment with the crossing pier cores (Figure 3-11, lines C and D). Finally, we mark all four corners of each future nave and transept chapel with square columns, also on 2 br square plinths (Figure 3-11, lines A, B, E, F, P, Q, and R).

As we insert these elements into the floor plan diagram, we must take care to place them such that the key dimensions of 19 br, 65 br, 92 br, and 130 br can be measured between them. Thus, the plinths that demarcate the 65 br x 130 br perimeter of the diagram are arranged *outside* that perimeter (Figure 3-11, lines A, F, G, and R), while the plinths that mark the future nave chapel openings (Figure 3-11, rows B and E) are arranged as shown in order to maintain square nave chapels and side aisle bays.

Step 6: Break Schematic Diagram Into Three Parts

We now encounter three problems in the floor plan diagram. First, the future nave now measures only 90 br long, plinth to plinth, rather than 92 br as we intended (Figure 3-12, O-G). Second, the future high altar chapel now measures only 17 br deep, plinth to plinth, rather than 19 br (Figure 3-11, P-R). Third, the four future transept chapels flanking the high altar chapel now measure only $7\frac{1}{2}$ br deep, plinth to plinth (Figure 3-11, P-Q), while the future nave chapels all measure $9\frac{1}{2}$ br deep (Figure 3-11, bays A-B and E-F). The first conflict is particularly serious, for without the 92 br dimension there can be no 65 br x 92 br approximate root-2 rectangle superimposed over the nave, the 65 group loses one of its key members, and the overall basilica set of proportions loses much of its geometrical and numerical significance.

There would seem to be but two possible resolutions to these conflicts: 1) switch to an on center measuring system, such that the thicknesses of the structural members become inconsequential, or 2) break up the floor plan diagram into three parts, separated by 2 br wide gaps to accommodate the crossing pier cores (Figure 3-12, rows O and P). The first solution might seem the more logical of the two, since the second solution merely spares the 92 br nave length at the expense of the 130 br overall length, which must elongate to 134 br (Figure 3-12). Nevertheless, the second solution is the one the architect appears to have chosen, and thus the one that we will reconstruct here.

Step 7: Shift Cylindrical and Square Nave Columns 1 br Toward the Transept

Breaking the diagram into three parts introduces a significant asymmetry into the nave portion of it. The nave bays adjacent to the transept become $11\frac{1}{2}$ br wide, plinth to plinth (Figure 3-12, bay N-O), while all the others remain $9\frac{1}{2}$ br wide. We can mitigate this problem by shifting all forty-two cylindrical and square columns in the nave between but not including lines G and O in Figure 4-12 toward the transept by 1 br (Figure 3-13). This shift creates $10\frac{1}{2}$ br wide bays, plinth to plinth, at both the eastern and western ends of the nave (Figure 3-13, bays G-H and N-O), while all the bays in between remain at $9\frac{1}{2}$ br wide. This new arrangement may be considered an improvement over the previous one because now the nave is symmetrical, and because the maximum variation among the nave bay widths is only 1 br (because $10\frac{1}{2} - 9\frac{1}{2} = 1$), rather than 2 br as before ($11\frac{1}{2} - 9\frac{1}{2} = 2$).

Step 8: Insert Walls

Next we connect the square columns and crossing pier cores with interior and exterior walls to enclose the basilica and form the chapels. This process is guided by the following six rules: 1) all column plinths measure 2 br square; 2) all pilaster plinths measure 2 br wide and project $\frac{1}{2}$ br from wall surfaces; 3) all pilaster shafts measure $1\frac{1}{2}$ br wide and project either $\frac{1}{4}$ br (one flute) from walls, or $\frac{1}{2}$ br (two flutes) from other pilaster shafts[12]; 4) the four crossing piers conceptually consist of 2 br-square cores to which are variously attached crossing pilasters and high altar chapel walls; 5) all interior walls, excluding the two side walls of the high altar chapel, measure 1 br thick; and 6) all exterior walls, including the two side walls of the high altar chapel, measure $1\frac{1}{2}$ br thick.

The walls, once inserted, impact the footprints of the square columns and crossing pier cores in a variety of ways. At the back corners of all the chapels, the square columns become almost completely engulfed by the walls such that only corner slivers, one flute wide on each side, remain exposed (Figure 3-14). At the entrances to the nave and transept chapels, the square columns remain fully exposed except where the chapel walls plug in from behind. Furthermore, a new irregularity now appears: the two side walls of the high altar chapel, which according to the above-noted rules must measure $1\frac{1}{2}$ br thick, join their respective crossing pier cores off-center (Figure 3-14, intersections of C, D, and P). Also note that we must remove the two square columns that would have been partially visible in the middle of each side wall of the high altar chapel (Figures 3-13 and 4-14, intersections of lines C, D, and Q)

Step 9: Insert Crossing Pilasters and Miscellaneous Pilasters

Next we insert the crossing pilasters and a few other pilasters needed to maintain the visual and/or structural logic of the classical vocabulary of the basilica (Figure 3-15, arrows). Note that when we attach pilasters to all four sides of the crossing piers, the footprints of those piers become Greek cross-shaped and each pier footprint grows to 3 br in total width (Figure 3-15). Also note that since the walls of the high altar chapel plug into the backs of two of the crossing piers off-center (Figure 3-14), those piers now contain three full pilasters and one sliver pilaster each (Figure 3-15). To the interior façade at the east end of the basilica we add clusters of pilasters to symmetrically reflect the clusters of crossing pier pilasters at the west end of the nave (Figure 3-15, row G, at C and D). We add similar clusters to the interior façade at the locations marked B and E in Figure 3-15 so that the widths of the easternmost nave chapels and nave arcade bays will all be consistent at 10 br, plinth to plinth (Figure 3-15, bay G-H). Note that in this step the crossing piers, in addition to receiving the attenuated major order crossing pilasters, also receive several minor order pilasters (Figure 3-15, arrows; and Figure 2-1: FP 4, FP 5, FP 6, FP 7, and SP 33, SP 42).

These new pilasters introduce subtle dimensional changes into the floor plan, some of which may be considered beneficial because they help to smooth out the dimensional irregularities that appeared in Figure 3-14. Note, for example, that six of the eight nave arcade bay or nave chapel openings that measured $10\frac{1}{2}$ br plinth to plinth in Figure 4-14 now measure 10 br (Figure 3-15), which is closer to the $9\frac{1}{2}$ br norm. This improvement is uneven, however, for the two nave chapels nearest the transept remain $10\frac{1}{2}$ br wide, in awkward juxtaposition with the nave arcade bays directly in front of them, which now measure 10 br (Figure 3-15, bay N-O).

Other pilasters added in this step may be considered detrimental to the clarity of the set of proportions. Four of the pilasters attached to the crossing piers, for example, reduce the widths of the adjacent bay openings to 9 br, which is $\frac{1}{2}$ br less than the norm (Figure 3-15, bays B-C and D-E). More significant, four of the newly inserted crossing pilasters introduce the dimension 18 br plinth to plinth in the vicinity of the crossing square, disrupting the consistent appearance of 19 br as our diagram had shown until now (Figures 3-14 and 3-15). Although the crossing square itself still measures 19 br square (since the plinths of the newly-inserted crossing pilasters do not encroach into the 19 br x 19 br square that can be inscribed between the corners of the crossing pier cores; see Figure 3-15), this prominent introduction of the dimension 18 br into the basilica floor plan, like the extension of the total length of the basilica to 134 br, may be considered a significant flaw in the San Lorenzo overall basilica set of proportions.

Step 10: Insert Nave Arcade Bay Set of Proportions

At this stage in our reconstruction, the two San Lorenzo sets of proportions—the nave arcade bay set of proportions, and the overall basilica set of proportions—would seem to be fundamentally incompatible with one another. The nave arcade bay set of proportions is expansive. It is based on an inflexible proportional unit composed of an overlapping square, root-2 rectangle and dual diagon measuring $13\frac{2}{3}$ br in total width (or $9\frac{2}{3}$ br plinth to plinth).[13] This unit cannot be reduced in size, but it can be extended through replication. Conversely, the overall basilica set of proportions is reductive. It is based on an inflexible proportional unit composed of a perimeter rectangle measuring 65 br x 130 br. While extension of this unit through replication would be impractical due to its large scale, it can be reduced into smaller units through subdivision.

A conflict between the two sets of proportions seems unavoidable. According to the overall basilica set of proportions a nave length of 92 br (measured plinth to plinth) is needed to produce a closely-approximated root-2 rectangle expressed with two numbers from the 65 group, 65 br x 92 br (Figures 3-10 and 3-15). We now see, however, that this nave length must be produced *both* through replication of the basic unit of the nave arcade bay set of proportions (Figures 3-2 and 3-34) *and* through subdivision of the perimeter rectangle of the overall basilica set of proportions (Figures 3-7 to 3-14). Only by a fantastic coincidence, it would seem, could such a confluence of dimensions come about; and indeed, such a coincidence very nearly occurs. Since the nave arcades each contain eight bays and terminate with $\frac{1}{2}$ br pilaster plinth projections at both ends, according to the nave arcade bay set of proportions the total nave length must measure $92\frac{1}{3}$ br, as the following component-by-component addition demonstrates (refer to floor plan, Figure 2-1):

$$\frac{1}{2} + 9\ 2/3 + 2 + 9\ 2/3 + 2 + 9\ 2/3 + 2 + 9\ 2/3 + 2 + 9\ 2/3 + 2 + 9\ 2/3 + 2 + 9\ 2/3 + 2 + 9\ 2/3 + \frac{1}{2} = 92\frac{1}{3}.$$

The overall basilica set of proportions thus far, however, produces a nave exactly 92 br long (refer to Figure 3-15):

$$\frac{1}{2} + 10 + 2 + 9\frac{1}{2} + 2 + 9\frac{1}{2} + 2 + 9\frac{1}{2} + 2 + 9\frac{1}{2} + 2 + 9\frac{1}{2} + 2 + 9\frac{1}{2} + 2 + 10 + \frac{1}{2} = 92.$$

Note that the *average* plinth to plinth dimension produced by the overall basilica set of proportions is $9\frac{5}{8}$ br (9.625 br), or, a mere $\frac{1}{24}$ br (2.43 cm) per bay less than the plinth to plinth dimension specified by the nave arcade bay set of proportions, $9\frac{2}{3}$ br (9.667 br).[14] The architect, therefore, again faced a choice: either compress each nave arcade bay by $\frac{1}{24}$ br in order to maintain a precise 92 br nave length, or stretch the nave by $\frac{1}{3}$ br in order to maintain precise $9\frac{2}{3}$ br plinth to plinth distances. My measurements indicate that he chose the latter course.[15] Perhaps he felt that to compromise the nave length by $\frac{1}{3}$ br would be a small price to pay to ensure that each nave arcade bay, with its mathematically precise set of proportions, would continue to measure exactly $9\frac{2}{3}$ br plinth to plinth, and not $\frac{1}{24}$ br less. Better to compromise the overall basilica set of proportions just a bit more, he must have reasoned—for he had already stretched the total basilica length from 130 br to 134 br (see Step 6, above)—than to compromise the nave arcade bay set of proportions at all.

In light of this analysis, the next step in our reconstruction is to remove the plinth to plinth dimensions of the nave arcades shown in Figure 3-15, and replace them with those of the nave arcade bay sets of proportions, as shown in Figure 3-16. The length of the nave now increases from 92 br to $92\frac{1}{3}$ br, and the total length of the basilica increases from 134 br to $134\frac{1}{3}$ br. A variety of smaller dimensional adjustments also become necessary. First, the square columns that stand between all the nave chapels must be shifted to align with the nave columns opposite them (Figure 3-16). One result of these adjustments is the reduction of the widths of the two nave chapel openings nearest the transept from $10\frac{1}{2}$ br to $10\frac{1}{6}$ br (Figure 3-16, bay N-O). Next, in order to maintain square proportions in each side aisle bay, the widths of the side aisles must be increased to $9\frac{2}{3}$ br (Figure 3-16, bays B-C and D-E). These adjustments reduce the depths of the nave chapels from $9\frac{1}{2}$ br, to $9\frac{1}{3}$ br (Figure 3-16, bays A-B and E-F). Furthermore, this new nave chapel depth of $9\frac{1}{3}$ br carries through to the *widths* of the two outermost transept chapels (Figure 3-16, bays A-B and E-F). These various adjustments also increase the widths of the two transept chapels that flank the high altar chapel, from 9 br, to $9\frac{1}{6}$ br; and to the portals opposite them that lead to the side aisles (Figure 3-16, bays B-C and D-E, at O and P).

The last three new dimensions noted here, $10\frac{1}{6}$ br, $9\frac{1}{3}$ br, and $9\frac{1}{6}$ br may seem impossibly obscure, but examples of all of them are found in the actual basilica measurements today, in the locations indicated in Figure 3-17. Let us look at a few of them, bearing in mind that not all the basilica measurements correspond to our reconstruction due to complex overall dimensional irregularities, such as the slight splaying of the transept width, that we have yet to examine in detail.[16] Note that the westernmost nave chapel opening on the south side (Figures 3-17; and 2-1, SP 9-SP 10) today measures 592.7 cm wide plinth to plinth, which is just 0.6 cm larger than the $10\frac{1}{6}$ br that our reconstruction predicts (Figures 3-16).[17] Nearby, the portal that leads from the left side aisle into the transept (Figure 2-1, SP 10-FP 5), measures 533.9 cm, which is just 1 cm less than the $9\frac{1}{6}$ br that our reconstruction predicts (Figures 3-16 and 3-17). Finally, the Nelli Chapel opening (Figure 2-1, SP 47-50) measures 546.7 cm, which is just 2 cm greater than the $9\frac{1}{3}$ br that our reconstruction predicts (Figures 3-16 and 3-17).

Before proceeding further with this reconstruction, we must now reckon up all those centimeters that we rounded off at the start of this analysis.[18] From our reconstruction thus far, four significant floor plan discrepancies can be identified, two in width and two in length. Though not all of their causes are clear, some of these discrepancies have characteristics that suggest systematic and intentional deviations from our reconstructed dimensions.

Floor Plan Discrepancy #1: Central Spine Width and Transept Arm Asymmetry

We have seen that the width of the east-west central spine of the basilica (the widths of the high altar chapel, crossing square, and nave) measures about 18.9 br, rather than the 19 br that our reconstruction calls for (Figure 3-6). We can precisely analyze this discrepancy as follows (refer to Figure 3-18): Note that the width of the right transept arm, measured along the eastern edge of the transept to include the width of one crossing pier core, measures just 0.6 cm less than the 23 br called for by our reconstruction (actual dimension: 1341.7 cm). The 18.9 br crossing square width is 5.1 cm less than the expected 19 br (actual dimension: 1103.7 cm). The left transept arm measures 23.11 br in width, or, 6.4 cm greater than the 23 br that our reconstruction calls for (actual dimension: 1348.7 cm). Furthermore, let us now recall that the total transept width, measured along the edge nearest the nave, is a mere 0.7 cm greater than 65 br (actual dimension: 3794.1 cm).[19] Let us assume that this excess 0.7 cm was added as part of a construction error involving the left transept arm, the only component of the total transept width that is larger than our reconstruction calls for. If we subtract 0.7 cm from the width of the left transept arm (thus accepting it as a construction error and removing it, for now, from our discussion in order to make the total transept width exactly 65 br), that left arm now becomes only 5.7 cm too wide (because 6.4 cm—0.7 cm = 5.7 cm). Since the crossing square width, 18.9 br, is 5.1 cm too narrow relative to 19 br, only 0.6 cm of excess width in the left transept arm remains to be accounted for (because 5.7 cm—5.1 cm = 0.6 cm). This excess width is precisely compensated by the 0.6 cm *deficiency* in the width of the right transept arm, noted above.[20]

We may conclude from this analysis that the entire south (left) side of the central spine, including the south wall of the high altar chapel, the two southern crossing piers, and the south nave arcade, has been shifted about 5 cm north of where it is supposed to be (Figure 3-18, line D). Furthermore, the entire row of square columns one bay south of this line appears to have been shifted along with it by nearly the same distance (Figure 3-18, line E). This second shift is evidenced by the width of the arched portal that leads from the transept to the south side aisle: The width of this portal, as we have seen, does not measure 5 cm *greater* than $9\frac{1}{6}$ br, as we would have expected had this row not been shifted north. Rather, it measures 1.1 cm *less than* $9\frac{1}{6}$ br (actual dimension: 533.9 cm; Figure 3-17). Apparently the builders, in shifting this row of square columns (Figure 3-18, line E) north in order to keep it the correct distance from the neighboring row of crossing piers and cylindrical columns (Figure 3-18, line D), went 1.1 cm too far.

The reason for these apparent northward shifts of two entire rows of vertical supports in the basilica by the minute distances in question is unknown. Construction error, though possible, seems unlikely given both the importance of the crossing square dimensions, and the great dimensional accuracy achieved by the masons elsewhere in the transept. Equally unlikely seems the possibility that the masons sought firmer footing for the south crossing piers. Soil characteristics would not differ significantly over such small distances, and in any case, the masons could have made the crossing pier foundations, which are not visible above ground, as large as they wanted without necessitating a shift of a few centimeters in the above-ground locations of the piers that they support.[21] The question remains unresolved.

## Floor Plan Discrepancy #2: Splayed Transept

Earlier I noted that the transept gradually decreases in width, from 65.46 br (3820.0 cm) along the western edge, to 65.01 br (3794.1 cm) along the eastern edge, for a difference of 25.9 cm (Figure 3-2). We can now determine that this slightly trapezoidal shape is also slightly asymmetrical, as follows (refer to Figures 3-2 and 3-19): First, moving along the eastern edge of the transept from north to south (see Step 1, Figure 3-19), we cross the 23 br-wide north transept arm, and continue another $9\frac{1}{2}$ br southward, to the point that would have marked the central axis of the basilica had the central spine measured exactly 19 br plinth to plinth (because 19 br ÷ 2 = 9.5 br). Thus, we move a total of $32\frac{1}{2}$ br (or half of 65 br) to the south. Next we draw an assumed lengthwise central axis through this point and measure the north transept arm from it, but this time measuring along the wider, western edge of the transept (see Step 2, Figure 3-19). Finally, we subtract this distance from the total width of the western edge of the transept to obtain the width of the south transept arm along this edge. These measurements reveal that the southwest corner of the transept extends to the south 17.4 cm beyond the orthogonal, while the northwest corner extends to the north only 9.2 cm beyond the orthogonal.[22]

## Floor Plan Discrepancy #3: Transept Depth

The depth of the transept measures approximately $19\frac{1}{6}$ br, with a maximum variation of just 2.7 cm along the full north-south width of the transept (Figure 3-6). This approximately $\frac{1}{6}$ br (about 10 cm) deviation from the 19 br that we expected to find seems too large and consistent to be a product of construction error, but the reason for it is unknown. It is perhaps related to the former location of the old campanile (see Chapter 4).[23]

Floor Plan Discrepancy #4: Nave Length

This reconstruction first called for a nave length of 92 br (Figure 3-15), and then $92\frac{1}{3}$ br (Figure 3-16). My measurements, however, reveal that the actual nave length is longer still, varying from about $92\frac{2}{3}$ br along the south nave arcade, to nearly $92\frac{3}{4}$ br along the north arcade (Figure 3-3). Where do these excess nave arcade lengths—18.6 cm in the south arcade and 21.8 cm in the north—come from? A component-by-component analysis of the nave dimensions indicates that they are the cumulative results of numerous minute discrepancies distributed over the length of each arcade, primarily concentrated in the eastern four bays.[24] All but two of these discrepancies appear to be the results of construction error. Those two exceptions occur in the easternmost bay of each nave arcade, in which the plinth to plinth distances are more than 10 cm wider than the others (Figure 3-17). Such large discrepancies suggest intentional enlargement of that last nave bay, though for what reason is unknown. The nave length measurements are analyzed in two spread sheets shown in Figure 3-20. The first compares reconstructed (expected) total nave lengths against actual total nave lengths, the latter having been recorded in single readings from a long tape measure. The second compares reconstructed component dimensions against actual component dimensions, and thus allows us to pinpoint the locations of discrepancies distributed within the total dimensions. These discrepancies are also plotted in the two bar charts in Figure 3-20. Note the very large excess nave arcade bay widths in the easternmost bay of each arcade, labeled measurement line 16 in the spread sheets and bar charts. In theory the total nave lengths and the sum of the corresponding component measurements should be identical, but small discrepancies nevertheless appear (labeled "error" at the bottom of the second spread sheet), probably due to a combination of decimal rounding and measurement error in the present analysis.

These bar charts and spread sheets tell us that some of the nave length component dimensions are smaller than expected, most are larger (especially those at measurement line 16; see Figure 3-20), and that the sum of all the discrepancies in each nave arcade accounts for all but a few millimeters of the nave arcade length that exceeds $9\frac{1}{3}$ br. Thus the south nave arcade measures 5407.3 cm, which exceeds the length we expected based on our reconstruction, 5388.6 cm ($92\frac{1}{3}$ br), by 18.7 cm. Our component-by-component dimensional analysis shows exactly where 18 cm of that 18.7 cm discrepancy comes from (Figures 3-17 and 4-20). While the remaining 0.7 cm may be attributed to measurement error, we must also attribute to measurement error the 1.2 cm discrepancy between the total nave length as measured in one go with a long tape measure along the south arcade, 5407.3 cm (Figure 3-3), and the total of all the component measurements of the same arcade, 5406.1 cm (Figure 3-17); since in theory the two should be identical. Alas, no dimensional analysis of a building of this scale will ever tally up to the last millimeter. Readers may similarly analyze the north arcade measurement data in the same manner on their own. We may conclude that although the overall basilica set of proportions called for a nave length of 92 br, the architect accepted a compromise length of $92\frac{1}{3}$ br, and construction error added another $\frac{1}{3}$ br to the south nave arcade and nearly $\frac{3}{4}$ br to the north nave arcade.

## 3.4 Cross-Section Proportions

Thus far in our reconstruction we have raised the design of the basilica of San Lorenzo to about half its intended height. We have laid out the floor plan in detail, not yet including the sacristy and double chapel appendages (Figure 3-16), and we have erected four pilaster-clad crossing piers of yet-to-be-determined heights at the corners of the crossing square. We have erected two rows of cylindrical columns in alignment with those piers to the east to delineate the nave, and two square columns to the west of them to mark the back corners of the high altar chapel (Figure 3-16, line C and D). We have erected two rows of square columns on each side of this central spine to mark out the rest of the basilica (Figure 3-16, lines A, B, E, and F), and we have connected these square columns and two of the crossing piers with walls to create exterior enclosure and interior chapels. Atop the cylindrical nave columns we have placed entablature blocks of heights specified by the nave arcade bay set of proportions, and we have spanned them with semi-circular arches that have archivolts measuring $1\frac{1}{2}$ br in face width, to match the column diameters below (Figures 2-2 and 2-34).

We can now fill in a few more pieces of the above-ground portions of the basilica, which our floor plan reconstruction automatically implies. Atop all of the square columns and the walls that interconnect them we now place a continuous entablature corresponding in height to the entablature blocks of the nave arcades (Figures 2-3 and 2-51). Springing from this entablature, above all the transept chapel openings, we place arches formed of archivolts measuring $1\frac{1}{2}$ br in face width, just like those of the nave arcades (Figures 2-3 and 2-51). We place similar arches above all the nave chapels, even though their archivolts will be mostly embedded in the tympana and vaults of the side aisles, such that only the edges will be visible (Figures 2-3, 2-51, and 3-16, lines B and E). All of the elements discussed thus far—cylindrical columns, square columns, entablature blocks, entablatures, and archivolts—belong to the minor order. To complete our reconstruction, which we left off at Step 10, let us push upward to establish the heights of the major order.

Step 11: Determine Upper Entablature Height According to the Root-2 Rectangle

The upper entablature is a broad, horizontal datum of *pietra serena* and plaster that circumscribes the cruciform central volume of the basilica (Figures 2-1 and 2-51). Since this entablature rests on the peaks of the nave arcade arches, the height of its lower edge is predetermined by the nave arcade bay set of proportions. We would expect that lower edge to occur $24\frac{1}{4}$ br, or 1415.2 cm, above the floor.[25] Indeed, my survey shows it to be quite close to this dimension, at 1411.8 cm.[26] The height to the *top* of this entablature, however, is not pre-determined by the proportions we have established thus far. Rather, it is determined by a large root-2 rectangle.

We have seen that the width of the nave, measured plinth to plinth where the nave arcades meet the crossing piers, is approximately 18.9 br, or approximately 1104.5 cm (Figure 3-6). A root-2 rectangle based on this dimension would rise 1562.0 cm (because $1104.5 \times \sqrt{2} = 1561.99\ldots$; Figure 3-21). The *actual* height of the top of the upper entablature is 1562.2 cm—a negligible discrepancy of 2 mm., or, 0.01%.[27] Note that a nave width of 19 br (1108.8 cm) plinth to plinth would have produced, based on the proportions of a root-2 rectangle, an upper entablature height of 26.87 br (1568.1 cm, or approximately $26\frac{4}{5}$ br). A third option the architect might have considered, however, would have been to set this height equal to 27 br, thereby approximating the proportions of a root-2 rectangle using two whole numbers from the 65 group, 19 and 27, and tying the proportions of the nave cross section to those of the Old Sacristy, as we will see.[28] The difference between these two options is 0.48%, or 7.6 cm (the same as the error in the 19:27 approximation), and thus large enough to have required a conscious choice between the two. In the actual construction we know that the *capomaestro* in charge chose the geometrical option, presumably because the numerical option was not available due to the 18.9 br nave width, which precluded the possibility of creating a true 19:27 ratio. Evidence suggesting that the architect originally intended the numerical option, however, is perhaps provided by the transept ceiling height, which measures exactly 38 br, a number that is closely related to 19 and 27 as part of the 65 Group discussed previously.[29]

Step 12: Determine Crossing Pilaster Heights

In its cruciform journey around the perimeter of the basilica, the upper entablature passes through all four corners of the crossing square. At these four points eight tall crossing pilasters appear to support it (Figure 2-1). These major order pilasters share all the dimensions of the minor order pilasters except the shaft height: the crossing pilaster capital height measures $1\frac{2}{3}$ br; the plinth width, 2 br; the combined plinth-plus-base height, $\frac{3}{4}$ br; and the shaft widths, $1\frac{1}{2}$ br. The architect appears to have determined the crossing pilaster shaft height simply by placing the plinth-plus-base assemblies at floor level, setting the capitals directly below the upper entablature, and stretching the fluted shafts between them—quite an elastic, medievalizing approach to proportioning the classical orders. Since four of the crossing pilasters stand at floor level, while the other four stand atop three steps, the crossing pilaster shaft heights vary considerably (Figure 2-1). The shaft height of Crossing Pilaster 1, for example, measures 1312.5 cm (22.49 br), while that of Step Crossing Pilaster 6 measures only 1250.1 cm (21.42 br).

Step 13: Add Upper Entablature

Since the upper entablature rests directly atop the nave arcade arches (Figure 2-3), we might expect it to rest directly atop the transept chapel arches, and the other minor order arches, as well (Figure 2-51). When we recall, however, that the nave arcade arches span plinth to plinth distances of $9\frac{2}{3}$ br, while the transept chapel arches, according to our reconstruction, span plinth to plinth distances of either $9\frac{1}{3}$ br or $9\frac{1}{6}$ br (Figure 3-16), we realize that since all the arches are semicircular, the transept chapel arches cannot be as tall as the nave arcade arches because they have smaller radii. If the upper entablature remains horizontal as it passes from the nave into the transept, therefore, we would expect gaps to appear between the tops of the transept chapel arches and the bottom of the upper entablature. We would expect those gaps to be of two different sizes: 9.7 cm above the $9\frac{1}{3}$ br chapels, and 14.6 cm above the $9\frac{1}{6}$ br chapels.[30] Gaps do indeed appear above the transept chapel arches, but not quite as large as anticipated, for two reasons. First, due to the slight splaying of the transept noted previously (Figures 3-2 and 3-19), most of the chapel openings flanking the high altar chapel were built slightly wider than our reconstructed dimensions, and the chapel arches are thus correspondingly taller (Figures 3-16 and 3-17). Second, my survey, combined with visual observations made from scaffolding, indicates that the upper entablature sags slightly as it enters the transept from the nave (Appendix 8.1). Today the gaps are filled with improvised–looking cushions of plaster and wood, perhaps placed there by the original masons.

Step 14: Determine Ceiling Height According to the Double Square

The crown molding that traces the perimeter of the wooden ceiling of the basilica has a complex profile, in the middle of which is a flat fascia oriented parallel to the floor. The distance between this fascia and the floor, measured in the left transept arm (the oldest portion of the basilica) is 2217.0 cm, or nearly exactly 38 br.[31] Thus, had the nave measured 19 br wide, as our reconstruction suggests the architect originally intended, the height of the nave would have measured exactly twice the width, and the nave cross section would have conformed to the proportions of a two-square rectangle (in Figure 3-22). This two-square rectangle, furthermore, would have precisely overlapped with the bottom and sides of the root-2 rectangle shown in Figure 3-21 provided that the latter rectangle, too, had been based on a nave width of 19 br (rather than 18.9 br, as described above). Such an overlapping geometrical figure would have resembled the overall geometry of our Step 4 floor plan diagram (Figure 3-10), except that the latter contains the three largest numbers from the 65 group: 92, 65, and 130; while this one would have contained the three smallest: 19, 27, and 38. The preceding observations thus reveal a curious inconsistency in the proportions of the basilica as executed, the explanation for which is not yet clear: The actual ceiling height of 38 br is related, via the proportions of a two-square rectangle, to the *reconstructed* nave width of 19 br, while the actual upper entablature height of 26.77 br corresponds is related, via the proportions of a root-2 rectangle (Figure 3-21), to the *actual* nave width of 18.9 br.

Since the crossing dome was completed by Antonio Manetto di Ciaccheri in the 1450s and was criticized by contemporaries as having been built at variance with Brunelleschi's intentions, and since the lantern was reconstructed by the Ruggieri brothers in the 1780s, we will forego proportional analysis above the level of the ceiling crown molding.[32]

3.5 The Old Sacristy

Scholars have reached no consensus as to whether the Old Sacristy should be considered an integral part of the basilica of San Lorenzo, or a separate work.[33] Based on visual evidence, both positions would seem to have merit. The sacristy aspires to autonomy with its fully-glazed north windows that seem never to have anticipated construction of the abutting basilica that blocks them. Conversely, both structures are unified by a consistent pilaster capital design that is so distinctive it might be named San Lorenzo Corinthian. The overall basilica sets of proportions now provides compelling evidence that the two structures were indeed conceived as an integral complex. Although scholars unanimously agree that the domed main room of the Old Sacristy was intended to measure 20 br square, wall-to-wall, even though some acknowledge significant discrepancies with actual conditions, measuring pilaster plinth to pilaster plinth produces a more convincing proposal.[34] Measured as such the main room comes out to 19 br square, with errors of just 2.4 cm in width and 1.7 cm in length, and the total length of the sacristy including the *scarsella* measures within 3.4 cm of 27 br.[35] The sacristy floor plan thus contains a closely approximated root-2 rectangle formed of two numbers from the 65 group, 19 br x 27 br (Figure 3-23).[36]

The Old Sacristy is even more integrated with the basilica proper than these two numbers suggest. Since both the main room of the Old Sacristy and the basilica crossing square are nearly exactly 19 br. square, the domes that cover them are nearly identical in size, even though the sacristy dome appears much larger because it is closer to the ground (Figures 3-24 and 3-25).[37] Furthermore, we have seen that my survey reveals that in the basilica, the nave cross-section conforms to the proportions of a root-2 rectangle, when measured plinth-to-plinth in width, and to the top of the upper entablature in height, within a negligible discrepancy of 2 mm (0.01%; Figure 3-21).[38] Since the width in question is nearly 19 br, it is possible that the nave cross-section was conceived as an approximate root-2 rectangle measuring 19 x 27 br; which would be but a vertical reiteration of the Old Sacristy floor plan proportions (Figure 3-23). This hypothesis is consistent with the basilica ceiling height, which we have seen measures exactly 38 br (Figure 3-22).[39] Not only are all three of these numbers in the 65 Group, but together they imply a proportional framework for the nave cross-section consisting of a double square with a root-2 rectangle inscribed within it (Figures 3-21 and 3-22)—essentially a smaller version of the proportional framework for the overall basilica floor plan which, it will be recalled, is dimensioned with three other numbers from the 65 Group: 65, 92, and 130 (Figure 3-10). This abbreviated analysis of the overall basilica and Old Sacristy sets of proportions leaves little doubt that both structures were conceived together, as an integral whole. A more detailed analysis of proposed Old Sacristy sets of proportions will be presented later in this study, after the completion of our reconstruction of the overall basilica sets of proportions, to which we will now return.

Step 15: Derive Old Sacristy Proportions from Overall Basilica Proportions

The basic relationships between the overall basilica sets of proportions and those of the Old Sacristy have been discussed.[40] Let us now observe how the Old Sacristy footprint can be derived geometrically from the overall basilica floor plan proportions. When we overlay onto our last single-line floor plan diagram (Figure 3-10) a sideways, 65 br by 92 br approximate root-2 rectangle, a rectangular strip measuring 27 br wide remains (Figure 3-26). When we next extend to the left the two horizontal lines that define the transept, we have the 19 br x 27 br proportional footprint of the Old Sacristy (Figure 3-26). Within this new rectangle we then mark off a 19 br square to represent the main room of the sacristy, and within the 8 br x 19 br space that remains we mark off an 8 br square to represent the *scarsella* (Figure 3-26). Next we arrange square columns, wrap-around pilasters, and walls in and around this diagram such that the dimensions shown in Figure 3-27 can be realized (Figure 3-28). Finally, we move the entire sacristy away from the basilica proper by a distance equal to the thickness of the wall that they share, plus the pilaster plinth projections on both the sacristy and basilica sides (Figure 2-1; note that we have not yet shifted the sacristy to the west, as shown in this figure). I have measured this total distance as 150.4 cm (2.58 br), though whether this combined wall and plinth thickness found in the actual basilica today is the dimension the architect intended is unknown.

Step 16: Determine Old Sacristy Vertical Dimensions

The Old Sacristy appears to lack any geometrical sets of proportions relating the floor plan to the elevations. The main room does not consist of a cubic volume surmounted by a semi-spherical dome as it might appear (Figures 3-24, 3-28 and 3-29), and although the *scarsella* portal (Figure 3-29) may compositionally resemble both the San Lorenzo nave arcade bays and Serlio's perspective portal (Figures 2-2 and 2-37), it contains none of the sets of geometrical proportions that I have identified in those compositions.[41] Some of the dimensions inside the sacristy, however, appear to have numerical significance. The height of the dome, measured from the floor to the flat soffit ring that encircles the oculus, is nearly exactly 33 br (Figure 3-29).[42] As a pair of 3s, the number thirty-three (33) forms an iconographical ensemble with the four-sided main room of the sacristy and the twelve-lobed melon dome that covers it (Figure 3-24), such that all of these elements can be interpreted as the twelve (12) "…disciples preaching the Trinity (3) throughout the 4-fold world."[43]

By measuring the *scarsella* portal between the same key points of measurement that we examined in our analysis of the San Lorenzo nave arcade bays, the following dimensions are revealed: the plinth to plinth distance is $6\frac{1}{2}$ br; the pilaster shaft height, not including the astragal, is $9\frac{1}{3}$ br; and the total order height, measured to the top of the entablature, is $12\frac{1}{6}$ br (Figures 3-27, 3-28, and 3-29).[44] Note that the fractional endings of these numbers decrease in magnitude according to a 3:2:1 relationship ($\frac{1}{2} : \frac{1}{3} : \frac{1}{6} = 3:2:1$), and that their sum is 1, or, "unity" ($\frac{1}{2} + \frac{1}{3} + \frac{1}{6} = 1$). The integers to which these fractions are attached, 6, 9, 12, increase according to a 2:3:4 relationship

(6:9:12 = 2:3:4), all of them are multiples of 3, perhaps again symbolizing the Trinity; and their sum is 27 (6 + 9 + 12 = 27), which is both a number from the 65 group and the length of the sacristy in *braccia*.

The architect of the sacristy may not have had much flexibility in establishing the major horizontal divisions of the Old Sacristy once he decided to set the dome height from the floor at 33 br. The height of the dome, from the flat top of the crown molding to the soffit of the oculus ring, measures very nearly $10\frac{1}{4}$ br (597.1 cm). The middle stage of the sacristy, which is characterized by four large, semicircular-arched walls, has nearly the same height (596.75 cm). These dimensions, however, which vary by a centimeter or two around the circumference of the sacristy, are probably not numerically significant. Since both the dome and the middle stage of the sacristy are based on semicircular structures that spring from the walls of the main room, their heights were largely predetermined when the lengths of the side walls were established at 19 br. Some limited opportunity for height adjustment remained, for example, in the gap between the top of the middle stage and the base of the dome, which is partially filled by the crown molding at the base of the dome, but probably not enough to permit any significant numerical adjustment.

While other seemingly significant numerical relationships between the various architectural elements of the Old Sacristy, and between these elements and the corresponding features of the basilica proper, can be found, there is insufficient evidence to determine whether they are the results of the architect's intentions or mere coincidence.[45] We must conclude, therefore, that the Old Sacristy has a rather lackluster set of proportions compared to that of the basilica proper—an assessment that, considering the prominence of this structure in the canon of western art, would seem to support my earlier assertion that perceived aesthetic value and sets of proportions are unrelated. Having now concluded our examination of the Old Sacristy sets of proportions, we have but one more small step to complete in our reconstruction of the overall basilica sets of proportions.

<u>Step 17: Design Modifications</u>

Five floor plan modifications remain to bring our reconstruction thus far (Figures 3-16, which does not include the Old Sacristy) into conformity with the final scheme that Brunelleschi and Giovanni de' Medici agreed upon (see Figure 2-1, not including the present nave chapels and New Sacristy). These modifications are not logically implied by the preceding step-by-step reconstruction. Rather, they appear to be contingent transformations, made in response to social and economic pressures outside the pure logic of geometry. First, we must shift the Old Sacristy to the west, to its present position out of alignment with the crossing square. This shift, if indeed the Old Sacristy were aligned with the crossing square at some early step in the design process, was perhaps undertaken in order to allow the transept to terminate with chapels at both ends, thus increasing the number of transept chapels and spatially enlivening the ends walls. Another reason for such a shift, however, may have been to avoid an appearance of excessive grandeur for this structure that was effectively a Medici family mausoleum. Second, we must add the double chapels to the transept end walls, which appear to have been conceived as appendages that are independent of the overall basilica sets of proportions.[46] Third, we must turn the nave chapels nearest the transept to face the transept, again perhaps for the purpose of increasing the number of transept chapels (Figure 2-1, chapels SP12–SP15 and SP 60–SP63).[47] Fourth, we must remove the nave chapels, apparently due to the inability of the church to assemble enough patrons willing and able to build them.[48] Since none of these transformations appears to have implications for the San Lorenzo overall basilica sets of proportions, we need not discuss them further.

We now come to the end of our reconstruction of the overall basilica sets of proportions, with the Old Sacristy and four contingent design modifications evident in the present design taken into account. That system appears to have played a critical role in determining the form, scale, number of chapels, and spatial distribution of the Basilica of San Lorenzo. While sets of proportions appear to have imbued the basilica with a rich layering of intended meaning related to geometry, number and arithmetic, it may also have created at least one unintentional layer of meaning that could have caused confusion among early visitors to the church had the stewards of the design and construction process, perhaps making additions to the architect's original design, not taken remedial action. That potential source of confusion was unintented number symbolism, and the remedial action, if indeed any was taken, appears to have manifested itself in sculptural relief carving.

In this section I will propose an iconographical reading of the entablature block frieze reliefs of the San Lorenzo nave arcades that relates this sculptural program to an apparently unintended consequence of the San Lorenzo sets of proportions. Like any iconographical interpretation that proceeds without the benefit of unambiguous documentary evidence, my proposed reading is conjectural. Whether or not it proves to be an accurate description of historical design decisions and the motivations behind them, however, this proposed reading serves as a useful platform from which to explore a significant area of knowledge pertaining to medieval and Renaissance sets of proportions that I have not yet addressed in this study.

## 3.6 Symbolic Numbers and the Entablature Block Frieze Reliefs

The preceding reconstruction has revealed several important numbers embedded in the sets of proportions of the Basilica of San Lorenzo, the most significant of which are those ending in the fraction $\frac{2}{3}$ and those associated, through a variety of relationships, with the number 65. These numbers, expressed within the sets of proportions in *braccia*, are invisible and can only be comprehended mentally. To find them one needs either measuring equipment or access to the original design specifications. Consequently, these numbers were probably accessible only to a select group of people, such as the architect and his associates, the church adminstration, and the leading members of the community who were involved in the design and construction of the basilica.

Another number embedded in the design of the basilica is accessible to everyone, however, and probably attracted the keen interest of many fifteenth century visitors—the number seven (7), which is embodied in the dominant architectural feature of the basilica, the pair of monumental nave arcades composed of 7 columns each (Figures 2-1 and 2-3). This number is accorded added visual prominence due to the smooth surfaces of the unfluted, cylindrical column shafts, which contrast markedly with the textured surfaces of the fluted, rectangular pilaster shafts that characterize all other vertical point supports in the basilica. The pilasters thus tend to recede from view, bringing the columns into sharp foreground relief. The preceding step-by-step reconstruction of the San Lorenzo sets of proportions and floor plan demonstrates the likely reason for this particular number of columns in each arcade: A two-square rectangle, subdivided in a logical succession of steps, produces a nave floor plan 8 bays long, with 7 pairs of freestanding columns marking the points of connection between them (Figures 3-7 to 3-16).

The preceding reconstruction may provide a logical geometrical explanation for this prominent double appearance of the number 7, but most early fifteenth-century visitors to the basilica would have required a more immediately comprehensible explanation. For them, numbers could connote vivid meanings, and as such they effectively constituted a third category of number, distinct from the counted and counting numbers discussed above.

Previously I noted that counted numbers signify tangible quantities such as 7 columns or a length of 2 *braccia,* and that counting numbers signified numerical concepts that have no bearing on the material world, as in the observations that 3 follows 2, or that 3 is composed of 3 unities. In order to understand the problem that the presence of 7 columns in a nave arcade might have presented to the early fifteenth century observer, we must examine a category of number that acknowledges both quantity and abstract meaning, like counted and counting numbers, respectively, yet does not primarily signify either. In this study a symbolic number will be defined as a number that to the medieval and Renaissance mind signified programs of non-numerical meaning. Most numbers, perhaps with the help of a few external prompts to the observer, could fall into this category since every number between 1 (unity) and 9 bore some latent symbolic meaning, and others could take on the compounded meanings of smaller ones.

One (1, or unity) symbolized God.[49] Two (2) signified sin, for it was the first to recede from unity, the "First Good."[50] Three (3) symbolized the Trinity.[51] Four (4), according to Vincent Foster Hopper, whose book, *Medieval Number Symbolism*, serves as an important source for this analysis, signified the "mundane sphere," for it was associated with "…the 4 winds, the 4 elements, the 4 seasons, and the 4 rivers." Thus, "…knowledge of divine things is disseminated throughout the world by the 4 gospels, evangelists, or beasts, emblemized by the 4 extremities of the cross, the 4-fold division of Christ's clothing, and the 4 virtues, or forms of love, as Augustine names them."[52] Five (5) represented those living under Old Dispensation of the Pentateuch; the 5 points of the cross, the 5 wounds which provided the salvation of man, who has 5 fingers and 5 senses; and the 5 loaves blessed by Jesus that fed 5,000.[53] Six (6) were the days of creation, and 6 were the ages of mankind, from the Creation to the Second Coming.[54] Seven (7) provided the basic structure of the universe, and daily life within it: there were 7 planets, 7 days, and 7 canonical hours.[55] Seven (7) was the Sabbath, both as the 7th day, and the 7th age.[56] Eight (8) was the number of salvation, regeneration, and the Resurrection, for according to Augustine, the eighth day following the Creation represented a return to the original life.[57] Nine (9), as three sets of 3, amplified the symbolism of the Trinity. Larger numbers could additionally carry symbolism of their own. Twelve (12), for example, as the product of 3 and 4, represented the twelve (12) "…disciples preaching the Trinity (3) throughout the 4-fold world."[58] In a variation on this theme, the inner surface of the dome over the scarsella of the Baptistery of Padua is painted with 13 lobes containing figures of the 12 apostles plus the Virgin Mary.

The degree to which number symbolism melded with every aspect of medieval and early Renaissance thought is difficult for us to comprehend today, for during those periods no gap existed between the abstract and the concrete.[59] "Take number from all things, and all things perish" wrote the Early Christian philosopher Isidore of Seville (d. 636),[60] and this belief would have been particularly relevant to architecture. Numbers of walls, numbers of bays, numbers of columns, numbers of towers—all were bearers of number symbolism. Indeed, for an architect to design a building devoid of number symbolism would have been impossible. The experience of number symbolism was spontaneous, and could be profoundly moving. Johannes Scotus Erigena, a ninth century theologian and Neo-Platonist philosopher, writes that whenever he thinks of 8, thoughts of Easter, the resurrection, regeneration, spring, and new life "vibrate" within him.[61] What thoughts might have "vibrated" within the fifteenth-century observer who contemplated the 7-column nave arcades of San Lorenzo? Which of the many possible meanings of 7, if any, might the architect have intended to convey to him? In order to address these questions, I will first identify three subcategories of number symbolism that had the potential to interact with architectural form during the medieval and Renaissance periods, and then examine the 7-column nave arcades of San Lorenzo in relation to each. These three types of number symbolism, which I will term associative, generative, and derivative, required three different levels of participation on the part of the architect.[62]

## Associative Number Symbolism

Associative number symbolism required no participation on the part of the architect, for it occurred when an observer spontaneously associated a number of objects with some symbolic meaning. Some observers, for example, might have associated the 7-column nave arcades of San Lorenzo with wisdom, in reference to the Old Testament passage: "wisdom has built her house; she has hewn out its 7 pillars."[63] Alternatively, since all 7 columns in each nave arcade—and thus, all 14 of the nave columns—support entablature blocks decorated with carved lambs, another Old Testament passage might have come to mind, in which God calls for a series of offerings, including 14 lambs on each of the 7 days of the Feast of Tabernacles.[64] In a fifteenth century basilica dedicated to a Christian saint however, we might expect associative number symbolism to draw from New rather than Old Testament sources, unless selected references to both were meticulously juxtaposed in the mind of a well-educated observer through a more overt iconographical program.[65]

Among the many references to 7 found in the New Testament, the 7 flames of the Holy Spirit, and the 7 seals of the Book of the Apocalypse stand out as the most emotive, and will be considered in detail below.[66] Others include the mass, which Hopper notes is composed of 7 parts, or offices: "the full episcopal procession is led by 7 acolytes, indicating the 7 gifts of the [Holy] spirit. Then follow the pontiff, 7 subdeacons (7 columns of wisdom), [and] 7 deacons (from apostolic tradition)…".[67] Alternatively, 7 might have represented the sum of the 3 theological and 4 cardinal virtues, or the 7 deadly sins.[68] Less conventional interpretations develped by leading thinkers also emerged, such as, for example, Aquinas's argument that "…the number 7 signifies universality because the life of man revolves through 7 days, because of the 7 gifts of the Holy Spirit, because faith in the Trinity was announced through the 4 parts of the world, because there are 7 churches."[69] Augustine, for his part, found in scripture 7 steps to wisdom, 7 beatitudes, and, in the Lord's Prayer, 7 petitions.[70]

Generative Number Symbolism

Generative number symbolism required the most active participation on the part of the architect, for it occurred when symbolic numbers were used to generate architectural form. Early Christian basilicas typically contain nave colonnades composed of 12 columns each, as a representation of the New Testament assertion that Christianity was carried forth into the world by 12 apostles. Indeed, considering the notable resemblance between columns and human figures, such churches may even be considered examples of an Early Christian *architecture parlant*.[71] At San Lorenzo we find no evidence of generative number symbolism in the overall basilica design. I have argued that the 7 columns appear to have been placed in each nave arcade for reasons other than number symbolism. Only in architectural details do we find two possible examples of generative number symbolism, both based on the Trinity: 3 steps lead up to the transept and nave chapels (Figure 2-1); and in the entablature blocks that date to the earlier 1442-1457 nave construction campaign, 9 eggs (or, 3 x 3) fill each side of the egg-and-dart cornice molding (Figure 2-24).[72]

Derivative Number Symbolism

"Derivative number symbolism" occurs when an architect assigns iconographical significance to numbers that appear in his buildings as unintentional by-products of the design process. The architect thus *derives* the symbolism from the building, rather than designing the building with the aim of expressing that symbolism. Note that according to this definition, the actor must be the architect (or architects) and not an observer, as in associative number symbolism, no matter how closely associated with the design and construction process that observer may have been. Thus, this definition treats intangible symbolic intent as an integral component of design, equally important as the physical manifestations thereof. Note, furthermore, that the means of communication by which the architect assigns number symbolism to a building is not important. The symbolic content can be connoted by some physical sign such as a carved decorative motif, or by a surviving verbal comment. As long as we have some evidence of symbolic intent combined with some indication that the design of the building preceded this intent, we may say that we have an example of derivative number symbolism.[73]

Derivative number symbolism is often difficult to distinguish from generative number symbolism, and therefore must remain a matter of scholarly interpretation, which of course must be clearly identified as such. One apparent example of derivative number symbolism that the architects appear to have attempted to pass off as generative number symbolism is found in the archives of the cathedral of Milan. In 1392, in response to the criticisms of the French architect Jean Mignot, the

Italian master masons defended their design for a large crossing tower surrounded by four smaller towers, with the following elaborate argument:

> "…[The masters] say that the towers which they wanted to make are for many reasons and causes [desirable]. Namely, in the first place, to integrate aforesaid church and transept so that they correspond to a rectangle according to the demands of geometry, but beyond this, for the strength and beauty of the crossing-tower. To be sure, as if as a model for this, the Lord God is seated in Paradise in the center of the throne, and around the throne are the four Evangelists according to the Apocalypse, and these are the reasons why they were begun."[74]

The symbolism of the four evangelists in this passage has the ring of an afterthought; a seemingly desperate defense against the foreigner's criticisms. Surely, as the architects themselves seem to acknowledge, stylistic precedents, geometrical logic, and structural concerns were the primary factors leading to the inclusion of four corner towers in the design, not number symbolism. Nevertheless, in this passage the Italian architects may also have communicated a genuine mystical vision that, although most likely derived *from* their design, must be considered an integral part of their total design intent, even if that intent evolved during the course of the discussions. Returning now to the Basilica of San Lorenzo, we find one possible example of derivative number symbolism, and it is recorded in stone rather than a church document.

### The Seven-Sealed Book of the Apocalypse

We have seen that above each column and pilaster in the nave arcades is an entablature block frieze decorated with elaborate carved reliefs. Each relief depicts a pair of winged cherubim inflected inward, in adoration of a smaller scene framed by a laurel wreath (Figures 2-22, 2-24, 2-25, 2-28 and 2-29). The smaller scene contains a lamb, in the western three bays usually illuminated by a halo embellished with a cross (Figures 2-22 and 2-24). The lamb reclines on a rectangular slab, which is tilted to reveal its top. Along the front edge of the slab are arrayed 7 vertical lozenges. These lozenges suggest a deliberate attempt on the part of the designer of these reliefs—whether Brunelleschi or not will be considered shortly—to tie the number of columns in each nave arcade, 7, into an iconographical program.

The halo with cross definitively identifies the lamb as Christ, the *Agnus Dei*, the Lamb of God. In this context, the slab and seven lozenges together imply the seven-sealed book of the Apocalypse—updated in format from the biblical scroll—with which the *Agnus Dei* is typically associated in Christian iconography.[75] Support for this interpretation of the slab as a book, if not of the seven lozenges as seals, is found in the reliefs of the entablature blocks of Columns 5 and 10. The sculptor of these blocks clearly understood the slab to represent a book, for in each of the eight reliefs found on all four sides of these two entablature blocks, the slab bears unambiguously book-like details, including a stack of pages between two covers, and two straps or clasps securing them together (Figures 3-30 and 3-31). The sculptors of these blocks may have been overly ambitious, however, for in adding the aforementioned details they rendered the seven lozenges rather ambiguous—they appear more like flames lapping at the edge of the book than seals set in place to secure its contents. In most of the other entablature block reliefs of the nave arcades however, the slabs are more abstract, and the 7 lozenges overlap the leading edge in a manner consistent with the function of seals on a book (Figures 2-22, 2-24, 2-25, 2-28 and 2-29). A rendition of the Agnus Dei reclining atop a book bound by metal clasps that is similar to those of the entablature block reliefs found above Columns 5 and 10 found in the late *trecento* painting by Jacobello Alberegno titled "Polittico dell'Apocalisse (Figure 3-32), suggests that the San Lorenzo sculptors provided new interpretations of an established iconographical design.[76]

My interpretation of the lambs, slabs, and lozenges in the entablature block friezes as representations of the *Agnus Dei* and the seven-sealed Book of the Apocalypse, now raises the question of why this theme would have been given such prominence in a basilica dedicated to St. Lawrence, especially since the small portion of decorated exterior terra cotta frieze that was completed under Brunelleschi's supervision and that today outlines the perimeter of the Old Sacristy and Medici double chapel bears the similarly arranged, but more clearly relevant, motif of a gridiron--the instrument of St. Lawrence's martyrdom--flanked by winged angels (Figures 3-33 and 3-34).[77] The *Agnus Dei* standing on the seven-sealed Book of the Apocalypse, and holding the banner of the Cross, appeared on seals of the early Church, and thus may be considered a general symbol of Christianity,[78] but the replacement of the seemingly more iconographically appropriate gridiron motif with this one demands further explanation. A lamb quite similar to the entablature block lambs occupies the shield of the *Arte della lana* (Figure 3-35), but the wool guild, which was the patron of the *opera* of Santa Maria del Fiore and thus, Brunelleschi's patron for the cupola project, would seem to have lacked sufficiently strong connection either to this church or the Medici family to warrant such prominent iconographical representation in the San Lorenzo nave arcades.

A more likely explanation for the choice of the seven seals motif in the entablature block friezes is that the designer of the friezes believed that a powerful iconographical image was needed to accompany the inadvertently powerful symbolism of 7 columns marching down each side of the nave. For early fifteenth century visitors to the basilica these columns would have "vibrated" with the varied meanings of 7, and visitors would have looked to the iconographical program of the basilica for guidance as to which meanings to pay attention to. If no guidance was to be found, iconographical confusion might have resulted. Thus, the entablature block designer perhaps intended to prevent the basilica from becoming a locus of *ad hoc* associative number symbolism by providing a carefully orchestrated program of derivative number symbolism that would link the number 7 to the culminating event of the New Testament, the opening of the seven seals of the Book of the Apocalypse. It is a scriptural vision lodged in the last book of the New Testament, Revelation, in which the heavens open up to reveal the Lord himself seated on his throne (Rev. 8:1–6), in which his temple in heaven is opened to reveal the ark of the covenant (Rev. 11:19). It is, furthermore, an account suffused with seven: 7 churches, 7 spirits, 7 golden lampstands, and 7 stars (Rev. 1); 7 blazing lamps, the 7 spirits of God (Rev. 4:5), 7 horns and 7 eyes, the 7 spirits of God sent out into all the earth (Rev. 5:6), 7 bowls, 7 last plagues (Rev. 16:1, 21:9), and an earthquake that kills 7,000 (Rev. 11:13). The lamb takes the scroll "sealed with 7 seals" (Rev. 5:1) from the hand of God (Rev. 5:7). Seven (7) angels stand before God (Rev. 8:2) bearing 7 trumpets (Rev. 8:7–15). Seven (7) thunders speak (Rev. 10:3), and after the 7$^{th}$ seal is opened and the 7th angel sounds his trumpet, the vision of the Apocalypse is fulfilled:

> "…there were loud voices in heaven, which said: 'The kingdom of the world has become the kingdom of our Lord and of his Christ, and he will reign for ever and ever.'" (Rev. 11:15).[79]

If a central purpose of church architecture is to direct the attention of its occupants toward the contemplation of God and the liturgy of the church, then this iconographical program would have helped to fulfill this purpose in a most forceful way.

<u>Design Attribution of The Entablature Block Friezes Reliefs</u>

Early twentieth-century scholars questioned whether Brunelleschi designed the entablature block frieze reliefs, or whether his followers added them to his design, perhaps without his permission.[80] If the latter scenario were to be true, then Brunelleschi may not have been concerned about potentially ambiguous associative number symbolism that the two rows of 7 nave columns in the Basilica of San Lorenzo may have implied. Although docoumentary evidence indicates that two of the friezes could have been completed prior to Brunelleschi's death in 1446, there is no evidence that Brunelleschi continued in his role as *capomaestro* of the basilica construction project after 1429 except for a brief consultation with regard to the relocation of the choir made, according to Manetti, at Cosimo de' Medici's request.[81]

Indeed, another reason to question Brunelleschi's authorship of the entablature block friezes comes from those limited portions of the basilica that were unquestionably completed under his supervision, the Old Sacristy—not including the Donatello/Michelozzo embellishments—and the adjacent double chapel. Those portions contain an iconographical program that focuses on the theme of St. Lawrence. In addition to the above-noted exterior frieze that bears the gridiron motif, the instrument of St. Lawrence's martyrdom (Figures 3-33 and 4-34), another prominent manifestation of Laurentian iconography found not only in the Old Sacristy and adjacent chapel but throughout the basilica is the profusion of laurel wreath motif that adorns all the archivolts (Figures 2-3, 2-32 and 2-33). The laurel wreath is a primary symbol of Saint Lawrence, whose Roman name, *Laurentius*, derives from the Latin *lauream tenens*, or "one who holds a laurel wreath."[82] Laurel wreaths are also incorporated into the exterior terra cotta frieze motif, where they form roundels that frame the angels that flank the gridiron—angels which, according to some traditions, bore the saint's soul to heaven immediately following his martyrdom (Figures 2-33 and 2-34).[83]

For Brunelleschi to have interjected into this highly focused Laurentian iconographical program the apparently unrelated theme of the Apocalypse would seem contrary to his tendency toward consistency in all aspects of his designs. In this context Manetti's comment that "…the body of the church from the transept downward…although beautiful, does not conform to the aforesaid transept," takes on new potential relevance.[84] In addition to the nonidenticailty of the present nave and transept chapels noted previously, perhaps the marked contrast between the sculptural friezes of the entablature blocks and the minor order frieze in the transept constituted another source of Manetti's dissatisfaction with the appearance of the nave as executed. Except for the lack of ornament, the continuous minor order frieze in the transept closely resembles the entablature blocks of the nave arcades when it forms projections above the square columns of the transept chapel portals (Figure 2-51). Perhaps Brunelleschi intended blank entablature block friezes in nave arcades, like those in his later basilica of Santo Spirito (Figure 2-50).

The sculptural friezes of San Lorenzo have no parallels that can be securely attributed to Brunelleschi. The polychrome terra cotta frieze roundels in the Old Sacristy were executed by Donatello, probably as part of his collaboration with Michelozzo, and according to Manetti angered Brunelleschi.[85] If the San Lorenzo entablature block friezes were not designed by Brunelleschi, then Michelozzo and Donatello in collaboration would seem the most likely authors. These men collaborated not only on the elaborate interior embellishment of Brunelleschi's Old Sacristy, including the frieze motif that resembles that of the entablature blocks, but perhaps also on the addition of the high niches and other features to the San Lorenzo transept end walls.

The possibility that the sculptural frieze reliefs in the entablature blocks might have been added by Brunelleschi's successors, perhaps without his permission, suggests that the basilica Brunelleschi intended might have had not only more volume, provided by the deeper and taller nave chapels discussed above, and less light, due to the smaller clerestory windows that could have been accomodated above them, but also considerably less ornament in the nave arcades. While we have no way of knowing whether Brunelleschi would have been concerned about possible iconographical ambiguity resulting from 7-column nave arcades surmounted by blank—and thus iconographically mute—entablature block friezes, the Basilica of Santo Spirito strongly indicates that Brunelleschi was aware of the iconographical potential of number symbolism and was capable of using it to forceful effect.

At Santo Spirito we find nave arcades composed of 8 freestanding columns (each of which is terminated by two engaged columns, for a total of 10 visible columns) surrmounted by blank entablature block friezes. No visitors to that basilica, however, would have been confused by possible number symbolism embodied in the numerical quantity of 8 (or 10) columns in each nave arcade because the important number there is clearly 9, the number of bays that the columns separate. If there were ever any doubt about the Trinitarian intent of this apparent example of generative number symbolism, the number of bays that each of the transept- and apse-like wings project from the crossing square, 3, would have allayed them. In a basilica dedicated to the Holy Spirit, which is the third component of the Trinity, the number 3 would have have had particular resonance for fifteenth-century visitors. The recurrence of the number 9 in the plinth to plinth distances, measured in *braccia* (discussed in detail below), would have further reinforced that symbolism for those who were aware of the dimensions. Whatever Brunelleschi's intentions may have been for the design of the San Lorenzo nave arcade entablature block friezes, however, he may not have determined the number of columns in each arcade. Extensive evidence suggests that he inherited that number, along with all the most notable counted and counting numbers found throughout the basilica, from his predecessor as *capomaestro*. Indeed, those very numbers, which are embedded in the sets of proportions found throughout the basilica, constitute some of that evidence.

[1] Manetti, *Vita*, Tanturli, ed., 111.

[2] Cf. the slightly trapezoidal transept in the floor plan of the church of S. Pietro in Toscanella. William Henry Goodyear, "Constructive Asymmetry in Medieval Italian Churches," *Architectural Record* 6, no. 3 (Jan.-Mar. 1897), 401, Figure 18. For the term "architectural refinements," see William Henry Goodyear, "Architectural Refinements in Early Byzantine Churches and French Cathedrals," *Architectural Record* 16, no. 2 (Aug. 1904), 116-140. Similar non-parallel walls flank the stage area of the basilica-like Seiji Ozawa Music Hall, Lenox, Massachusetts, 1986, William Rawn Associates, Architects, Inc., as a device to mitigate the acoustical phenomenon of "flutter echoes." See Scott R. Riedel, *Acoustics in the Worship Space* (St. Louis, Missouri, 1986), 23. According to Manetti, the San Lorenzo choir was originally to be placed in the crossing square, perhaps motivating the construction of non-parallel transept end walls. Manetti, *Vita*, Tanturli, ed., 109; Irving Lavin, "Donatello's Bronze Pulpits in San Lorenzo and the Early Christian Revival," in *Past-Present: Essays on Historicism in Art from Donatello to Picasso*, (Berkeley, California 1993), 6; and Saalman in Manetti, *The Life of Brunelleschi*, Saalman, ed. 147-148 note 143.

[3] The side/diagonal approximation pair 65:92 is not generated from the simplest form of Theon of Smyrna's formula (see Figure 3-49). However, beginning with a theoretical square with a side of 1 and a diagonal of 4, it is produced in the fifth generation of the formula; and beginning with a side of 5 and a diagonal of 6, in the fourth generation. Thus, the formula can produce a far greater number of accurate approximation pairs than our analysis thus far has indicated.

[4] Giuliano da Sangallo, "Tacuino senese," fol. 21v, Biblioteca Comunale, Siena.

[5] Manetti, *Vita*, Tanturli, ed., 108.

[6] On the construction of the present nave chapels see Moreni, *Continuazione*, 1:14; Ginori Conti, 1940, pp. 72–73; Roselli and Superchi, *L'edificazione*, 104-124, 128-129; and Saalman, *Filippo Brunelleschi: The Buildings*, 439, Document 12.1.

[7] *Ibid*., 111.

[8] Excluded from consideration here is the width of the high altar chapel measured plinth-to-plinth along the rear wall, 1114.1 cm (19.09 br), since both plinths that bound that dimension date to the nineteenth century. Valerio Tesi, "I restauri di Gaetano Baccani," in *San Lorenzo, 393-1993* (Florence, 1993), 163-164. The remaining high altar chapel measurements may vary slightly from original measurements since all three chapel walls were reconstructed in the eighteenth century. See floor plans (April 1742) showing the scope of work directed by architect Giuseppe Ruggieri in *San Lorenzo, 393-1993*, 26. There is no evidence to support Battisti's claim that at some point in the

design process Brunelleschi reduced the dimensions of the transept. Eugenio Battisti, *Brunelleschi: The Complete Work* (New York: Rizzoli, 1981), 188.

[9] Note, however, that 46 is divided into two symmetrical transept widths of 23 each (see Figure 4-10).

[10] Indeed, these numbers contain five side/diagonal approximation pairs: 19:27, 27:38, 46:65, 65:92, and 92:130, which vary in accuracy from 0.08% to 0.48%.

[11] These numbers can also be derived, in close approximation, through two different series of rotated squares (the first consisting of three squares, with sides measuring 19, 27, 38; the second consisting of four squares measuring 46, 65, 92, 130), other geometrical constructions (such as an overlapping root-2 rectangle and double square rectangle having a short side measuring either 46 or 65), or simple arithmetical intervals (note that the intervals between 46, 65, 92, 130 are 19, 27, 38). The number 65 also bears a relationship to the nave arcade set of proportions: in the above-noted progression $1\frac{2}{3}$, $5\frac{2}{3}$, $9\frac{2}{3}$, $13\frac{2}{3}$, $17\frac{2}{3}$, the next number is $21\frac{2}{3}$. When converted to complex fractions through simple arithmetic as described previously, these numbers become $\frac{5}{3}$, $\frac{17}{3}$, $\frac{29}{3}$, $\frac{41}{3}$, $\frac{53}{3}$, $\frac{65}{3}$.

[12] See for example SP 42 (Figure 2-1), the shaft of which projects $\frac{1}{2}$ br (two flutes) from the crossing pilaster on the east side, and $\frac{1}{4}$ br (one flute) from the wall on the west side.

[13] See Cohen, “How Much Brunelleschi?...,” 19-37.

[14] Note that this average calculation is not used here as a substitute for statistical analysis, which would not be a mathematically valid procedure, but merely as a way to even out all the bay widths produced by the overall basilica set of proportions. See Appendix 8.4).

[15] In fact, his choice was a bit more complicated than indicated here, because $9\frac{5}{8}$ br itself would seem to have presented a viable plinth to plinth distance within the nave arcade set of proportions (refer to the preceding analysis of the nave arcade set of proportions.). Assuming 2 br plinth widths, both the distance between the farther edges of the column plinths and the column shaft height could have measured $13\frac{5}{8}$ br; and the height to the tops of the entablature blocks, derived from the dual diagon proportion, could have measured $17\frac{5}{8}$ br (compare to Figure 2-45). The capital height could

have measured $1\frac{5}{8}$ br to begin a progression of Boethian root hexagonal numbers that would have been called out by flags of repeating $\frac{5}{8}$ fractions, rather than $\frac{2}{3}$. Note that the ratio $9\frac{5}{8} : 13\frac{5}{8}$ is equivalent to the whole number ratio 77:109, which approximates the ratio 1:√2 within 0.1%. A root-2 rectangle and a dual diagon derived from a plinth to plinth distance of $9\frac{5}{8}$ br, therefore, would have risen 2.5–2.6 cm short of the required $13\frac{5}{8}$ br and $17\frac{5}{8}$ br dimensions, respectively. By comparison, the corresponding discrepancy associated with the dimensions $9\frac{2}{3}$, $13\frac{2}{3}$, $17\frac{2}{3}$ is only 1-3 mm, which perhaps accounts for their selection.

[16] On the splaying of the transept, see Cohen, "How Much Brunelleschi?...," 37.

[17] The arch that spans this $10\frac{1}{6}$ br chapel opening has been imperceptibly flattened out to appear equal to the other chapel arches nearby, a feat that is more readily accomplished here than in the transept since here, the chapel portal archivolt is embedded in the side aisle vaults, with only the soffit edge remaining visible (Figures 2-1 and 2-51).

[18] On the temporary dimensional rounding, see Cohen, "How Much Brunelleschi?...," 37.

[19] On transept width measurements, see Cohen, "How Much Brunelleschi?...," 37.

[20] Good fortune may be playing a role here, since a measurement error of several millimeters over such a long distance would not be unusual. In this case, however, the component measurements add up to the overall transept width measurement with no error at all. Also note that the portal leading from the transept into the north side aisle (Figure 2-1, FP 6-SP 65) measures only 9.11 br (531.6 cm), or 3.36 cm less than $9\frac{1}{6}$ br (Figure 3-17). This discrepancy can be accounted for by the slightly excessive widths of the adjacent chapel opening and nearby pilaster plinths.

[21] One final dimensional irregularity that we may observe in the central spine of the basilica is a slight splaying of the nave, widening from Columns 7 and 8 toward the east end of the nave (Figure 3-6). This irregularity is so slight, however—on the order of 1-2 cm—that I will attribute it to construction error.

[22] On a possible acoustical reason for this splaying of the transept, see Cohen, "How Much Brunelleschi?...," 37.

[23] This apparent enlargement of the transept by $\frac{1}{6}$ br is unrelated to Battisti's unsubstantiated suggestion that Cosimo de' Medici reduced the dimensions of the transept "by almost one bay from east to west." Battisti, *Filippo Brunelleschi*, 188.

[24] On the increased dimensional irregularity of the eastern four bays of the nave compared to the western three bays, see Cohen, "How Much Brunelleschi?...," 21-23.

[25] If we assume the arch diameter to be equal to the clear intercolumniation of $10\frac{1}{6}$ br (since both archivolt face width and column diameters measure $1\frac{1}{2}$ br wide), the assumed height of the lower edge of the upper entablature can be calculated as follows: entablature block height from floor ($17\frac{2}{3}$ br) + arch radius ($5\frac{1}{12}$ br) + archivolt face width ($1\frac{1}{2}$ br) = $24\frac{1}{4}$ br.

[26] This measurement was recorded between Columns 8-9 (see Appendix 8.1). The cause of the 3.4 cm discrepancy (1415.2 - 1411.8 = 3.4) is unknown, though arch settlement is one likely possibility. Alternatively, since the 1411.8 cm measurement was recorded as the height to the top of the archivolt, not the bottom of the entablature, it is possible that 3-4 cm gaps, invisible from the floor, separate the tops of the arches and the bottoms of the entablatures.

[27] This measurement was recorded between Columns 8-9. This root-2 rectangle proportional relationship, however, displays a comparable level of precision when measured in all three westernmost bays of the nave.

[28] See Cohen, "How Much Brunelleschi?," 40-41.

[29] *Ibid*. See also Step 12 below.

[30] We have seen that an arch that spans a plinth to plinth distance of 9 2/3 br has a radius (and thus a height) of $5\frac{1}{12}$ br, or, 296.64 cm. An arch spanning a plinth to plinth distance of $9\frac{1}{3}$ br would have a radius of $4\frac{11}{12}$ br, or, 286.94 cm. The difference between the two is thus: 296.64 cm - 286.94 cm = 9.7 cm. An arch spanning a plinth to plinth distance of $9\frac{1}{6}$ br would have a radius of $4\frac{5}{6}$ br, or, 282.07 cm. Thus, 296.64 cm - 282.07 cm = 14.57 cm (rounded to 14.6 cm).

[31] Measured in June 2005 with a Leica Disto A5 Laser Distance Meter. Measurements vary between 2217.4 cm and 2218.1 cm. Note that 2217.0 cm ÷ 58.36 cm = 37.99 br, and that 2218.1 cm ÷ 58.36 cm = 38.0 br.

[32] Manetti, *Vita*, ed. Tanturli, 1976, 110–111; *Archivio Mediceo l. c. filza 9*, quoted in Giovanni Gaye, *Carteggio inedito d'artisti dei secoli XIV, XV, XVI* (Florence, 1839), 1:167–169; and Valerio Tesi, "La 'generosa pietà' dell'elettrice palatina: restauro e completamento della basilica laurenziana nel tramonto dei Medici," in *San Lorenzo, 393-1993, L'Architettura: le vicende della fabbrica*, eds. Gabriele Morolli and Pietro Ruschi (Florence, 1993), 152.

[33] Fabriczy considers the two structures to be integral, Battisti sees them as separate, and Saalman seems to take both positions, calling the Old Sacristy "…a contiguous but wholly separate building" while nevertheless embedding his discussion of it within the San Lorenzo chapter of his Brunelleschi monograph. Cornel von Fabriczy, *Filippo Brunelleschi: Sein Leben und seine Werke* (Stuttgart: J. G. Cotta, 1892), Chapter 5; Battisti, *Brunelleschi: The Complete Work*, 79-97, 174-196; and Saalman, *Filippo Brunelleschi: The Buildings*, 113, 107-209, 113-144.

[34] Saalman, *Filippo Brunelleschi: The Buildings*, 209; Zervas, *The Parte Guelfa*, 148; and Pietro Ruschi, "Considerazioni di storia e architettura," in Francesco Gurrieri, ed., *La Sacrestia Vecchia di S. Lorenzo: Il comportamento statico e lo stato di conservazione* (Firenze, 1986), 24.

[35] The measurements are: 1110.5 cm, or 19.03 br, long (west wall), 1111.2 cm, or 19.04 br, wide (south wall), and 1579.1 cm, or 27.06 br, total length (west wall). Note that 19 br = 1108.84 cm (see Figure 3-28).

[36] Nyberg proposes a root-2 rectangle relationship in the Old Sacristy floor plan indicated wall-to-wall, but provides no measurements. D. Nyberg, "A Study of Proportions in Brunelleschi's Architecture," master's thesis, New York University, 1953, 2-15. Zervas proposes that measured wall to wall, the floor plan proportions of the Old Sacristy conforms to those of a root-2 rectangle: "…the ground plan of the Old Sacristy is a rectangle of 20 by 28 *braccia*. Such a rectangle is in fact a rationalized 1:√2 rectangle, based on a module of 1 *braccio*. Diane Finiello Zervas, *The Parte Guelfa, Brunelleschi, and Donatello*, Locust Valley, New York, 1987, p. 148. According to my measurements, however, the total length of the main room is only 1624.6 cm., or 27.84 br. (Figure 3-28). Furthermore, the ratio 20:28, even if it were found in the Old Sacristy floor plan, could not be described as a "rationalized 1:√2 rectangle," but merely as a rather poor approximation of the proportions of such a rectangle, for it has an error of 1.4%, compared to the that of the ratio 19:27 which approximates the proportions of the root-2 rectangle within 0.48%. Cf. Ruschi, "Considerazioni," 24-25.

[37] Although the San Lorenzo crossing dome was executed by Antonio di Manetto Ciaccheri, evidently at variance with Brunelleschi's exact intentions, Antonio would have had little flexibility

regarding the dome diameter. See Isabelle Hyman, "Towards Rescuing the Lost Reputation of Antonio di Manetto Ciaccheri," in *Essays Presented to Myron P. Gilmore*, 2:261-280.

[38] The precision of this proportional correspondence with actual measurements proves that the root-2 rectangle shown in Figure 3-21 is tied to the nave width measured plinth-to-plinth, and *not* in the clear, between crossing pilaster shafts, as proposed by Saalman, who provides no measurements. A root-2 rectangle drawn as Saalman proposes would rise 41.09 cm higher than the actual upper entablature height. Saalman, *Filippo Brunelleschi: The Buildings*, 361-362. The root-2 rectangle proportions of the nave cross-section of Santo Spirito correspond to those of San Lorenzo (Figure 3-21) with similar accuracy.

[39] The distance from the main floor to the horizontal soffit in the middle of the crown molding profile, measured near the door to the Old Sacristy, is 2218.4 cm, or 38.01 br (Figure 3-22).

[40] Cohen, "How Much Brunelleschi?," 40-41.

[41] See Cohen, "How Much Brunelleschi?," 19-37.

[42] The actual dome height is about 3-4 cm less than 33 br. The heights from the vestment table surface to the soffit of the oculus ring, measured in four locations with a Leica Disto A5 Laser Distance Meter, are 1825.1 cm, 1824.0 cm, 1825.7 cm, and 1825.7 cm. Each of these measurements was added to the average table height, 97.65 cm, to produce the following four interior dome heights, from the floor to the oculus ring soffit: 1922.75 cm (32.95 br), 1921.65 cm (32.93 br), 1923.35 cm (32.96 br), and 1923.35 cm (32.96 br). Note that 33 br = 1925.88 cm.

[43] Vincent Foster Hopper, *Medieval Number Symbolism: Its Sources, Meaning and Influence on Thought and Expression* (New York, 1938), 99.

[44] Based on my survey (Appendix 8.1), these measurements are: 381.8 cm, or 6.54 br (plinth to plinth distance); 543.7 cm, or 9.32 br (left column shaft height); 544.4 cm, or 9.33 br (right column shaft height); 710.5 cm, or 12.17 br (order height at left pilaster); 710.3 cm, or 12.17 br (order height at right pilaster). The column and order heights noted here are measured to the bottoms of the plinths of the square columns at the *scarsella* entrance. Note that in the Old Sacristy, the pilasters and square columns stand at three different levels: The northwest corner pilaster stands on the floor of the main room. The square columns and pilasters along the *scarsella* wall stand on the first step leading up to the *scarsella*, and the square columns at the rear of the *scarsella* (which appear as sliver pilasters), stand at the level of the *scarsella* floor. Apparently troubled by this height variation, Stegmann and Geymüller incorrectly show the latter sliver pilasters without plinths. Carl von Stegmann and Heinrich von Geymüller, *Die Architektur der Renaissance in Toskana* (Munich, 1885), 1: Bl. 6.

[45] Some of the smaller vertical dimensions in the *scarsella* portal bear root-2 scalar relationships with the corresponding basilica dimensions. For example, the sacristy capital height, $1\frac{1}{6}$ br, and entablature height, $1\frac{2}{3}$ br, bear a 7:10 relationship to one another (a side/diagonal approximation accurate within 1.02%), while the two corresponding dimensions in the basilica proper, $1\frac{2}{3}$ br (capital height), and $2\frac{1}{3}$ br (the entablature block height that was likely intended), bear a 5:7 relationship (side/diagonal approximation accurate within 1.01%). Furthermore, the height of the sacristy order, measured from the sacristy floor to the top of the entablature, $12\frac{1}{2}$ br, is smaller than the total height of the minor order in the basilica, $17\frac{2}{3}$ br, by a ratio of 75:106—or, very nearly $1{:}\sqrt{2}$ ($12\frac{1}{2} : 17\frac{2}{3} = 75{:}106$), which is another side/diagonal approximation accurate within 0.06%.

[46] This interpretation of the double chapels differs from that of Bruschi, who treats these chapels as integral to the original overall floor plan layout. Arnaldo Bruschi, *Filippo Brunelleschi* (Milan, 2006), 107-109.

[47] There is no reason to believe that the nave chapels nearest the transept were ever intended to open to both the nave and transept as Saalman suggests. Howard Saalman, *Filippo Brunelleschi: The Buildings* (University Park, Pennsylvania, 1993), 206-207. Such a configuration, as shown in Saalman's axonometric drawings (Saalman, *Filippo Brunelleschi: The Buildings*, Figures 11 and 13), would have introduced just two instances of a new structural element into the architectural vocabulary of the basilica—the freestanding square fluted column—and would have placed them in confusing juxtaposition to the engaged square fluted columns (wrap-around pilasters), and the freestanding cylindrical unfluted columns. Freestanding square columns such as those Saalman proposes would thus have created an architectural hodge-podge that Brunelleschi would not likely have tolerated, for the very reason that Saalman himself states: "Brunelleschi…preferred to work with few, relatively undifferentiated, parts in his designs to express homogeneity and uniformity rather than hierarchy and variety." Saalman, *Filippo Brunelleschi: The Buildings*, 206. The Santa Trinita precedent, which Saalman cites as the only supportive evidence for his proposal, has limited relevance here because, while it has two chapels that open to both the transept and the nave, it contains only rectangular piers and pilasters. Thus, the corner chapels of S. Trinita are supported by freestanding piers that blend harmoniously with all the other piers in the basilica.

[48] On the removal of the nave chapels, see Cohen, “How Much Brunelleschi?,” 56 n. 99.

[49] Hopper, *Medieval Number Symbolism*, 99-100 (hereinafter Hopper). On the oneness of God, Hopper quotes Aquinas as follows: “The human soul requires many and various operations and powers. But to angels a smaller variety of powers is sufficient. In God there is no power or action beyond his own Essence” (*Summa Theologica*, I, qu. 77, art. 2, as quoted in Hopper, p. 99). Hopper furthermore notes that according to Alanus de Insulis, “God is unity because unity regulates all plurality” (Regulae Alani de sacra theologia; P.L. 210, 623, as quoted in Hopper, p. 100). Similarly, in a discussion of cubic numbers Alberti, as noted previously, writes: “The first of all Cubes, whose Root is one, is consecrated to the Deity, because, as it is derived from One, So it is One every Way.” (see p. 104 n. 52).

[50] Hopper, 100.

[51] Hopper notes: “References to the Trinity do not become common or definitive until the third century and the doctrine was not to receive its final and official formulation until the Council of Constantinople (A. D. 381)” (Hopper, pp. 73 and 73 n. 10).

[52] Hopper, pp. 71-72, 83-84; Matthew (24:31); and Revelation (7:1). Umberto Eco additionally notes that “there were “four cardinal points…four phases of the moon, four letters in the name ‘Adam,’ and four was the constitutive number of Plato’s tetrahedron, which corresponded to fire. Vitruvius taught that four was the number of man, because the distance between his extended arms was the same as his height—thus giving the base and height of a square. Four was the number of moral perfection, and men experienced in the struggle for moral perfection were called ‘tetragonal’” (an expression that calls to mind my own boyhood Cub Scout pledge to “…be square and obey the laws of the pack) Umberto Eco, *Art and Beauty in the Middle Ages*, New Haven and London, 2002, 35-36.

[53] Hopper, pp. 74, 84 n. 58. Umberto Eco additionally notes that “there were five essences of things, five elementary zones, five genera of living creatures (birds, fish, plants, animals, men). Five was the number of Divinity, and was scattered throughout the Scriptures (the Pentateuch, the five wounds). The number five was found in man, for if the extremeties of his body were joined by straight lines they formed a pentagon.” Ibid, 36; and cf. Edmund Reiss, "Number Symbolism and Medieval Literature," *Medievalis et humanistica*, n.s. 1, 1970, 161-174.

[54] Alfred W. Crosby, *The Measure of Reality: Quantification and Western Society, 1250-1600*, Cambridge, 1997, p. 29.

[55] *Ibid*., pp. 29, 33.

[56] Seven represents the “Sabbath and Salvation” (Hopper, p. 85), and on Judgement Day, Albertus Magnus writes, the 7 ages of the world would come to an end (Hopper, p. 112).

[57] Hopper, p. 77.

[58] Hopper, p. 99. Similarly, Early Mesopotamian witings include references to "the four corners of the universe" and "heaven's four corners." Piotr Michalowski, :"Masters of the Four Corners of the Heavens: Views of the Universe in Early Mesopotamian Writings," in *Geography and Ethnography: Perceptions of the World in Pre-Modern Societies*, eds. Kurt A. Raaflaub and Richard J. A. Talbertp, Oxford, 2010, 153.

[59] I paraphrase here Hopper's remark: "…in the medieval mind a weblike structure of abstract ideas and concrete realities [was] so closely interwoven and interdependent that no serious gap was felt to exist between them" (Hopper, p. vii). This rather literal interpretation of medieval iconography is useful as a general guideline for understanding medieval number symbolism, but must be approached with caution. In a more general discussion of medieval architectural iconography, Crossley notes the problematic nature of the so-called *Strukturforschung* school, exemplified by Sedlmayr's proposal that Gothic architecture was an actual representation of Heaven, and not merely a symbol thereof. Rather, Crossley proposes, "The Christian church had always seen individual churches as metaphors of the Heavenly Jerusalem…" (Paul Crossley, "Medieval Architecture and Meaning: The Limits of Iconography," *Burlington Magazine*, February, 1988, pp. 118-119).

[60] As quoted in: Hopper, p. 113.

[61] As quoted in Richard Krautheimer, "Introduction to an 'Iconography' of Mediaeval Architecture," *Journal of the Warburg and Courtauld Institutes*, V, 1942, p. 9.

[62] Krautheimer similarly distinguishes between three types of symbolic interpretation of particular geometrical forms in architecture, each of which corresponds to one of the three categories of number symbolism proposed here (which I have inserted, in brackets, into the following passage by Krautheimer): "Rather than being either the starting point [generative symbolism] or else a *post festum* interpretation [derivative symbolism], the symbolical significance is something which merely accompanied the particular form which was chosen for the structure [associative symbolism]." *Ibid.*, p. 9.

[63] Proverbs, 9:1.

[64] Numbers, 29:12–32

[65] See, for example, the fresco cycles of the Arena Chapel and the Sistine Chapel, to name just two well-known iconographical programs that juxtapose scenes from the New and Old Testaments.

[66] Revelation, 4:5, 5:1.

[67] Hopper, p. 115.

[68] Hopper, p. 84–85.

[69] Hopper, p. 95, cf. p. 85. On the 7 gifts of the Holy Spirit, see Isaiah, 11:1-3.

[70] Hopper, pp. 84-85.

[71] On the symbolic association between columns and people, see: John Onians, , Bearers of Meaning: The Classical Orders in Antiquity, the Middle Ages, and the Renaissance (Princeton, 1988), p. 8; on the Early Christian symbolism of 12 columns, see: Onians, *ibid.*, p. 70ff. Similarly, Krautheimer cites numerous examples of centralized medieval buildings that contain 8, 12, or 20 columns or piers, evidently in direct reference to the 8 columns and 12 piers (20 total supports) in the rotunda of the Holy Sepulchre in Jerusalem (Richard Krautheimer, "Introduction to an 'Iconography' of Mediaeval Architecture," *Journal of the Warburg and Courtauld Institutes*, V, 1942, p. 10ff.). In the Early Christian basilica of S. Apollinare Nuovo in Ravenna, glittering mosaic processions of white-robed figures, walking toward the apse, occupy frieze bands above each arcade, and thus perhaps implying a direct relationship between columnar and human form.

[72] Hopper notes: "The altar steps are always 3 or some multiple" (Hopper, p. 114). That the total number of transept chapels, including the high chapel, that Giovanni de' Medici and Brunelleschi agreed to is also 9 is probably coincidental with regard to number symbolism, since Manetti's account, as we have seen, indicates that this number resulted from political and economic considerations (see p. 26).

[73] Note, however, that if symbolic intent existed in the mind of the architect but no evidence of it survives, we must assume that it did not exist.

[74] James Ackerman, "'Ars Sine Scientia Nihil Est': Gothic Theory of Architecture at the Cathedral of Milan," *Art Bulletin*, XXXI, 1949, 2, p. 100.

[75] Revelation, 4–11, 5:1; Margaret Kremers, "The Sculptured Friezes in the Nave of San Lorenzo," Thesis (bachelor's or master's not specified), Smith College, 1933, pp. 2-4.

[76] Galleria dell'Accademia #17, Jacobello Alberegno, "Polittico dell' Apocalisse," c. 1360 to 1390 (cat. 1000).

[77] This decorated exterior frieze constitutes one aspect of Brunelleschi's work that is prefigured in the architecture of ancient Rome, for example, in the sculptural frieze of the 1st century B. C. Temple of the Sibyl at Tivoli, but not in any work of the Tuscan Romanesque period. On the question of Roman influences, or lack thereof, in the works of Brunelleschi, see: Marvin Trachtenberg, "On Brunelleschi's Choice: Speculations on Medieval Rome and the Origins of Renaissance Architecture," in *Architectural Studies in Memory of Richard Krautheimer*, Cecil L. Striker, ed., Mainz, 1996, pp. 169-173.

[78] Kremers, *op. cit.*, pp. 3-4.

[79] Revelation 8:1, 11:15. In this account we also find themes of 4, linking the vision of the Apocalypse to the mundane world: "…I saw 4 angels standing at the 4 corners of the earth, holding back the 4 winds of the earth…" (Revelation, 7:1).

[80] Kremers notes that at the time of her writing, the theory that the entablature block frieze reliefs of San Lorenzo should be attributed to a follower of Brunelleschi, due to "their inappropriateness both architecturally and symbolically[,] gained many adherents." (Kremers, *op. cit.*, p. 4). Unfortunately, she names none of these adherents, and I have yet to come across any such commentary in the literature.

[81] The two freestanding crossing piers to which these friezes are attached appear to have been nearly complete in September 1443. See *Regesto* Doc. 1443c.

[82] Jacobus de Voragine, *The Golden Legend*, trans. Granger Ryan and Helmut Ripperger (New York: Arno Press, 1969), 437.

[83] George Kaftal, *Saints in Italian Art, Iconography of the Saints in Tuscan Painting* (Florence: Sansoni, 1952), 620, Episode No. 9.

[84] Antonio Manetti, *Vita di Filippo Brunelleschi*, Giuliano Tanturli, ed., Milan, 1976, p. 111.

[85] Manetti, *Vita*, ed. Tanturli, 110.