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

Cohen, M.A.

Beyond Beauty:
Reexamining Architectural Proportion in the Basilicas of San Lorenzo and Santo Spirito in Florence

> "Per lequale tutte cose essendo io studioso & di voluptate infiammato di intendere il fetoso intellecto, & la pervestigatione acre dil perspicace Architecto, dilla sua dimensione, & circa il liniamento & la prattica perscrutandola subtilmente cusi io feci. // Uno quadrato collocato soto le columne, bine per lato diligentemente mensurai. Dallaquale mensuratione facilmente tuta la symmetria compresi dilla prælibata porta. Laquale explanando transcorrero brevemente."
>
> —Francesco Colonna, *Hypnerotomachia Poliphili*, c. 1467[1]

1. Introduction

The basilica of San Lorenzo has a serene, orderly appearance that tends to make one think of geometry and mathematics, especially when it is compared with the medieval buildings that preceded it (Figure 1-1). Consequently, for over two centuries architectural historians have praised the proportions of the basilica. In the first volume of the *Encyclopédie Méthodique* of 1788, Antoine-Chrysostome Quatremère de Quincy remarks that "other than the beauty of the plan, one admires the beautiful proportions of the columns, and the purity of the profiles and entablatures."[2] While William Henry Goodyear, writing just over a century later, contends that compared with the "…picturesque cathedrals of the Middle Age…" the churches of the early Renaissance, of which he cites San Lorenzo as a representative example, "…cannot claim an equal interest…," he allows that they do have one redeeming quality: "…their sense of proportion and of system is a most interesting illustration of the modern spirit of fifteenth century Italy."[3] Emilio Lavagnino, in his condensed Brunelleschi guidebook of 1931, praises the "…geometrical regularity…" of the nave that reveals a "…necessity of rhythm…" and a "supreme all-encompassing Tuscan elegance."[4] These accounts present architectural proportion as an aesthetic problem.[5]

In an influential article of 1953, Rudolf Wittkower describes the basilica as having "metrical discipline," and associates its proportions with the mathematics underlying Brunelleschi's invention of scientific perspective drawing.[6] Ever since, most scholars have expressed *de rigueur* praise for the orderly beauty of the basilica using quantitative, mathematical terminology. Thus the fourth edition of *Helen Gardner's Art Through the Ages*, published in 1959, departs from Gardner's earlier editions by describing the San Lorenzo proportions in terms of ratios, and concluding that early Renaissance

architects strove "…to express simple, mathematical relationships in their buildings."[7] H. W. Janson, in his *History of Art* first published in 1962, similarly concludes, after a lengthy discussion of the San Lorenzo proportions, that "…the harmonious, balanced character…" of the design is a product of "…proportional ratios expressed in simple whole numbers."[8] In his slim *Pocket Guide to Architecture* of 1980, Patrick Nuttgens also summarizes what appears to be his aesthetic assessment of the basilica in the following quantitative terms: "S. Lorenzo is notable for the precision of its proportions."[9] In their architecture survey textbook of 1986, Marvin Trachtenberg and Isabelle Hyman perpetuate this Wittkower-inspired convention when they note the "lucid…mathematical ordering of space" in San Lorenzo.[10] Only Howard Saalman, in his 1993 Brunelleschi monograph, provides quantitative, if largely inaccurate, discussions of the San Lorenzo proportions that are mostly free of aesthetic assessments.[11] These post-1953 accounts present architectural proportion as a mathematical problem, usually with aesthetic implications.

The preceding exerpts from the San Lorenzo literature indicate that the persistent scholarly association of this basilica with the subject of architectural proportion stems from a longstanding scholarly consensus that the basilica possesses orderly beauty, and that proportion is somehow a cause or explanation of it.[12] We see that scholars have framed architectural proportion either as an aesthetic problem, a mathematical problem; or both simultaneously, when they have assumed that qualitative aesthetic assessments can have quantitative causes (see Epilogue). These aesthetic judgments and attendant mathematical interpretations of architectural form, however, are merely modes of visual description. They draw scholarly attention away from the value of architectural proportion as an historical problem. They focus primarily on the aesthetic judgements of the *observers* (i.e., of *us*, the historians) in various periods in history, including the present, rather than on the knowledge and interests of the *original architects, patrons and intended audiences* of the basilica of San Lorenzo (i.e., of *them*, the subjects of the historians' research).[13] They thus have limited value in the study of architectural history.

The present study reexamines the problem of architectural proportion in the basilica of San Lorenzo following a rigorous new methodology that combines observation-based and documentary evidence for the purpose of identifying the proportional intentions of its fifteenth-century creators. It finds that the proportions of this basilica are indeed extraordinary, but for reasons different than previous scholars have believed. This study analyzes the proportions of the basilica with greater quantitative precision than any previous study, and demonstrates that carefully-crafted *sets of proportions* expressed in the measurements constitute mental constructs that communicate non-visual, iconographical content. This study thus reframes the subject of architectural proportion as part of the rhetorical, rather than visual, structure of architecture. Like Francesco Colonna's

investigation of an ancient portal recounted in the epigraph above, this study begins by measuring the proportions of an arched portal, and uses the resultant measurements as tools with which to probe the "fertile intellect" of the architect; and indeed that intellect, rather than the physical products of its labors, is the ultimate subject of this study.

1.1 Definitions

Architectural proportion is part of the rhetoric of architecture both as a mode of communication *through* architecture and *about* architecture. Thus, in the first case architectural proportion is a subject of study, such as when an architect uses a particular set of dimensions to form a number progression that communicates iconographical content; and in the second case it is a tool with which to study, such as when the architect or a later observer uses numbers to describe physical proportions in purely mathematical terms. As a rhetorical tool, the idea of architectural proportion requires clarification not only because architects often understood it differently than did later observers of their buildings (i.e., communication through vs. about architecture), but because both the word proportion, at least in English and the Romance languages, and the concept of proportion each simultaneously signify two fundamentally opposed ideas. In 1914 Geoffrey Scott elegantly summarized this problem as follows: "It was realised that 'proportion' is a form of beauty; it was realized that 'proportion' is a mode of mathematics. But it was not realized that the word has a different bearing in the two cases."[14] Thus, when architectural historians use the word proportion, the meaning is often unclear to both author and reader alike.

When Quatremère de Quincy writes of the "beautiful proportions of the columns" of San Lorenzo, or when Goodyear praises the "sense of proportion" in early Renaissance churches, the modifiers that precede the word "proportion" in both cases leave no question that proportion signifies architectural beauty. What, however, could Nuttgens mean by the "precision" of San Lorenzo's proportions in the passage quoted above? If he were referring to proportions solely in the mathematical sense, the comment would be redundant and undescriptive, since proportional ratios are by definition precise. He could not be referring to the precision with which the proportions were constructed in accordance with the architect's specifications, since no such specifications have come down to us, and since Nuttgens had no way of knowing with quantitative precision what the proportions of the basilica are.[15] Nuttgens includes no modifiers, such as "precise-looking," to denote proportion as an aesthetic assessment. Rather, he seems to mean *both* that the basilica looks orderly—presumably in a beautiful way or he would not have made the comment—and that the assumed presence of precisely-executed mathematical sequences in the dimensions of the building must be the cause of this appearance. Thus, he seems to be referring *simultaneously* to orderly beauty

and mathematical proportions. The same ambiguity may be observed in all the post-1953 remarks about the San Lorenzo proportions quoted above.

The problem with this qualitative/quantitative ambiguity inherent in both the term and concept of proportion is that, as anyone who has ever measured an orderly-looking building knows, mathematically regular proportions are not necessary preconditions for an *appearance* of orderly beauty in architecture—and indeed, mathematical regularity is as often associated with architectural monotony as with beauty.[16] Thus, mathematical regularity cannot logically constitute a basis for aesthetic judgment. Indeed, mathematical regularity cannot even be perceived unless it is identified through measurement since the naked eye, unaided by measuring instruments, is not capable of perceiving metrical order with precision. If it were, human beings would not have invented measuring instruments. Therefore, architectural proportions cannot be objectively described using quantitative terminology (such as "mathematical" and "science" in the preceding quotations) unless they have first been measured. Furthermore, invisible iconographical devices such as symbolic numbers expressed in building dimensions must also be unrelated to architectural aesthetics, for they can only be apprehended by the intellect, through the intermediary of language.[17]

Since the word proportion, which I am obliged to use in this study for lack of any suitable substitute, by convention carries an aesthetic connotation and thus the potential to create confusion as to my purpose and conclusions, I provide the following definitions to separate aesthetics from architectural proportion. With my verbal analytical tools thus sharpened, I will study architectural proportion as a non-aesthetic historical problem.

Proportion-1 (Ratio), Proportion-2 (Beauty), Proportion-3 (Sets of Proportions) and Proportion-4 (Proportion in General)

As elucidated by Scott above, the word proportion, as commonly used in his day and ours, has two main meanings, one quantitative and the other qualitative.[18] The quantitative meaning denotes a mathematical ratio, such as 2:3. Typically, however, the word connotes the broader qualitative meaning, which appears to have entered the English language in relation to architecture with Ephraim Chambers's 1723 translation of the French *Traité d'architecture* of 1714 by Sébastien Le Clerc: "By Proportion I don't here mean a Relation of Ratios as the Geometricians do; but a Suitableness of parts, founded on the good Taste of the Architect."[19] These two meanings are unrelated and opposite to one another because the first, which I will call "proportion-1," is an abstract quantitative comparison; while the second, which I will call "proportion-2," is a qualitative aesthetic assessment of an identified object. In this study I will always use the word proportion with sufficient context to indicate whether the quantitative or qualitative meaning is intended. For

example, an unmodified reference to the proportions of a column would signify the quantitative, width-to-height ratio that the column embodies (proportion-1). In such a case, due to the dimensional complexity of entasis, I would specify the height above the ground at which the column width was measured. Conversely, when I intend the qualitative sense of the word (proportion-2), I will use appropriate modifiers, such as the "more robust proportions" of the Santo Spirito columns compared with those of San Lorenzo, in order to make clear the aesthetic nature of the observation.

While this study avoids discussion of proportion-2, it requires a term that is more inclusive than proportion-1. Architectural proportion as an historical phenomenon is a rhetorical construct that combines multiple geometrical, numerical and arithmetical relationships, rather than just one as proportion-1 (a ratio) denotes.[20] The term "proportional system" has proven ill-suited to fill this role because it is laden with distracting preconceptions.[21] The word "system" implies a dynamic, quantitative mechanism that leads to a result, and many scholars tend to assume that the result of proportional systems is beauty, due to the aforementioned dual meaning of the word proportion. Furthermore, the word system can misleadingly imply that the subject under consideration is intensely scientific and mathematical, when in fact sets of proportions in historic architecture typically involve only rudimentary geometry, number theory and arithmetic. To supplement proportion-1, therefore, I will use the term "set of proportions," or "proportion-3," to denote:

> A group of geometrical, numerical or arithmetical correspondences between important dimensions throughout a building or major part thereof, placed there by the architect with the intention of imbuing built form with desirable qualities, physical or otherwise.[22]

Since this definition requires that a minimum of two proportional correspondences be present, it provides a useful way to distinguish intentional proportions from coincidental ones. For example, many individual proportions (proportion-1) that may seem to be historically significant, such as a root-2 rectangle ($1:\sqrt{2}$), might appear in a complex building through mere dimensional coincidence rather than the intentions of the architect, especially if the researcher includes numerous points of measurement in the analysis and leaves generous allowance for assumed construction error. A geometrical proportion that is *simultaneously* expressed in terms of whole numbers of the local unit of measure, however, may be considered less likely to be coincidental than one that lacks such simultaneous numerical expression.[23]

This definition is only useful, however, when the historian presents evidence that the individual proportional correspondences that make up an identified set of proportions were indeed

conceived separately by the architect, and are not merely the historian's alternative interpretations of a single proportional correspondence. For example, if documentary or other evidence were to indicate that an architect laid out a church floor plan in conformance with proportions that he understood to be those of a square-and-a-half rectangle, an historian would not, according to this definition, be able to assume that the architect simultaneously understood the floor plan proportions in terms of the whole-number ratio 2:3, nor an harmonic diapente ratio (2:3), nor any other descriptions of the proportional ratio in question other than those that could be documented as representing the architect's intentions. The kinds of evidence that might be acceptable for such an identification will be discussed below. This definition furthermore requires an acknowledgement on the part of the historian that complexity and irregularity are the normal conditions of architecture, and that consequently, any intentional sets of proportions in an executed work are likely to contain deviations from the architect's original intentions due to construction errors or other contingencies. Some intended sets of proportions, therefore, may be impossible to identify, and thus lost to history.

In addition to "proportion-1," "proportion-2," and "sets of proportion" (proportion-3), for convenience I also allow for a fourth mode of discussing proportion, which I will call "proportion-4." This mode includes general references to the subject of architectural proportion that leave intact the quantitative/qualitative ambiguity that typically accompanies the term proportion today. My reference to proportion in the title of this study, for example, and in the second sentence of this introduction before my presentation of the sub-definitions noted above, fall into the category of proportion-4. This mode is used sparingly in this study.

1.2 The Wittkower Paradigm

The belief among most scholars today that certain proportions (proportion-1) contribute to widespread perceptions of orderly architectural beauty (proportion-2) traces back at least as far as the fifteenth century, but became formalized in the scholarly literature in the writings of Rudolf Wittkower.[24] We have seen that with an article of 1953 Wittkower effectively branded the basilica of San Lorenzo as a building that possesses orderly beauty due to the "metrical discipline" of its proportions.[25] Wittkower's aesthetic interpretation of proportional ratios in architecture had become widely-accepted in the field of architectural history several years earlier, however, with the publication of his book *Architectural Principles in the Age of Humanism* in 1949; and had been first introduced into the scholarly literature earlier still, with the publication of a future chapter of the book as an article in the *Journal of the Warburg and Courtauld Institutes* in 1945.[26]

Wittkower's blending of proportion-1 and proportion-2 constitutes the basis of his comprehensive theory of medieval and Renaissance architecture, which I call the Wittkower

Paradigm because it is widely-accepted and rarely questioned in the field of architectural history today.[27] Indeed, some scholars have interpreted my previously-published findings pertaining to the proportions of the basilicas of San Lorenzo and Santo Spirito in terms of this paradigm, even when I have specifically noted that my findings contradict it.[28] The present study continues my reexamination of the measurable proportions of these basilicas (proportion-1 and proportion-3) independent of the Wittkower Paradigm. Although challenging the Wittkower Paradigm is not a purpose of this study, such a challenge is nonetheless provided by the extensive contrary evidence that this study brings to light, which the paradigm cannot explain. A brief summary of this paradigm is necessary in order to help the reader recognize it and understand where my findings challenge it. The Wittkower Paradigm has three main characteristics: 1) an aesthetic interpretation of the problem of architectural proportion in architecture, 2) suppression of the physical object of study, and 3) a set of assumptions that I call "Geometry vs. Number."

Aesthetic Interpretation of Architectural Proportions

In his Preface to the 1962 edition of *Architectural Principles*, Wittkower notes that he intended the book primarily to addresses the issue of aesthetics in Renaissance architecture. According to Wittkower, when the book first came out in 1949, "Kenneth Clark wrote in the *Architectural Review* that the first result of this book was 'to dispose, once and for all, of the hedonist, or purely aesthetic, theory of Renaissance architecture,' and this defined my intention in a nutshell."[29] The word "purely" in this passage indicates that Wittkower does not object to *all* aesthetic interpretations of Renaissance architecture, but only those that would interpret it as "art-as-such," independent of any theoretical, social, practical, or other considerations.[30] As the title implies, Wittkower's *Architectural Principles in the Age of Humanism* appears to be a reply to Geoffrey Scott's *The Architecture of Humanism* of 1914, in which Scott declares: "The Renaissance produced no theory of architecture. It produced treatises on architecture…. [Renaissance architects] gave us rules, but not principles [my underline]. They had no need of theory, for they addressed themselves to taste."[31]

For Scott, Renaissance architecture is based on taste rather than theory, and the aesthetic impulse of taste is "…guided, if it is guided at all, by instincts of which the intellect can give no immediate account."[32] Scott furthermore denies that any "exact mathematical sequences," "fixed ratios," or "fixed proportions" can be responsible for architectural beauty.[33] Thus, while Scott recognizes proportion-1, as in the preceding quotations; and proportion-2, as in his references elsewhere to, for example, a scheme of "vast proportions" and an "ill-proportioned" decorative order, he does not recognize proportion-3, or, the possibility that Renaissance architects might have used

particular proportional relationships (proportion-1), in sets, for theoretical purposes.[34]

Wittkower's contribution to the study of architectural proportion is his recognition of what I have labeled proportion-3 as a promising topic of scholarly inquiry. Indeed, prior to the publication of *Architectural Principles*, no scholar had ever seriously considered the possibility that sets of proportions (also my term) might contain theoretical content.[35] Wittkower, however, sees no need to separate proportion-3—or, for that matter, proportion-1, which proportion-3 contains—from proportion-2. Thus, he sees no need to separate quantitiative proportions from architectural aesthetics. On the contrary, he bases much of his theory of Renaissance architecture on the assumed unity of all three. Thus he asserts: "I think it is not going too far to regard commensurability of measure [proportion-1] as the nodal point of Renaissance aesthetics [proportion-2]."[36]

That Wittkower's reference to aesthetics in the preceding quotation refers *both* to the aesthetic perceptions of Renaissance architects (any anachronism in his use of the term aesthetics to apply to the Renaissance notwithstanding), *and* to the aesthetic perceptions of Wittkower and his readers, is made clear in his claim that: "Italian architects strove for an easily perceptible ratio between length, height and depth of a building, and Palladio's villas exhibit this quality most lucidly."[37] Thus, according to Wittkower, Renaissance architects "strove"—past tense—to produce a particular aesthetic effect, and their buildings "exhibit"—present tense—this effect to us today. We must not, therefore, make the mistake of interpretting Wittkower's theory of Renaissance architecture as entirely historical. It uses historical analysis as a tool of architectural criticism, in order to explain the orderly appearance of Renaissance architecture today (proportion-2) as a product of particular proportional ratios (proportion-1). Wittkower may speculate about the intentions of Renaissance architects, but he always returns to the aesthetic perceptions of the present-day observer, which are his main concerns, even if such perceptions are subjective, and ultimately Wittkower's own perceptions.

Wittkower initiates another historical discussion for the purpose of explaining his aesthetic interpretation of Renaissance architecture(proportion-2) in terms of quantitative architectural proportions (proportion-1), in his discussion of the façade of the basilica of Santa Maria Novella. In *Architectural Principles* he writes:

> "All the new elements introduced by Alberti in the façade, the columns, the pediment, the attic, and the scrolls, would remain isolated features were it not for that all-pervading harmony which formed the basis and background of his whole theory. Harmony, the essence of beauty, consists, as we have seen, in the relationship of the parts to each other and to the whole, and, <u>in fact</u> [my underline], a single system of

> proportion permeates the façade, and the place and size of every single part and detail is fixed and defined by it. Proportions recommended by Alberti are the simple relations of one to one, one to two, one to three, two to three, three to four, etc., which are the elements of musical harmony and which Alberti found in classical buildings."[38]

In this passage Wittkower presents his description of the façade from Alberti's point-of-view up to the words "in fact." He then shifts to the reader's (and thus his own) point-of-view. In the next sentence he shifts back to Alberti's point-of-view, with a discussion of some of the quantitative proportions that Alberti recommends in *De re aedificatoria*, Book IX. Wittkower continues with a proportional analysis accompanied by his own single-line diagrams of the façade in question, quantitatively describing proportional ratios that he believes to be present in the façade, by noting: "…the whole building is related to its main parts in the proportions of one to two, which is in musical terms an octave."[39] He bases these descriptions, however, neither on measurements nor on documentary evidence of Alberti's intended proportions, but rather, on his own aesthetic interpretations. Wittkower's absolute confidence in the correctness of these interpretations, such that he accords them the reliability of quantitative, factual evidence—he even uses the word "fact" in the preceding passage to describe his aesthetic interpretation of Alberti's façade—helps to explain his consistent suppression of the object in his studies of architectural proportion, which is the second characteristic of the Wittkower Paradigm.

Suppression of the Object

Wittkower's confidence in his ability to describe aesthetically-pleasing proportions (proportion-2) in the quantiative terms of proportion-1, and to supplement these descriptions with documents that he believes supports them by providing evidence of Renaissance ways of thinking that are consistent with them, leads him to suppress the object—i.e., the building under consideration—in favor of the ideas that he believes the object represents. He sees no need to confirm his aesthetic interpretations through direct observation of the object, such as measurement. Thus in the preceding example, Wittkower makes the aesthetic judgement that Alberti's Santa Maria Novella façade appears orderly, finds in *De re aedificatoria* evidence that Alberti was interested in simple whole number ratios; and then, based on these aesthetic and documentary observations, concludes that "in fact" Alberti used such proportions in the design of this façade.

That Wittkower is not opposed to measurement as a research method, however, but simply finds it to be unnecessary, is indicated by his footnote to his later comment in *Architectural*

Principles: "…Palladio's conception of architecture, as indeed that of all Renaissance architects, is based on commensurability of ratios." The footnote reads: "The time for a reliable survey of Renaissance buildings has not yet come, but I feel confident that it would confirm my assumption."[40]

In his 1953 discussion of the aesthetic proportions (proportion-2) of the basilicas of San Lorenzo and Santo Spirito, Wittkower uses an overtly psychological tactic to suppress the object. After making the aesthetic observation that when the basilica of San Lorenzo is viewed down the length of the nave it appears "metrical" (i.e., orderly), and conveys a visual impression similar to that of an early Renaissance perspective panel, he refers to documentary evidence that Brunelleschi invented scientific perspective drawing. Then, based on these aesthetic and documentary observations, he asks his readers to meditate upon the orderly appearances of both of Brunelleschi's basilicas, while trying to imagine that Renaissance people saw these buildings in the perspectival manner that he proposes. He writes:

> "We all know that the way we see visual images depends on the notions in which we believe. Brunelleschi's invention of linear perspective set the seal to the Renaissance conviction that the observing eye perceives metrical order and harmony throughout space. If one is keyed up to the metrical discipline of buildings like S. Lorenzo or S. Spirito and tries to see as if through a screen the lines retreating towards the vanishing point and the quickening rhythm of the tranversals, it is possible to evoke visual reactions similar to those which Renaissance people must have experienced."[41]

When in this passage Wittkower encourages his readers to become "keyed up to the metrical discipline" of Brunelleschi's basilicas, he is not encouraging them to measure the buildings in order to understand the actual metrical characteristics of the objects. On the contrary, the objects are far from his concern in this presentation of an abstract theory of Brunelleschi's assumed aesthetic intentions. He writes "metrical discipline," which implies proportion-1, but he clearly means orderly beauty, which is proportion-2. He thus suppresses the object (the bearer of proportion-1), in order to avoid what he considers to be the distraction of unecessary measurements. He considers measurements to be unecessary due to his belief that the subject of his study, the orderly beauty of the basilica (proportion-2) is a product of mathematical ratios (proportion-1), and that a causal relationship between the two is plainly visible and therefore factually certain without measurements.

According to the Wittkower Paradigm, even documentary evidence that pertains directly to the physical characteristics of the object can be suppressed when it conflicts with a preferred aesthetic interpretation. A critical element in Wittkower's "metrical" interpretation of the basilica of

San Lorenzo, for example, is the dark, *pietra serena* grid pattern in the pavement, which includes a dark line running down the middle of the nave (Figure 1-1). According to Wittkower, this "…dark line of the central axis invites the visitor to move along it so that both walls of the nave seem to diminish equally towards the vanishing point." In a footnote to this statement Wittkower notes: "The present floor dates from 1886, but the design, no doubt, repeats the original one."[42] In fact, no evidence of the original pavement pattern has come to light, but an interior view of 1671 by Giovanni Baptista Falda shows a different pavement design with no central stripe (Figure 1-2).[43] Whether this design is the original one or Falda's invention is unknown, but its lack of correspondence with the present design at least raises doubt about the originality of the latter. Despite the lack of evidence pertaining to the original pavement, Wittkower suppresses the nineteenth-century identity of the present pavement and substitutes it with an assumed fifteenth-century design intention. He does so based on his belief that his aesthetic interpretation of the building, which he supports by citing documentary evidence of Brunelleschi's interest in perspective, provides more reliable evidence about the original pavement design than any potentially contrary physical evidence provided by the object (such as a post-fifteenth century date of manufacture), even if that contrary physical evidence is supported by documentary evidence.[44]

Once one believes that one's aesthetic judgements of proportion-2 can be accurately described in the quantitative terms of proportion-1, but a small intellectual step is required to believe that one's perceived aesthetic distinctions between architectural styles can be described in quantitative terms as well. Thus, if one believes that some buildings contain orderly beauty (proportion-2) because of particular proportional relationships in their dimensions (proportion-1), one might be inclined to believe that some buildings look Gothic and others Renaissance because of differences in the kinds of proportional relationships contained in their dimensions.[45] Furthermore, if "commensurability of measure" can be the "nodal point of Renaissance aesthetics," as Wittkower claims (see above), then perhaps *incommensurability* of measure can be the nodal point of *medieval* aesthetics. Such hypothetical reasoning provides a possible explanation for the third characteristic of the Wittkower Paradigm, the theory of "Geometry vs. Number."

Geometry vs. Number

Wittkower began revealing the principles of the Geometry vs. Number theory as a component of the Wittkower Paradigm in 1945, with the publication of his aforementioned article "Principles of Palladio's Architecture—II" in the *Journal of the Warburg and Courtauld Institutes*.[46] In this article he first presents his theory of a Palladian, and thus Renaissance, system of architecture based on whole number ratios. In his 1949 revision of this article for inclusion in *Architectural Principles*, he

makes an inconguous yet revealing digression from his discussion of Palladio and music theory: he inserts a brief analysis of a drawing by Sebastiano Serlio that depicts a classical, pedimented door frame inscribed within a large square. The square, he notes, is crisscrossed by regulating lines that intersect the corners of the frame (Figure 1-3). Serlio thus appears to present a geometrical method for generating the proportions of the frame. Not so, Wittkower continues however, for Serlio's intentions, he claims, were in fact numerical and harmonic. He writes: "Serlio does not mention explicitly that the opening thus constructed is related to the width of the bay as 1:3 and to the height of the square as 2:3. Thus we are back to ratios of small integral numbers with their musical connotations."[47] The possibility that a Renaissance architect might have determined architectural proportions using geometry rather than number evidently caused Wittkower considerable discomfort, so in this passage he simply interprets Serlio's geometrically-derived door frame proportions as numerical.

In the third edition of *Architectural Principles*, published in 1962, Wittkower further reveals this discomfort in his complicated elaboration of this numerical interpretation of Serlio's geometrical door frame proportions. In the revised passage Wittkower admits that Serlio's drawing "...seems to suggest a geometrical procedure, not very different from the 'ad quadratum' method practiced during the later Middle Ages."[48] There is a difference, Wittkower claims however, between medieval geometry and Serlio's method, for "...in Serlio's case, the geometrical scheme is posterior rather than prior to the ratios chosen for the door. His design was evidently the result of commensurable divisions of the large square." The proportions of the door are all whole number ratios, Wittkower continues, such as 1:3 and 2:3, and thus "'mediaeval' geometry here is no more than a veneer that enables practitioners to achieve commensurable ratios without much ado."[49]

Wittkower must have considered Serlio's geometrical door frame construction to be a highly visible potential contradiction to his numerical interpretation of Renaissance architectural aesthetics to have devoted so much intellectual energy to keeping "'mediaeval' geometry" and Renaissance number separated. A Renaissance architect such as Serlio, according to the Geometry vs. Number theory within the Wittkower Paradigm, could not have used geometry in any important way to establish architectural proportions; and if any evidence, such as Serlio's door construction, appears to indicate that he did, then some explanation for it must, and inevitably can, be found within the limits of the paradigm.

In his article "Systems of Proportion," published in the *Architect's Yearbook* in 1953, Wittkower articulates the Geometry vs. Number theory more comprehensively. There he summarizes the theory in three non-consecutive paragraphs. In the first, Wittkower establishes the basic premise of Geometry vs. Number:

> "It has, I hope, become evident that two different classes of proportion, both derived from the Pythagoreo-Platonic world of ideas, were used during the long history of European art, and that the Middle Ages favored Pythagoreo-Platonic geometry, while the Renaissance and classical periods preferred the numerical, i.e., the arithmetical side of that tradition."[50]

In the second paragraph, he elaborates on the Renaissance side of this two-sided theory—the side that claims that the Renaissance favored the use of whole numbers rather than irrational proportions generated by geometry, and that such use expressed the spirit of the age:

> "It seems almost self-evident that irrational proportions would have confronted Renaissance artists with a perplexing dilemma, for the Renaissance attitude to proportion was determined by a new organic approach to nature, which involved the empirical procedure of measuring, and was aimed at demonstrating that everything was related to everything by number. I think it is not going too far to regard commensurability of measure as the nodal point of Renaissance aesthetics."[51]

He devotes the third paragraph to the medieval side of the theory, which claims that the medieval period favored the use of geometry in art and architecture, rather than number, and that such usage also expressed the spirit of the age:

> "While to the organic, metrical Renaissance view of the world rational measure was a *sine qua non*, for the logical, predominantly Aristotelian medieval approach to the world the problem of metrical measure hardly arose. And although the Pythagoreo-Platonic concept of the numerical ratios of the musical scale never disappeared from mediaeval theological, philosophical, and aesthetic thought, there was no over-riding urge to apply them to art and architecture. On the contrary: the mediaeval quest for ultimate truth behind appearances was perfectly answered by geometrical configurations of a decisively fundamental nature; that is, by geometrical forms which were irreconcilable with the organic structure of figure and building.[52]

> Wittkower subsequently republished variations of these three broadly-worded paragraphs,

with little or no elaboration, several times throughout his career.[53] These far-reaching statements have received little scholarly challenge to date.[54] The resilience of the theory of Geometry vs. Number may owe in part to its lack of specificity, a characteristic that Wittkower enhances by allowing five exceptions to it:

Exception #1: Flexible Historical Interpretation of Geometry and Number

According to Wittkower's first and most general exception to the Geometry vs. Arithmetic component of the Wittkower Paradigm, examples of whole number proportions in medieval architecture, and of geometrical proportions in Renaissance architecture, are acknowledged to exist but are not considered to be historically significant because number, according to Wittkower, was not as important to the medieval period as it was to the Renaissance, and geometry was not as important to the Renaissance as it was to the medieval period. Wittkower writes:

> "Of course, metrical proportions were used during the Middle Ages—indeed no building is possible without them—and geometry played a considerable part in Renaissance aesthetics and Renaissance thought. I have only to remind the reader of the importance attached to the circle. On the other hand, it must be asked whether the same numerical and geometrical proportions also had the same meaning in the Middle Ages and the Renaissance. The answer seems to be in the negative."[55]

Exception #2: The Circle and the Square

The second exception is a subsidiary of the first, but deserves separate consideration due to the importance of both the circle and the square in the architecture of both the medieval and Renaissance periods. To Wittkower's reference to the circle in the preceding quotation we may add his comments regarding the capability of the square to have either a medieval or Renaissance identity, depending on the interpretations of the original users:

> "The medieval 'just measure' with its setting of one square into another was discarded by Renaissance artists, no doubt, because of the incommensurability of this configuration. But it was during the Renaissance that artists became aware of the simple numerical ratios of the sides of a square, and in the ratio 1:1 (unison in music) a Renaissance mind found beauty and perfect harmony. Thus it appears that such a simple geometrical figure as the square can be used in a metrical and rational as well as in a geometrical but irrational context, and can elicit completely different reactions."[56]

Thus, Wittkower claims here, just as Serlio drew geometrical figures to explain his contruction of a classical door surround, as noted above, but in fact—according to Wittkower—meant to communicate not geometrical relationships but numerical harmonic ones; whenever Renaissance architects used the square, they intended to express not a geometrical figure but the numerical harmonic ratio of 1:1, or, a unison. I describe the preceding passage as a claim rather than an argument because it is not supported by evidence.

Exception #3: The Ratio 1:√2

According to Wittkower, the ratio 1:√2 "…is the only irrational number widely propagated in the Renaissance theory of architectural proportion."[57] Since the ratio 1:√2 is by far the most commonly-mentioned irrational ratio in the scholarly literature pertaining to medieval architectural proportions, this exception is very significant indeed, especially since Wittkower addresses neither the contradiction between it and the second sentence that follows it in *Architectural Principles*: "It is probably right to say that rarely did Palladio or any other Renaissance architect use irrational proportions in practice…"; nor between it and his above-quoted claim that "…irrational proportions would have confronted Renaissance artists with a perplexing dilemma."[58]

Exception #4: *Quattrocento* Transition

Wittkower excludes the entire fifteenth century, or approximately half of the Renaissance, from his theory of Geometry vs. Number by interpreting this century as a "transition" during which mixtures of medieval geometry and Renaissance number might be found. He writes:

> "To be sure, nobody in his senses will deny that mediaeval geometrical concepts survived and were still being used in the Quattrocento. Nevertheless such a statement should not obscure a recognition of the new and characteristic pattern of the Renaissance position. It is even possible to point out precise moments of transition from a primarily geometrical to an arithmetical approach to proportion."[59]

Exception #5: Medieval Survivals

Finally, Wittkower allows the possiblity that some Renaissance architects might "still" have been aware of "medieval conceptions of proportion," and might have used them on occasion, as in

the following statement pertaining to sixteenth-century plans for the continuation of construction of the basilica of San Petronio in Bologna:

> "In 1592 an architect who was still aware of medieval conceptions of proportion published an engraving in protest against the proposed reduction of height. He suggests that by abandoning the medieval triangulation the church would lose proportion and coherence."[60]

Thus, according to this exception, knowledge of triangular proportions could not have constituted Renaissance knowledge, even if it reached the Renaissance from the medieval period through the continuity of cultural transmission. Rather, such knowledge could only constitute an exception to normal, number-oriented, Renaissance knowledge.

The Present Study vs. The Wittkower Paradigm

Readers will have to evaluate for themselves how many exceptions Wittkower's theory of Geometry vs. Number can accommodate before the exceptions invalidate it. The present study is inadvertently based on the inverse of the three-part Wittkower Paradigm, which we have seen consists of: 1) an aesthetic interpretation of the problem of proportion, 2) suppression of the object, and 3) "Geometry vs. Number"; for the present study is characterized by the following three assumptions and methods: 1) sets of architectural proportions are interpreted as rhetorical devices that have no influence on anyone's aesthetic appreciation of architecture, 2) all hypotheses are based on evidence derived from direct observation of the object, and 3) geometry and number are assumed to have been complementary and equally-important tools of architectural design throughout both the medieval and Renaissance periods.

In summary, Wittkower's framework for the study of medieval and Renaissance architecture is based on an aesthetic interpretation of architectural proportion that assumes that orderly beauty (proportion-2) has quantitative causes (proportion-1). The present study removes aesthetic considerations from the study of architectural proportions as mathematical constructs (proportion-1), and reframes the subject as a study of rhetorical structures composed of sets of proportions (proportion-3) that are incorporated into architectural dimensions to communicate non-visual iconographical content.

In this study I avoid aesthetic considerations of architectural proportions by maintaining a strict separation between proportion-1 and proportion-2, and by assuming that these two types of proportion can have no significant influence on each other. I do so based on the following two

contentions: 1) aesthetic interpretations of quantatitive architectural proportions are inherently illogical (see Epilogue), and 2) such interpretations constitute unproductive distractions from the study of architectural proportion as an historical problem. I expect that most readers will not readily accept either of these contentions. I simply ask those readers to set aside temporarily all aesthetic considerations of proportion (proportion-2) in order to test the new approach to the study of architectural proportion (proportion-1 and proportion-3) that I present in this study.

1.3 Summary of Chapters

In preparation for the historical investigations of the basilicas of San Lorenzo and Santo Spirito presented in the main body of this study, this introduction (Chapter 1) examines longstanding scholarly preconceptions pertaining to the first of these buildings, and their likely causes. It demonstrates that the persistent scholarly association of the orderly appearance of the basilica of San Lorenzo with the subject of architectural proportion stretches back over two centuries, and appears to be rooted in the inherent ambiguity contained within both the word and concept of proportion. Since the eighteenth century, this introduction argues, most architectural historians have associated proportion *simultaneously* with mathematical (or geometrical) relationships *and* architectural beauty. This conflation has led architectural historians to treat architectural proportion as an aesthetic problem rather than an historical one; and thus, to treat it as a mode of speculation about the causes of early Renaissance architectural beauty as perceived by historians, rather than as a cultural product of the fifteenth-century that can illuminate the intentions of early Renaissance architects and patrons.

In order to remove aesthetics from any discussion of proportion as an historical problem, this introduction establishes definitions that distinguish between proportion as a description of architectural beauty, and proportion as a mathematical (or geometrical) relationship. It then builds upon the latter definition by proposing that late medieval and early Renaissance architects created "sets of proportions," embedded in the dimensions and quantities of architecture, to communicate non-visual, iconographical content. Thus, the present study reframes the subject of architectural proportion as part of the rhetorical rather than aesthetic structure of architecture.

This reframing represents a radical departure from the customary view of architectural proportion as a primary contributor to Renaissance aesthetics. Indeed, this customary view is so firmly established among scholars today that it may be considered a paradigm—I call it the Wittkower paradigm in acknowledgment of Rudolf Wittkower's singular role in promoting it in his various publications of the 1940s and 1950s. Since most scholars will likely be inclined to interpret the findings of this study in terms of the Wittkower Paradigm, and since I argue that such an interpretation would be fundamentally incorrect, in this introduction I provide a brief critical

summary of this paradigm, identifying three main characteristics of it: 1) an aesthetic interpretation of architectural proportion, 2) suppression of the object of study, and 3) the theory that I call "Geometry vs. Number." Readers will thus be able to recognize this paradigm as a distinct theoretical framework that need not be accepted as a given.

Chapter 2 turns to the basilica of San Lorenzo and begins with a metrical analysis of a single bay of the nave arcades. This analysis is based on an original survey, conducted by the author from mobile scaffolding erected in the basilica by the Italian government for this purpose. This metrical analysis forms the basis of a new methodology that combines observation-based and documentary sources in order to identify intentional proportions and distinguish them from coincidental ones. It then applies this new methodology to reveal three overlapping sets of proportions in the San Lorenzo nave arcade bays, each exhibiting the architect's mastery of geometry, number theory and arithmetic, respectively. The scope of this chapter expands when necessary to include the arcade bays of the basilica of Santo Spirito, and broad historical themes pertaining to late medieval geometry, number, arithmetic, and systems of measurement, all for the purpose of illuminating the intentional sets of proportions in the San Lorenzo nave arcade bays. Although I have measured and analyzed the basilica of Santo Spirito as comprehensively as the basilica of San Lorenzo, and although the former provides crucial evidence in support of the findings of this study, the majority of this study is devoted to the basilica of San Lorenzo because it is by far the more historically complex and important of the two basilicas.

Chapter 3 applies the methods and concepts developed in Chapter 2 to the problem of understanding the proportions (proportion-1 and proportion-3) of the overall basilica, including the Old Sacristy. This chapter proposes a logical, step-by-step reconstruction of the basilica floor plan, and many of the vertical sets of proportions as well, based on successive subdivisions of a two-square rectangle. This procedure reproduces many of the obscure and seemingly irregular measurements found in the basilica today, and thus suggests that the logic of proportion can serve not only as a subject of architectural history research, but also as a tool with which to study it—provided that that logic can be demonstrated to be the result of the architect's intentions, rather than coincidence. This chapter concludes by identifying a seemingly anomalous feature of the iconographical program of this basilica—a feature unrelated to Saint Lawrence or any common Medici themes as might be expected—and interprets it as a possible effort by the builders to use number symbolism to explain a prominent feature of the basilica that appears to have been generated unintentionally by the design process that I have reconstructed.

The notion, developed in Chapter 3, that certain sets of proportions can be considered genuine historical artifacts, and thus can be used as tools to explore an architect's intentions, is

pursued further in Chapter 4. Here documents rather than measurements are the main focus of analysis, but the proportional findings from Chapters 2 and 3 nevertheless serve as critical new tools to help resolve several persistent questions pertaining to the construction history of the basilica of San Lorenzo. Progress in resolving the questions of 1) who designed the spatial conception and sets of proportions throughout the basilica, 2) who designed and supervised the manufacture of the sculptural details of the nave arcades, 3) what were the exact location and configuration of the old basilica of San Lorenzo in relation to the new one, and 4) what was the precise sequence of the various stages of construction of the basilica, receive particular impetus from these new proportional findings. This chapter culminates in a step-by-step reconstruction of the above-noted stages of construction. This reconstruction may be considered a continuation of the one offered in Chapter 2, carrying forward the proposed design process from the detailed design through the various stages of execution on the site.

Chapter 5 explores yet further the potential value of the study of sets of architectural proportions (proportion-3) in advancing architectural history by using the proportional findings from Chapters 2 and 3 to help identify two likely medieval precedents for various design features of the basilicas of San Lorenzo and Santo Spirito. The apparent influence of one these earlier works, the basilica of Santa Maria del Carmine in Pavia, on the Florentine basilicas in question, and on other works in Florence, calls attention to Lombardy as a region of vibrant proto-Renaissance creativity and Roman revivalism that is worthy of increased scholarly attention.

This study concludes in Chapter 6 by using the weight of the findings presented in the preceding chapters to propose an alternative to the Wittkower Paradigm, since this paradigm is unable to explain these findings. Chapter 6 proposes 1) the notion of "simultaneity" instead of Wittkower's separation of medieval geometry and Renaissance number; 2) a rhetorical interpretation of sets of proportions as used in the history of architecture, instead of Wittkower's aesthetic interpretation; and 3) a methodology that blends observation-based and documentary sources instead of Wittkower's almost exclusively document-based approach.

1.4 Previously Published and New Sections

This study incorporates and elaborates upon several articles that I have published within the past four years. The analysis of the San Lorenzo nave arcade set of proportions in Chapter 2 is based on my articles: "Ugly Little Angels: Deliberately Uneven Construction Quality in the Basilica of San Lorenzo in Florence," published in *arq: Architectural Research* in 2007; and "How Much Brunelleschi? A Late Medieval Proportional System in the Basilica of San Lorenzo in Florence," published in the *Journal of the Society of Architectural Historians* in 2008.[61] Most of the online

appendices to the latter have been substantially reworked and incorporated throughout the present study, while the postscript to that article, "A Disciplinary Triad," now forms part of Chapter 6. "Ugly Little Angels Revisited," which appeared as a book chapter in *Quality Out of Control: Standards for Measuring Architecture* (eds. Allison Dutoit, Juliet Odgers, and Adam Sharr) in 2010, has been substantially reworked and incorporated into Chapter 4.[62] My articles "The Lombard Connection: Northern Influences in the Basilicas of San Lorenzo and Santo Spirito in Florence," which appeared in *Annali di Architettura* in 2009; and "Quantification and the Medieval Mind: An Imperfect Proportional System in the Basilica of Santa Maria del Fiore in Florence," which appeared in *Some degree of happiness, Studi di storia dell'architettura in onore di Howard Burns* in 2010, have been incorporated into Chapters 5 and 6.[63] I developed some of the definitions of terms presented in Chapter 1 in the prepration of the international conference "Proportional Systems in the History of Architecture," hosted by Leiden University, 17-19 March 2011, which I organized in collaboration with Caroline van Eck and Eeclo Nagelsmit. In order to maintain the internal consistency of each chapter, many of which were conceived as separate articles, I have let stand occasional redundancies, such as repetitions of quotations or documentary references.

The present electronic version of this dissertation contains a correction to Figure 2-37 and various minor corrections to the text with respect to the two-volume printed version.

[1] Francesco Colonna, *Hypnerotomachia Poliphili: Venice 1499* (New York and London: Garland Publishing, Inc., 1976), c (verso); In the following translation by Godwin, I have changed Godwin's "door" to "portal." "...Being inclined to study, and inflamed with desire to understand the fertile intellect and the sharp awareness of him who had been the perceptive architect of its proportions, being interested in both its underlying geometrical scheme and its organizing lines, analysing it carefully, I did as follows: I precisely measured the square form under the coupled columns either side of the portal. From this measurement I readily grasped the system of proportions of the aforesaid portal, which I will briefly explain." Francesco Colonna, *Hypnerotomachia Poliphili: The Strife of Love in a Dream*, ed. and transl. Joscelyn Godwin (London: Thames & Hudson, 1999), 44.

[2] "Outre la beauté du plan on y admire la belle proportion des colonnes, la pureté des profils & des entablemens." Quatremère de Quincy, "Brunelleschi (Philippe)" in *Encyclopédie Méthodique*, vol. 1: "Architecture" (Paris: Panchoucke, 1788), 341.

[3] William Henry Goodyear, *Renaissance and Modern Art* (New York: Flood & Vincent, 1894 [printed in 1900]), 76.

[4] The complete passage is: "Ma questa sorta di regolarità geometrica, questo bisogno di ripetere il motivo fondamentale con insistenza che può apparire gotica, è per noi rivelatore di una necessità di ritmo, e il predominio dei vuoti, la pacata bicromia sono indici di una suprema eleganza del tutto toscana." Emilio Lavagnino, *Brunellesco* (Rome: Istituto Nazionale "L.U.C.E.," 1931), 8.

[5] In this study I use the term "aesthetic" to refer to the appreciation or criticism of the beautiful, with acknowledgment of the eighteenth and nineteenth-century origins of this concept. "Aesthetic," *Oxford English Dictionary Online*, 2nd ed., 1989, <http://www.oed.com/view/Entry/3237?redirectedFrom=aesthetic#eid> (30 June 2011, access limited to subscribers).

[6] Rudolf Wittkower, "Brunelleschi and 'Proportion in Perspective,'" *Journal of the Warburg and Courtauld Institutes* 16 (1953), 275-291 (for "metrical discipline" and other uses of the term "metrical": 289). Ackerman writes that this article "…had a great influence on the way my generation has thought about early Renaissance architecture." James S. Ackerman, "Rudolf Wittkower's Influence on the History of Architecture," *Source: Notes in the History of Art* 8-9 (1989), 88.

[7] Sumner McK. Crosby, ed., *Helen Gardner's Art Through the Ages*, 4th ed. (London: G. Bell and Sons, 1959), 301. Gardner does not mention the basilica of San Lorenzo in the first three editions of this textbook, which were written entirely under her authorship. In the first edition she uses proportion in the qualitative sense in a description of the church of Sant' Andrea in Mantua: "Here one feels that the artist was not dominated by religious emotion, as was the builder of the Gothic cathedral, but by a desire for quiet, harmonious design based upon orderliness and proportion." Helen Gardner, *Art Through the Ages: An Introduction to its History and Significance* (New York: Harcourt, Brace & Company, 1926), 238. In the second and third editions, she makes aesthetic observations that imply the idea of proportion in the qualitative sense, noting that the Pazzi Chapel, San Francesco in Rimini and Sant' Andrea in Mantua exhibit "…the classical balance of vertical and horizontal…." Idem, *Art Through the Ages: An Introduction to its History and Significance* (New York: Harcourt, Brace & Company, 1936), 345; and Idem, *Art Through the Ages*. 3d ed. (New York: Harcourt, Brace & Company, 1948), 438.

[8] H.W. Janson, *History of Art: A Survey of the Major Visual Arts from the Dawn of History to the Present Day* (New York: Harry N. Abrahms, Inc., 1962), 320.

[9] Patrick Nuttgens, *The Pocket Guide to Architecture* (New York: Simon and Schuster, 1980), 115.

[10] Marvin Trachtenberg and Isabelle Hyman, *Architecture, from prehistory to post-modernism: the Western Tradition* (New York: H.N. Abrams, 1986), 286. Although this comment does not appear in the second edition, the authors' similar aesthetic assessment of the Ospedale degli Innocenti expressed in quantative terminology, attributing "…its discernible *all'antica* resonance…" in part to the "…science behind its proportions…," appears in both editions. Note that "science" is a term that implies a foundation in quantitative data. *Ibid*., 284; and Idem, *Architecture: From Prehistory to Postmodernity*, 2d ed. (Upper Saddle River, New Jersey: Prentice Hall, Inc., 2002), 280.

[11] Saalman rather ambiguously seems to suggest that Brunelleschi's "…decision to make the main space of the sacristy [i.e., the Old Sacristy] a square…" was a matter of "…personal artistic expression…." Howard Saalman, *Filippo Brunelleschi: The Buildings* (University Park, Pennsylvania: Pennsylvania State University Press, 1993), 141. For Saalman's other remarks about the proportions of the basilica of San Lorenzo, including the Old Sacristy, see: *Ibid*., 208-209, 350, 361-362, and 431.

[12] In my word choice here I am influenced by Geoffrey Scott: "The attempt has constantly been made to discover exact mathematical sequences in beautiful buildings as though their presence were likely either to cause beauty or explain it." Geoffrey Scott, *The Architecture of Humanism* (New York and London: W.W. Norton & Company, 1974 [1914]), 155.

[13] Wittkower often states that his aesthetic interpretations correspond to Brunelleschi's intentions (and thus, that the historian's aesthetic interpretations are the same as were the subjects'), but provides no evidence to justify these claims, as in the passages: "…it would almost appear a historical necessity that he, the genuius who brought about single-handed the new metrical architecture of the Renaissance, should have regarded harmony and proportion in the elevations of his buildings and their changing perspective views as a single problem…"; "granted that Brunelleschi wanted his buildings to be looked at as if they were projected on to an intersection, the difference between architecture and painting becomes one of artistic medium rather than of kind;" and "I venture to say that Brunelleschi would have liked seeing his buildings in photographs." Wittkower, "Brunelleschi and 'Proportion in Perspective,'" 276 and 289-290. In a similarly unsupported narration of Brunelleschi's intentions expressed in a tone of certainty, Janson claims: "…the secret of good architecture, Brunelleschi was convinced, lay in giving the 'right' proportions—that is, proportional ratios expressed in simple whole numbers—to all the significant measurements of a building." Janson, *History of Art*, 320.

[14] Scott, *The Architecture of Humanism*, 155. For a similar distinction between these two definitions of the word proportion in French see Claude Perrault, *Ordonnance des cinq espèces de colonnes selon la méthode des anciens* (Paris: Jean Baptiste Coignard, 1683), vi-vii.

[15] Prior to the publication of my surveys and proportional analysis of the basilica of San Lorenzo, no one had ever studied the proportions of this building based on accurate and comprehensive measurements. Matthew A. Cohen, "How Much Brunelleschi? A Late Medieval Proportional System in the Basilica of San Lorenzo in Florence," *Journal of the Society of Architectural Historians* 67 (2008), 18-57.

[16] Tom Wolfe memorably critiques the bland monotony of Avenue of the Americas in New York City as "Row after row of Mies van der row of glass boxes." Tom Wolfe, *Bauhaus to Our House* (London: John Cape Ltd., 1982), 4.

[17] In light of this discussion, Janson's above-quoted claim that "...proportional ratios expressed in simple whole numbers" influence the appearance of the basilica of San Lorenzo can be seen to be illogical because such ratios, which my survey indicates are not present in this basilica in any case, could never have such an influence even if they were present. See note 8 above.

[18] Older definitions of proportion found in the architectural literature, such as those of Vitruvius, Sylvio Belli, Andrea Palladio, and Daniele Barbaro, are not relevant to this discussion because they do not reflect modern English usage. Vitruvius, *The Ten Books on Architecture*, trans. Morris Hicky Morgan (New York: Dover Publications, Inc., 1960 [1914]) III.1.i, p. 72; and James S. Ackerman, *Palladio* (London: Penguin Books, 1966), 161.

[19] Sébastien Le Clerc, *A Treatise of Architecture, with remarks and observations necessary for young people, who wou'd apply themselves to that noble art*, trans. Ephraim Chambers (London : Printed and sold by W. Taylor, W. and J. Innys, J. Senex, and J. Osborne, 1723), vol. 1, p. 29; "Par proportion, on n'entend pas ici un rapport de raisons à la manière des geomètres; mais une convenance de parties, fondée sur le bon goût de l'architecte." Sébastien Le Clerc, *Traité d'architecture, avec des remarques et des observations trés utiles pour les jeuns gens qui veulent s'appliquer à ce bel art* (Paris: P. Giffart, 1714), 39. Cf. *The Oxford English Dictionary* 12, 2d ed. (Oxford: Clarendon Press, 1989), 647; and Hanno-Walter Kruft, *A History of Architectural Theory: from Vitruvius to the Present* (London: Zwemmer, 1994), 142.

[20] For the distinctions between numerical and arithmetical relationships, see note 22, below.

[21] I have already used this term in my previous publications "How Much Brunelleschi? A Late Medieval Proportional System in the Basilica of San Lorenzo in Florence" (see note 15, above); and "Quantification and the Medieval Mind.": An Imperfect Proportional System in the Basilica of Santa Maria del Fiore in Florence," in M. Beltramini and C. Elam, eds. *Some degree of happiness, Studi di storia dell'architettura in onore di Howard Burns* (Pisa: Edizioni della Normale, 2010), 1-30; as well as in the title and statement of purpose for the conference "Proportional Systems in the History of Architecture," co-organized with Caroline van Eck and Eelco Nagelsmit at Leiden University, 17-19 March 2011.

[22] The difference between numerical and arithmetical correspondences in this definition is a matter of interpretation. For the purposes of this definition I will consider numerical correspondences to be those that highlight certain numerical qualities of integers, such as number progressions, and arithmetical correspondences to be those that highlight particular relationships between numbers that can only be revealed through simple calculation, such as whole-number approximations of the ratio 1:√2.

[23] The simultaneity in sets of proportions under consideration here, which refers to the designs of medieval and Renaissance architects, should not be confused with the above-noted simultaneity of qualitative and quantitative meanings associated with the English word proportion today.

[24] Leonis Baptiste Alberti, *De re aedificatoria* (Florence, 1485), IX, v-vi.

[25] Wittkower, "Brunelleschi and 'Proportion in Perspective,'" 289.

[26] Rudolf Wittkower, *Architectural Principles in the Age of Humanism* (London: The Warburg Institute, 1949); and Idem, "Principles of Palladio's Architecture-II," *Journal of the Warburg and Courtauld Institutes* 8 (1945), 68-106.

[27] My use of the term "Wittkower Paradigm" is independent of Payne's reference to "Wittkower's paradigm," a term that Payne does not define. Alina A. Payne, "Rudolf Wittkower and Architectural

Principles in the Age of Modernism," *Journal of the Society of Architectural Historians* 53 (1994), 332.

[28] In a response to my article "How Much Brunelleschi?," for example, Herzner misrepresents my analysis of the sets of proportions in the basilicas of San Lorenzo and Santo Spirito in terms of the "Geometry vs. Number" characteristic of the Wittkower Paradigm (see below), even though in the introduction I note that my article "…forgoes common preconceptions such as Wittkower's medieval geometry vs. Renaissance arithmetic paradigm…." Cohen, "How Much Brunelleschi?," 18. Herzner writes: "Da dieses Proportionssystem mit seinen irrationalen Zahlen sich jedoch grundlegend von demjenigen unterscheidet, das Brunelleschi in Sto. Spirito angewandt hat, wo die auf ganzen Zahlen beruhenden Proportionen der Renaissanceästhetik entsprechen, stellt sich Cohen im Hinblick auf die Autorschaft von San Lorenzo unvermeidlicherweise die Frage 'how much Brunelleschi?,' die schon im Titel seiner Untersuchung die größtmögliche Aufmerksamkeit sicherstellt." Volker Herzner, "'How much Brunelleschi?' Matthew Cohen und sein Phantom-Architekt von San Lorenzo in Florenz," *Kunstgeschichte*: *Texte zur Diskussion*, 2009-26, < http://www.kunstgeschichte-ejournal.net/discussion/2009/herzner > (21 April 2009). Several other scholars, in conversation with me, have expressed similar Wittkower Paradigm-inflected interpretations of my San Lorenzo and Santo Spirito findings.

[29] Wittkower, *Architectural Principles*, 2d. ed. (1962), Preface, n.p. In the third edition "defined" was changed to "defines." Idem, *Architectural Principles*, 3d. ed. (1971), Introduction, n.p.; and Kenneth Clark, "Humanism and Architecture," *Architectural Review* 109 (1951), 65. Payne similarly describes *Architectural Principles* as: "…the only available (and unchallenged) comprehensive study of Renaissance architectural aesthetics…." Payne, "Rudolf Wittkower and Architectural Principles," 324.

[30] For an overview of the notion of "art-as-such," see M.H. Abrams, "Art-as-Such: The Sociology of Modern Aesthetics." *Bulletin of the American Academy of Arts and Sciences* 38 (1985): 8-33.

[31] Scott, *The Architecture of Humanism,* 40.

[32] *Ibid.,* 37.

[33] *Ibid.,* 170, and cf. 155.

[34] *Ibid.,* 49, 92; and cf. 62, 84, 86. For examples of late medieval sets of proportions, which will be discussed in detail below, see Figures 4-12 and 5-19.

[35] The question of whether Wittkower's studies of sets of proportions (proportion-3) are correct however—for example, whether Renaissance architects used harmonic ratios to the extent and in the ways that Wittkower claims—requires additional analysis. For two explorations of this question, see Deborah Howard and Malcolm Longair, "Harmonic Proportion and Palladio's Quattro Libri," *Journal*

of the Society of Architectural Historians 41, (1982), 116-143; and George Hersey and Richard Freedman, *Possible Palladian villas: (plus a few instructively impossible ones)* (Cambridge, Massachusetts: MIT Press, 1992).

[36] Rudolf Wittkower, "Systems of Proportion," *Architect's Yearbook* 5 (1953), 16. Wittkower provides a similarly explicit statement of the aesthetic basis of his theory of Renaissance architecture in his article on the basilica of San Lorenzo published four years later. In it he argues that the regularity of this basilica, which he claims is related to Brunelleschi's knowledge of the mathematics of perspective drawing, constituted a deliberate aesthetic strategy on Brunelleschi's part. Wittkower writes: "E. Panofsky was, I think, the first to formulate that 'from the point of view of the Renaissance, mathematical perspective was not only a guarantee of correctness but also, and perhaps even more so, a guarantee of aesthetic perfection.'" Wittkower, "Brunelleschi and 'Proportion in Perspective,'" 275. Later Wittkower reinforces this aesthetic interpretation of Renaissance architecture as follows: "…it was only during the Renaissance that 'perspective ratios' became an essential element of stylistic consideration…and that everything was done to make the perception of a harmonic diminishing series in space a vividly felt experience." *Ibid*., 288.

[37] Wittkower, *Architectural Principles*, 2d. ed. (1962) and 3d. ed. (1971), 74. In earlier editions the passage reads: "Italian architects always strove for an easily perceptible ratio between length, height and depth of a building, and all villas by Palladio have that block-like quality. Idem, *Architectural Principles*, (1962) and 2d. ed. (1952), 66.

[38] *Ibid*., 2d. ed. (1962) and 3d. ed. (1971), 45.

[39] *Ibid*., 2d. ed. (1962) and 3d. ed. (1971), 46.

[40] *Ibid*., 2d. ed. (1962) and 3d. ed. (1971), 108 and 108 n 8.

[41] Wittkower, "Brunelleschi and 'Proportion in Perspective,'" 289.

[42] Wittkower, "Brunelleschi and 'Proportion in Perspective,'" 132 n 47. He cites Paatz as the source of this information. Walter and Elisabeth Paatz, *Die Kirchen von Florenz* 2 (Frankfurt am Main: Vittorio Klostermann, 1940), 471.

[43] Manfredi Mancigni, *Esequie del serenissimo Ferdinando II. gran duca di Toscana celebrate in Firenze dal serenissimo gran duca Cosimo III* (Florence: Stamperia di S.A.S. per il Vangelisti e Matini, 1671).

[44] For a summary of Wittkower's German art historical training, and thus possible insights into his attitude toward the object, see David Watkin, *The Rise of Architectural History* (London: The Architectural Press, 1980), 149-154.

[45] Cf. note 7, above, for Gardner's comments of 1926 contrasting the feeling of "religious emotion" of the Gothic cathedral with the "harmonious design based upon orderliness and proportion" of the Renaissance church.

[46] Wittkower, "Principles of Palladio's Architecture-II," 68-106.

[47] Wittkower, *Architectural Principles* (1949), 110-111; and Wittkower, *Architectural Principles in the Age of Humanism*, 2d. ed. (London: Alec Tiranti Ltd., 1952), 110-111.

[48] Wittkower, *Architectural Principles*, 3d. ed. (London: Alec Tiranti Ltd., 1962), 126; and *Ibid.*, 4th ed. (London and New York: W.W. Norton and Company, 1971), 126.

[49] *Ibid*. (1962 and 1972), 127.

[50] Wittkower, "Systems of Proportion," 15.

[51] *Ibid*., 16.

[52] *Ibid*., 17.

[53] Wittkower, "Systems of Proportion," 15-17; Idem, "The Changing Concept of Proportion," *Daedalus* 89 (1960), 201-202; Idem, *Idea and Image: Studies in the Italian Renaissance* (London: Thames and Hudson, 1978), Chapter 4: "The Changing Concept of Proportion," 116-117; Idem, *Architectural Principles*, 2d. ed. (1962) and 3d. ed. (1971), Appendix II: "The Problem of Commensurability of Ratios in the Renaissance," 158-161; and posthumously, Idem, *Architectural Principles in the Age of Humanism* (London: Academy Editions and New York: St. Martin's Press, 1988), Appendix IV: "Proportion in Art and Architecture," 150-152.

[54] John Summerson questions the overall premise underlying Geometry vs. Number in the following statement, which he never developed into a comprehensive critique: "To think of the 12th century as having witnessed a 'renaissance' is greatly to modify the customary view of Gothic and classic art as 'opposites'; and in fact this habitual thesis is in many ways highly unsatisfactory. It is a too obvious conclusion drawn from prima facie impressions.... And it is probably nearer the truth to think of the whole flow of European art as a classic stream, distorted for a period from its course, than to think of an opponent 'will to form' breaking in during a Gothic interval and disappearing again with the exhumation of antiquity during the *quattrocento*." John Summerson, "Antitheses of the Quattrocento," in Summerson, *Heavenly Mansions and Other Essays on Architecture* (New York and London: W.W. Norton, 1963), 24-25.

[55] Wittkower, *Architectural Principles*, 2d. ed. (1962) and 3d. ed. (1971), 160.

[56] Idem, "Systems of Proportion," 17.

[57] Idem, *Architectural Principles*, 2d. ed. (1962) and 3d. ed. (1971), 108. In the first and second editions this passage reads: "As far as we can see this is the only irrational number of importance

involved in Renaissance theory of architectural proportion." Idem, *Architectural Principles* (1949) and 2d. ed. (1952), 95.

[58] *Ibid*., 108 and 158; and Idem, "Systems of Proportion," 16. For discussions of the ratio 1:√2 in medieval architecture, see for example: Paul Frankl, "The Secret of the Mediaeval Masons," *Art Bulletin* 27, (1945), 46-65; Howard Saalman, "Early Renaissance Architectural Theory and Practice in Antonio Filarete's Trattato di Architettura," *Art Bulletin* 41, (1959), 89-107; Lon R. Shelby, "The 'Secret' of the Medieval Masons," in: Bert S. Hall and Delno C. West, eds., *On Pre-Modern Technology and Science Studies in Honor of Lynn White, Jr.* (Malibu: California, Undena Publications, 1976), 201-219; *Gothic Design Techniques: The Fifteenth-Century Design Booklets of Mathes Roriczer and Hanns Schmuttermayer*, edited, translated, and introduced by Lon R. Shelby (Carbondale, Illinois: Southern Illinois University Press, 1977); and Peter Kidson, "A Metrological Investigation," *Journal of the Warburg and Courtauld Institutes* 53 (1990), 71 -97. Wittkower lists several geometrical figures that he claims "…formed the basis of medieval aesthetics," including the equilateral triangle and the "right-angled isosceles triangle," but does not mention what ratios are associated with them or how medieval architects used them. Wittkower, "The Changing Concept of Proportion," 201.

[59] Wittkower, *Architectural Principles*, 2d. ed. (1962) and 3d. ed. (1971), 160-161. Wittkower, however, provides no examples of the "precise moments of transition" to which he refers.

[60] Wittkower, "Systems of Proportion," 13.

[61] Matthew A. Cohen, "Ugly Little Angels: Deliberately Uneven Construction Quality in the Basilica of San Lorenzo in Florence," *arq: Architectural Research Quarterly* 11, (2007), 276-89; Idem, "How Much Brunelleschi? A Late Medieval Proportional System in the Basilica of San Lorenzo in Florence," published in the *Journal of the Society of Architectural Historians* 67 (2008), 18-57.

[62] Matthew A. Cohen, "Ugly Little Angels Revisited," in Allison Dutoit, Juliet Odgers, and Adam Sharr, eds., *Quality Out of Control: Standards for Measuring Architecture* (London: Routledge, 2010), 79-91.

[63] Matthew A. Cohen, "The Lombard Connection: Northern Influences in the Basilicas of San Lorenzo and Santo Spirito in Florence," *Annali di architettura* 21 (2009), 31-44; and Cohen, "Quantification and the Medieval Mind."