Part I
Introduction

1
Two Kinds of Proportion

Dedicated to Caroline van Eck

Matthew A. Cohen

The diverse collection of essays presented in this volume grew out of the international conference "Proportional Systems in the History of Architecture," held in Leiden in March 2011 (Fig. 1).[1] The conference was scheduled to commemorate the sixtieth anniversary of the last international conference on proportional systems in the arts, held in Milan in 1951 and titled "De divina proportione," which similarly gathered leading thinkers of its day (Fig. 2).[2] This anniversary thus offers a valuable opportunity to reflect on where the study of proportional systems has gone over the past sixty years, and where it might most productively go from here. Although the premises of the two conferences were fundamentally different from one another—the Milan conference promoted the contemporary use of proportional systems in the arts for the aesthetic and spiritual betterment of society, while the Leiden conference promoted the historical study of specifically architectural proportional systems for the advancement of scholarly knowledge—certain noteworthy attitudes toward the subject of proportional systems manifested in the Milan conference are still prominent today.[3] Both conferences together demonstrate a sustained recognition of the importance of the multidisciplinary study of proportional systems as integral parts of human culture across time and geography. Less productively, while sympathy with the overtly mystical beliefs that drove the Milan conference is substantially more subdued in the scholarly community today, a fundamental ambiguity inherent in the concept of proportion that enabled those beliefs to flourish in 1951 continues to characterize much scholarly thinking about this subject today: when architectural historians use the word "proportion," whether they intend it to signify a ratio, architectural beauty, or both simultaneously, is often unclear to author and reader alike.

Fig. 1. Matthew A. Cohen (left) with Mark Wilson Jones (right), at the conference "Proportional Systems in the History of Architecture," Leiden, March 17, 2011. Photo: Anonymous gift.

Fig. 2. Rudolf Wittkower addressing the Milan conference "De divina proportione," as part of the Ninth Triennale, Milan, September 1951. Photo: Fondazione La Triennale di Milano.

This introduction will explore this ambiguity, and propose a clarification of it to serve as a common thread tying together the two editorial premises of this volume: first, that there is no causal relationship between proportional systems and the aesthetic qualities of architecture; and second, that proportional systems, as non-visual bearers of meaning and objects of belief, contributed to the rhetorical rather than visual structure of architecture prior to the advent of modern structural engineering, which Rowland Mainstone dates to 1742–1743.[4] Proportional systems during this long period may thus be understood as having served no practical purposes, but nevertheless to have played critical roles in distinguishing architecture from mere building.[5] After 1742–1743 a nostalgic strain of pre-engineering, belief-based proportional systems (such as Le Corbusier's "Modulor" and Hans van der Laan's "plastic number"; see Chapters 21 and 22 herein) continued this non-practical tradition into the 20th century, albeit with diminished influence on mainstream practice, ignoring the appearance and widespread acceptance of certainty-based proportional systems (such as structural engineering specifications and urban building regulations), which reflect modern scientific thinking and do succeed in fulfilling practical purposes.[6]

Of course not all of our contributors or readers will necessarily agree with these premises, which are presented here with the intention of inspiring productive discussion and debate. Indeed, these premises can be difficult to understand and controversial because they contradict a set of assumptions so widespread and deeply ingrained in contemporary thought as to constitute a paradigm.[7] Let us call it the "Wittkower paradigm" in acknowledgement of Rudolf Wittkower's critical role in promulgating it by synthesizing various strands of 19th- and early 20th-century thought in a series of influential publications after World War II.[8] Paradigms are not easily overturned, but this introduction will at least confront this one in order to propose some guidelines to help navigate the inherent ambiguities of this subject. This process will continue in the conclusion to this volume (Chapter 25), which outlines ten principles to serve as a proposed framework for future discussions of proportional systems in the history of architecture.

The beauty problem

During my conversations about proportion with architectural historians at the Leiden conference and elsewhere, I have found that many, perhaps even most, scholars tacitly seem to believe—or at least concede some agnostic acceptance of the possibility—that proportional systems contribute beauty to architecture.[9] When pressed, however, many of these scholars have been disinclined to defend or elaborate upon their positions. For some, proportion is a subject firmly rooted in intuition (i.e., subjective perceptions, feelings and beliefs) that they believe cannot and should not be submitted to logical scrutiny. For others it is a complex intellectual morass that they prefer not to wade into too deeply without further reflection.[10] This reticence extends to the scholarly literature, where no in-depth defense of the beauty-in-proportion belief system can be found.[11] Nevertheless, a general sympathy with such beliefs in contemporary scholarship can be documented to some degree in non-peer-reviewed venues such as survey texts and educational films.[12] This belief among scholars thus seems to be both widespread and yet rather casual and not fully worked out as a scholarly premise.

Productive discussion of the historical issues pertaining to proportional systems is today often limited by a general lack of consensus over basic assumptions about the relationship, or lack thereof, between proportional systems and architectural beauty. This lack of consensus can have significant negative consequences for the study of architectural history. It can create, for example, us/them ambiguity, which occurs when the belief that proportional systems create beauty in architecture directs scholarly attention toward *us*—i.e., toward our perceptions today—rather than toward *them*, or, the people in history whose products, activities, and beliefs are ostensibly the subjects of architectural history. *Us* and *them* cannot be conflated when dealing with the subject of beauty because assessments of beauty are not universal across time and geography, as the beauty-in-proportion belief system presupposes, but always subjective. Us/them ambiguity thus creates uncertainty as to whether an investigation is a work of architectural criticism, or history; a commentary on current, or on past, interpretations of architecture.[13]

To refute the notion that proportional systems have visible—and invariably favorable—aesthetic influences on architecture, one can turn to simple, logical argumentation.[14] For example, since you cannot *see* proportional systems, they must be mental, not visual constructs. You cannot see, for example, numerical ratios expressed in terms of the local unit of measure in use at the time a particular proportional system was deployed. You can only recognize these ratios mentally, in relation to their historical context, after studying measurement data for a particular building, the history of local units of measure, and other related information.[15] Nor, for that matter, can you see *any* abstract numerical ratio, whether expressed in terms of a local unit of measure or not, *as* a numerical ratio. That which is not visible, therefore, cannot be visually beautiful.[16]

Sometimes you can see geometrical relationships, but only in approximation. For example, you can distinguish a rectangle from a triangle; but you cannot distinguish a root-2 rectangle (Fig. 3, left) from a slightly stretched one, though you may think you can once you are made aware of the discrepancy through measurement. In any case, for the architectural historian the distinction between a root-2 rectangle and a slightly stretched one is significant not visually but historically, as a matter of identifying the *intentions* of the architect or builder, and the circumstances in which he worked. Was a

root-2 rectangle intended or not? If so, why was it intended? If one was intended but not executed precisely, why was it not? There can be no logical justification for a modern viewer to accord higher visual-aesthetic value to a geometrical figure for which we have a name, such as a root-2 rectangle, than to one for which we have no name, such as a slightly stretched root-2 rectangle, if we recall that aesthetic preference (including intellectual satisfaction) would be an emotional, not a logical, justification for such judgments. Thus, a root-2 rectangle (or any other rectangle, for that matter) cannot have more intrinsic beauty than a slightly stretched one, because neither of them has any universally recognizable beauty at all. All rectangles, as mathematical-geometrical constructs, are aesthetically neutral.[17] It logically follows, therefore, even from this brief discussion, that a proportional system per se, which is but a set of proportional relationships, cannot contribute beauty to architecture.[18]

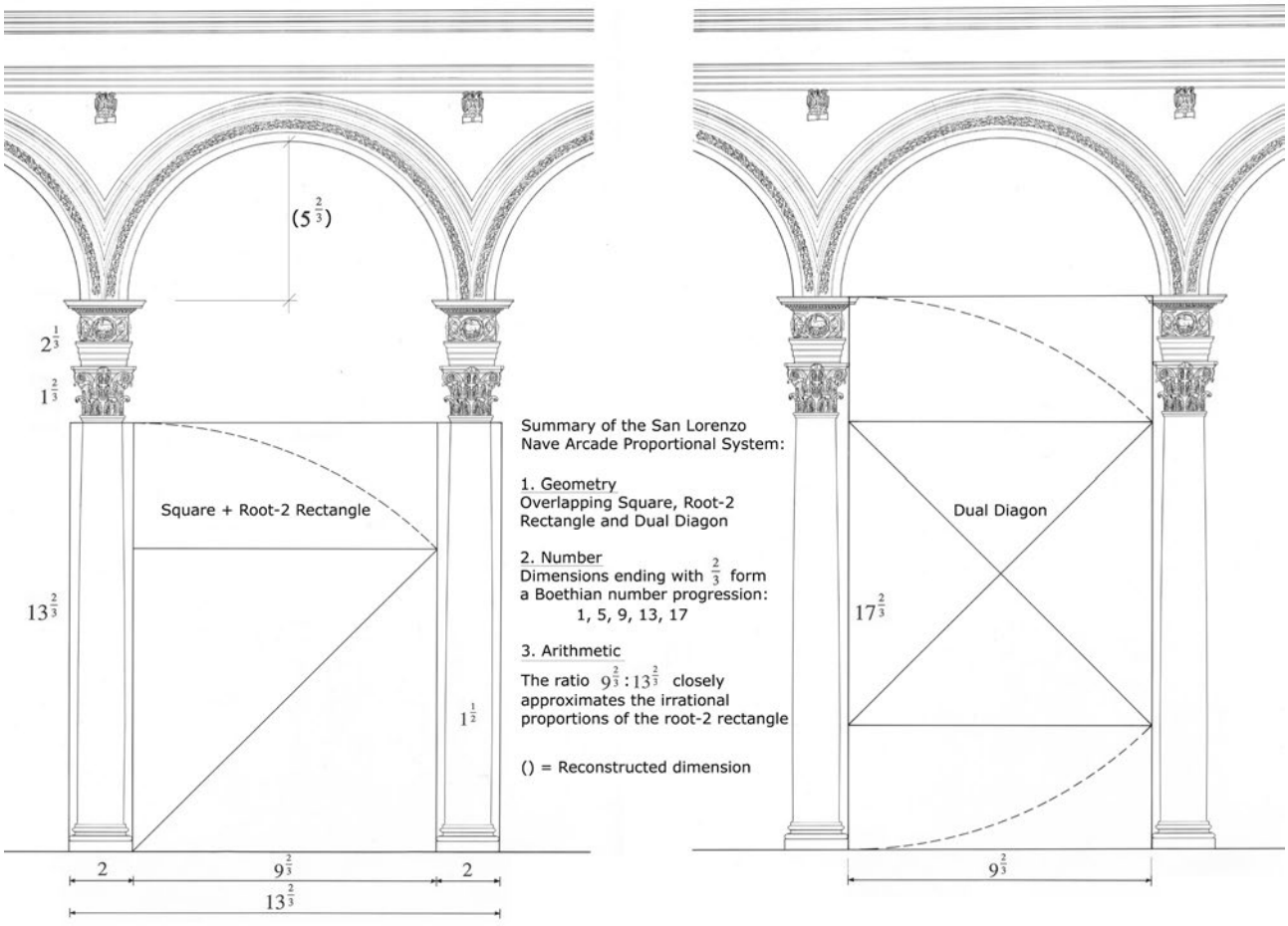

Fig. 3. Summary of the San Lorenzo nave arcade bay proportional system (spread between two drawings for clarity). Author.

This introduction does not aim to spoil anyone's personal, spiritual-aesthetic enjoyment of the notion that proportional systems might contribute beauty to architecture—a kind of enjoyment that I, too, partake in to some extent, when wearing my architect's rather than architectural historian's hat—; and indeed, no single essay would ever have much likelihood of disrupting a beauty-in-proportion belief system that is millennia old, and arguably woven into the very fabric of western civilization, even if it set out to; nor is it even necessary that everyone agree on these matters.[19] The beauty-in-proportion belief system can co-exist with rigorous scholarship, as long as the two are kept strictly separated. This introduction explores what such a separation might look like, first by continuing to shed a critical light on the beauty-in-proportion belief system, its modern dissemination in particular in the work of Wittkower, and its origins in the conceptual ambiguity built into the word "proportion" and its various Romance language equivalents at least since the 15th century. It then proposes that this word be broken down into its incongruent component meanings, "proportion-as-ratio" (or mathematical proportion) and "proportion-as-beauty," and that one of these meanings hereafter be specified whenever scholars use this word, either through the use of the preceding terms or in the context of the discussion.

One example of the ambiguity that can result when the two meanings of the word "proportion" are not separated is found in an address by Nikolaus Pevsner to a meeting of the Royal Institute of British Architects in 1957. When Pevsner refers to "laws of proportions," "fixed proportions," and "proportional canons," he is clearly referring to proportions-as-ratio; but when later in the same address he contends that the west front of St. Paul's Cathedral "...is without doubt badly bungled in its proportions...," he now uses the same word, proportion, to refer to proportion-as-beauty, and thus reveals his assumption that some particular selection of proportional ratios caused the west front to lack beauty.[20] Pevsner, however, provides no exposition of which particular ratios he finds offensive. His belief that the west front is unbeautiful due to its proportions is perhaps metaphysical (for example, a belief that the assumed proportional ratios in the west front fail to conform to some indistinct notion of assumed ideal ratios), or perhaps empathetic (a seemingly *felt* comparison between the west front and the human body and its states, as in the towers seeming too large for the nave like arms too large for a body), or perhaps some ambiguous combination of the two. Either way, his illogical conflation of imagined missing ratios and lack of beauty could have been avoided had he simply noted that he found the west front to be unbeautiful (or "badly bungled"), without any unqualified reference to proportions. Separating the two meanings of proportion, alternatively, would have forced Pevsner to confront his beauty-in-proportion preconceptions, and made his criticism of the west front more acute.[21]

Before exploring in more detail the double meaning of the word proportion, let us clarify another multivalent word that recurs in this introduction: "aesthetic." As used here this term usually refers to judgments of beauty based on relationships between sense perception and taste.[22] In architecture, the sense perceptions of primary concern are usually visual. This use of the term "aesthetic" with an emphasis on sense perception was appropriated into German from the Greek *aisthesis* (meaning "perception" or "sensation") in 1750 by Alexander Gottlieb Baumgarten, who considered aesthetics to be a "...science of perception that is acquired by means of the senses."[23] Since the 19th century the term has typically carried the more general

meaning: "Of or pertaining to the appreciation or criticism of the beautiful," whether manmade or natural.[24] Aesthetics, however, can also refer to theories of what beauty is and how it arises. Finally, aesthetics can refer to the philosophical discipline that explores the cognitive basis of beauty, with fundamental texts by Baumgarten, Kant, Hegel, Schelling and others. Baumgarten's insistence on sense perception as a central concern of aesthetics, if not his conception of aesthetics as a science, is useful in grounding discussions of the question of causation between proportional systems and architectural beauty, because it directs our attention toward the physical properties of architecture and away from vague notions of intellectual or emotional satisfaction that could have any cause, related to architecture or not. Thus Baumgarten's definition of "aesthetic," as qualified here, will be the general sense in which this term will be used in this introduction.

The "beauty problem" discussed here may indeed be that some scholars today are to varying degrees distracted from important areas of scholarly inquiry by the belief that proportional systems contribute beauty to architecture, but some readers may now be wondering where beauty in historic architecture—at least of the orderly-looking variety—comes from, if not proportional systems. The answer to this question will not be found in this volume, the focus of which is architectural history rather than criticism. Indeed, no definitive answer will likely ever be found because beautiful, orderly-looking buildings can only be so when someone believes them to be. Education and empathy theory would seem to provide more useful explanations for architectural beauty than proportional-system metaphysics, but this proposition requires a different venue for discussion.[25]

The Wittkower paradigm

The modern study of proportional systems in the history of architecture may be said to have started with the 1949 publications of James S. Ackerman's "'Ars sine scientia nihil est:' Gothic Theory of Architecture at the Cathedral of Milan," and Wittkower's *Architectural Principles in the Age of Humanism*.[26] These works first demonstrated that valuable insights into the meanings associated with proportional systems by architects and other thinkers of the past could be derived from the scholarly study of historical texts. Prior to these publications, studies of architectural proportional systems were almost exclusively aesthetic, attempting to determine why Gothic and classical architecture looks the way it does either through geometrical and modular reconstructions, or through mystical ruminations.[27] Although Ackerman's study remains a landmark in the scholarship of Gothic architectural theory and practice, it has remained singular because of the uniqueness of the Milan archives on which it is closely based. Wittkower's study, by contrast, with its broad theoretical generalizations and citations from a wide variety of primary sources, created a new school of thought pertaining to proportional systems in the medieval and Renaissance periods.[28]

Despite Wittkower's stated intention in publishing *Architectural Principles*, "...'to dispose, once and for all, of the hedonist, or purely aesthetic, theory of Renaissance architecture,'..." he in fact replaces one aesthetic theory with another.[29] Indeed, the word "purely" in this passage suggests that Wittkower did not object to all aesthetic interpretations of Renaissance architecture, but only those that treated it as "art-as-

such," independent of any theoretical, social, practical or other considerations.[30] For Wittkower, architectural aesthetics contained meanings as well as feelings. His notion of aesthetics is thus more inclusive than Immanuel Kant's definition of (italics added): "Taste as the faculty of judging of that which makes universally communicable, *without the mediation of a concept*, our feeling in a given representation."[31] For Wittkower, a mediating concept is necessary for any notion of aesthetics worthy of a thinking person's attention.[32]

The most easily recognizable component of the Wittkower paradigm is the theory of medieval geometry vs. Renaissance number.[33] It is based on two premises, one historical and the other aesthetic. Wittkower summarizes the historical premise as follows: "two different classes of proportion, both derived from the Pythagoreo-Platonic world of ideas, were used during the long history of European art, and…the Middle Ages favored…geometry, while the Renaissance and classical periods preferred the numerical, i.e. the arithmetical side of the tradition."[34] Wittkower did not originate this premise, but merely elaborated upon an existing tradition. As early as 1867 Joseph Gwilt, in his popular *Encyclopedia of Architecture*, had already characterized the history of Western architectural theory as a contrast between geometrical "medieval proportion" and numerical or grid-based classical proportion, and Gwilt had compiled these notions from earlier sources.[35]

Wittkower infused this 19th-century formulation, which may have originally carried implicit aesthetic undertones, with an explicitly aesthetic premise by associating it with Alois Riegl's concept of *Kunstwollen*.[36] Thus he claims that "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."[37] By contrast, he claims, "...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."[38] Thus, according to Wittkower, the kinds of proportional systems used in each period can be interpreted as reflections of the worldview of each period. The historical premise of the theory of medieval geometry vs. Renaissance number (described above), considered independently of the aesthetic premise (above and below), at best represents an oversimplification of available evidence, which evidence indicates that during both the medieval and Renaissance periods geometry and number served as *equal partners* in architectural theory and practice—albeit with occasional emphasis on one or the other depending on the situation—and were not separately dominant in separate eras as Wittkower contends.[39]

The aesthetic premise of "medieval geometry vs. Renaissance number" presents a very different problem than the historical premise. Consider Wittkower's statement: "I think it is not going too far to regard commensurability of measure as the nodal point of Renaissance aesthetics."[40] One cannot logically propose a causal relationship between the dimensional properties of a proportional system and an assessment of architectural aesthetics, any more than one can attribute dimensional qualities to an idea, except metaphorically. Yet Wittkower is not writing metaphorically here—he is conveying his genuine belief that a causal relationship exists between the quantitative and the qualitative; between numbers, and opinions about architectural beauty. It is an ultimately metaphysical belief that, when observed in mid-20th-century and later

contexts, we may call "proportional aestheticism." As a modern phenomenon it thrives in part due to the high-volume, Wittkower-influenced textbooks that continually shape the thinking of new generations of art and architectural historians worldwide.[41] The persistence of this particular aesthetic belief system owes more, however, to its deep roots in Western culture. In proportional aestheticism the association of numbers with beauty exploits a cognitive ambiguity reflected in the very languages that help millions of people form their thoughts. When speakers of at least English and the Romance languages say the word "proportion," two contradictory meanings fire off simultaneously in their minds, and seem to meld together: the concepts of ratio and beauty become unified.

Perrault's "two kinds of proportion"

Proportion technically denotes a ratio, but in common usage it usually connotes a broader meaning that appears to have entered the English language, with all its current ambiguity, 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."[42] The term thus embodies what may be called quantitative/qualitative ambiguity because the first meaning, which may be described as proportion-as-ratio (or mathematical proportion), is an abstract quantitative comparison, while the second, which may be described as proportion-as-beauty, is a qualitative aesthetic assessment of an identified object.[43] The former cannot bring about the latter because objective numerical relationships cannot *cause*, predictably and repeatedly, subjective emotional responses such as the opinion that a building is beautiful. When the beauty-in-proportion belief system originated centuries ago, however, the notion of beauty was not always considered to be a subjective product of human emotion.

Antecedent to Le Clerc's dualistic description of proportion is Claude Perrault's similar observation, in the preface to his *Ordonnance* of 1683, that "...there are two kinds of proportion...." The first, which Perrault notes is difficult to perceive, describes "...the magnitudes that the various parts [of a building] have in relation to each other or to the whole...," while the second, which he notes is called *Symmetrie* [sic] in French, "...consists of the relationship of all the parts together [...and] is a very apparent thing, [for...] it never fails to make apparent the defects..." in a building.[44] Thus, according to Perrault, the first kind of proportion consists of a series of quantitative relationships that are difficult to see with the unaided eye and presumably can only be revealed by measuring instruments, while the second is a relationship among the parts of a whole that is universally distinguishable by all human beings as either aesthetically correct or defective. We need only observe, however, that as an example of one of the defects that the second kind of proportion purportedly reveals, Perrault describes the interior of the Pantheon—an example that only confirms that aesthetic judgments are ever subjective from time to time, place to place, and individual to individual (Fig. 4). Perrault writes: "...the bands of the dome do not correspond with the windows below, causing disproportion and a lack of *symmetrie* that everyone can readily recognize."[45] Three centuries later, however, contra-Perrault, scholars began to interpret the misalignments

between the vertical ribs of the Pantheon dome and the elements below as an aesthetic *tour de force* of Roman design.[46]

Perrault's inability to understand the second of his two kinds of proportion as a subjective aesthetic assessment rather than as a universal "...that everyone can readily recognize," was his blind spot, and helps to explain why the distinction he also made between two kinds of beauty, arbitrary (i.e., learned) and positive (i.e., universal)—according to which he controversially associated architectural proportional systems with the former—created no significant impediment to the continuation of the beauty-in-proportion belief system into the present day. In modern scholarship Perrault is typically characterized as the pivotal figure in architectural history whose association of proportional systems with arbitrary beauty initiated a new non-aesthetic attitude toward proportional systems that would remain dominant in mainstream culture thereafter. Perrault's place in the history of this subject, however, is in fact considerably more nuanced. His theory about proportional systems, though radical in his day, did not attack the core of the beauty-in-proportion belief system, or, the notion of positive beauty. Indeed, it was never his intention to undermine this notion itself, but only the belief that *proportional systems* could be sources of positive beauty in architecture.[47]

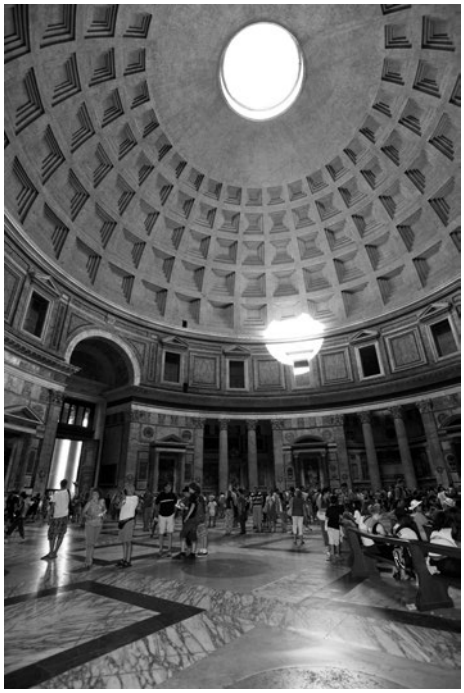

Fig. 4. The Pantheon, Rome, interior view.
Photo: Emilio Labrador.

Perrault's notion of positive beauty, which understands beauty as an objective entity not unlike a mathematical principle, unreliant on subjective human judgment for its existence yet universally recognizable by all human beings, happens to be the necessary precondition for the belief that particular proportional systems create beauty in architecture, or, the very belief that he developed the notion of arbitrary beauty to combat.[48] Perrault could very well claim that the proportional systems of the past, and for that matter his own new proportional system for the orders presented in the main body of the *Ordonnance*, only create beauty arbitrarily, through the familiarity of custom; but his affirmation of the existence of positive beauty has only affirmed the core belief of beauty-in-proportion believers from his day to our own: that a metaphysical well of ideal beauty exists somewhere outside of architecture, and that architects can learn various ways in which to tap into it in order to create works of universal appeal. Perrault attacks the efficacy of one of those ways—the use of proportional systems—but not the core of the belief itself.

Perrault's notion of positive beauty is similar to Leon Battista Alberti's notion of innate beauty, and might strike most modern readers as a contradiction in terms, for beauty, it would seem, can never be positive (i.e., non-subjective).[49] All assessments of beauty are arbitrary aesthetic opinions—or so it would seem in light of this discussion. Perrault's particular conception of positive beauty is based on a blend of quantitative and qualitative architectural qualities, or "convincing reasons," that to him signal the presence of positive beauty. He provides four examples of such qualities: "...richness of materials, the size and *magnificence* of the building, the precision and cleanness of the execution, and *symmetrie*...." The first and third of these examples can be interpreted as primarily subjective judgments. The second combines a measurable quality, size, with a subjective judgment, *magnificence*, and is thus best interpreted as a pair of words referring to the subjective quality of *magnificence*. Perrault describes

his fourth example, *symmetrie*, as the same as his second kind of proportion, or, a quality that produces "...an unmistakable and striking beauty" (*une beauté evidente & remarquable*) that all people recognize.[50] It is thus also subjective, and Perrault's entire conception of positive beauty would seem to consist of but a series of arbitrary aesthetic assessments.

Perrault, however, did not consider qualities such as *magnificence* and *symmetrie* to be subjective aesthetic judgments, even though today we have no other reliable way to characterize them because their properties cannot be confirmed with the predictability and repeatability that the scientific method requires. Indeed, he based his assumptions not on scientific standards of verifiability, but on the then seemingly irrefutable approbation of expert opinion—the consensus among those who had the education and training to judge art and architecture. Another century would pass before Kant would state that

> there is no Science of the Beautiful, but only a Critique of it.... For...if it could be decided scientifically, *i.e*. by proofs, whether a thing was to be regarded as beautiful or not, the judgment upon beauty would belong to science and would not be a judgment of taste.[51]

Perrault did not have the benefit of the fully mature scientific revolution to help him sort out these distinctions, but no matter, because the concept of beauty-in-proportion, which depends on the illogical and unscientific assumption of a causal relationship between proportion-as-ratio and proportion-as-beauty, ignored the scientific revolution in its uninterrupted passage from Perrault's day to our own.[52]

By codifying the notion of positive beauty, and thus the positive/arbitrary beauty dichotomy, Perrault's writings may have contributed to *maintaining* the beauty-in-proportion belief system in subsequent centuries as much as those of François Blondel.[53] In Part V of the *Cours d'architecture* of 1683, Blondel replies to Perrault's denial, in Perrault's preface to the *Ordonnance*, that proportional systems can be sources of beauty with what Anthony Gerbino calls a "defense of proportion."[54] Blondel's defense focuses on "harmony" (*harmonie*), an adjunct to the word and concept of proportion that for architectural theorists had carried the ambiguous double signification of proportion-as-ratio and proportion-as-beauty since at least 1485, when Alberti published his celebrated promulgation of harmonic architectural proportions in Book IX of *De re aedificatoria*.[55] Thus Blondel sees no contradiction in using both of these terms, proportion and harmony, in one sentence qualitatively, to describe the beauty of "...old and modern buildings..., [and] the beautiful proportions that their parts have between them...which have... [an] agreeable harmony that gives so much pleasure to the eyes"; and, in another sentence on the following page quantitatively, in reference to the musical-numerical proportions (i.e., proportions-as-ratio) of a specific building as "...a continual harmonic proportion...."[56]

Blondel emphasizes his belief that an inherent beauty of harmonic ratios in music is directly transferable to architecture in an unsubtle graphic comparison between the horizontal lines of a column base, annotated with numerical dimensions that form harmonic ratios, and the lines of a musical staff. The staff poignantly includes a bass clef (Fig. 5).[57] Blondel's claim that musical harmonies contain inherent beauty

that can be transferred to architecture is not fundamentally different than Perrault's claim that *magnificence* and *symmetrie*, among other qualities, serve as vehicles for transferring positive beauty to architecture, for both authors believe that great works of architecture somehow access a metaphysical well of ideal, universal beauty. Perrault's skepticism toward the traditional notion of proportional systems as tools capable of tapping into that well did not extend to the notion that such a well, which he calls positive beauty, existed in the first place. Thus, in the aftermath of the highly visible Perrault-Blondel debate, Perrault's skeptical approach to the traditional association of proportional systems with positive beauty did not decisively win out over Blondel's respectful approach. Perhaps the problem was that it was not different enough from Blondel's approach. Perhaps, furthermore, the beauty-in-proportion belief system that Blondel espoused, being illogical, was for its adherents impervious to any logical counter argument, including those parts of Perrault's counter argument that are indeed extremely logical, because by definition illogical thinkers do not listen to logic.[58] Instead, these two general approaches to the beauty-in-proportion belief system—skeptical and respectful—continued in subsequent centuries as parallel, sometimes mutually antagonistic developments of architectural culture.

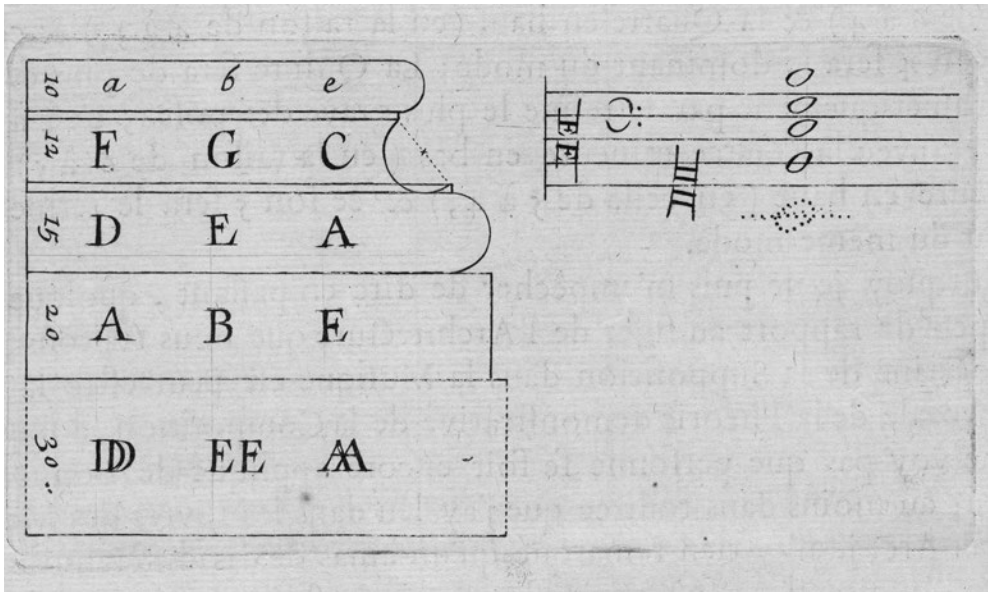

Fig. 5. Column base and musical staff comparison. François Blondel, *Cours d'architecture enseigné dans l'Académie royale d'architecture* (Paris, 1675-83), 2:V.vii.759. Photo: Typ 615.75.219 v. 2, Houghton Library, Harvard University.

Wittkower's "break-away" reconsidered

Wittkower surveys the European literature that reflects the aforementioned parallel developments from the 17th through the early 20th centuries—though rather than parallel developments of two different approaches Wittkower sees a transition from one to the other—in a section of *Architectural Principles* titled "The Break-away from the Laws of Harmonic Proportion in Architecture."[59] The literature he surveys is wonderfully varied, ranging from the analytical to the whimsical, and most of it highlights the notion of harmony.[60] An important shortcoming of Wittkower's overall quite useful

survey, however, is his conclusion that beginning in England in the late 18th century, "...the whole structure of classical æsthetics was overthrown from the bottom," and that

> ...in this process man's vision underwent a decisive change. Proportion became a matter of individual sensibility and in this respect the architect acquired complete freedom from the bondage of mathematical ratios. However, mathematical ratios survived in a degenerated form as a teaching expedient for architectural students and without any connection with their original meaning.[61]

Wittkower's freedom/bondage dichotomy appears to be overstated, for pre-18th century architects appear to have had more proportional freedom than Wittkower acknowledges, and while later architects may indeed have acquired the option of freedom from belief-based proportional systems (see below), not all of them opted for it; and of course architects were not the only interested parties in the history of architectural proportional systems. For some 18th-century and later thinkers, proportional systems continued to carry the same general payload of metaphysical meanings that they had carried for some thinkers of preceding centuries. Thus it may be more useful to think of the history of architectural proportional systems as characterized by two continuous, parallel strands of thought—a skeptical-pragmatic strand and a respectful-metaphysical strand—rather than a transition from one way of thinking to another, characterized by an 18th-century sea change separating a long period of universal obedience to proportional system metaphysics from a modern period of liberation.

Wittkower's denial of pluralism in European attitudes toward architectural proportional systems during the centuries in question is reflected in his survey selections.[62] The earlier works included in Wittkower's survey tend to reflect the respectful-metaphysical strand, while his later selections mostly reflect the skeptical-pragmatic strand. Wittkower brings his survey only as far as Archibald Alison's *Essays on the Nature and Principles of Taste* of 1790 and his follower Richard Payne Knight's *An Analytical Inquiry into the Principles of Taste* of 1805, before proclaiming victory for the skeptics. He then provides proportion-skeptical quotations from two subsequent works, John Ruskin's *The Seven Lamps of Architecture* of 1849, and Julien Guadet's *Éléments et théorie de l'architecture* of 1901–1904, as examples, he claims, of the "general feeling" prevailing from Knight's day "down to our own days."[63] He neglects to acknowledge, however, that many other works from the 19th and early 20th centuries reflect a broad range of vigorous alternative views.[64]

Perhaps fueled by an enduring tradition of occultism, which had flourished in England with particular fervor during the late 17th and 18th centuries, English beauty-in-proportion believers in the mid-19th century appear to have been very active, the legacies of the influential, proportion-skeptical writings of William Hogarth, David Hume, and Edmund Burke cited by Wittkower notwithstanding.[65] Thus Edward Lacy Garbett, in his *Rudimentary Treatise on the Principles of Design in Architecture*, published in London in 1867, decries the "immense abuse" he attributes to the beauty-in-proportion believers of his day, in a passage that he subsequently supports with quotations from Alison's aforementioned *Essays*. Garbett writes:

> A proper understanding of the nature of physical harmony, whether in sound or colours, will guard the reader against the immense abuse which mystics make of this plain commonsense principle, in the theories of what is called *proportion* in architecture;—a sort of beauty made easy, an artistic philosopher's stone, by which baser productions are to be transmuted into works of art...only by applying arithmetical rules.[66]

John Pennethorne's impressive tome, *The Geometry and Optics of Ancient Architecture* of 1878, indicates that Garbett's mystics were not relegated to the fringes of English society. Pennethorne blends his acute archaeological observations, which are still valuable today, and which he presents in rigorous, large format measured drawings and lucid verbal descriptions, with extensive metaphysical reflections. His first mention of optical corrections in ancient Greek temples as being necessary "...to produce an apparent harmony between all the members of the executed design" seems to refer to harmony as visual beauty in a casual, non-metaphysical way.[67] He continues, however, in the universalizing first person plural ("we"), to claim that rather than perceiving harmony in universally-appreciated works of art merely with our eyes, we *feel* it through an occult sympathy with the "constitution of our minds," which contains "an original impression" of the inherent structure of the universe. Thus he claims, as part of a lengthy metaphysical declaration strongly reminiscent of Robert Morris's *Lectures* from 150 years earlier, that when we (i.e., all human beings)

> are able to perceive the harmony and the exact proportions in which the several parts of the Universe are linked together, we feel an intellectual pleasure, arising perhaps from an original impression on our minds of what appear to be the essential attributes of a perfect work.[68]

Another expression of belief in intangible, beneficial properties of proportional systems evident in mainstream, 19th-century English architectural theory will be discussed below, in relation to Gwilt's *Encyclopedia*.

The ambiguous, metaphysically-driven melding of the two kinds of proportion discussed in this section, proportion-as-ratio and proportion-as beauty, has found four main categories of expression in the art and architectural literature from Alberti to the present. Two of them, we have seen, are the terms "proportion" and "harmony."[69] Indeed, today scholars and architects still commonly refer to "harmony and proportion" without understanding specifically what these words mean, or realizing that by using them they are perpetuating an ambiguity that traces back at least as far as the early Renaissance. The third category is the notion of regulating lines—networks of imaginary lines that purportedly contribute to architectural beauty—which along with harmony Blondel also promotes in his *Cours* (Fig. 6).[70] The fourth, the virtual cult of the golden section, originated in Germany in the mid-19th century, and is only superficially related to the occasional and probably often inadvertent appearance of this ratio (1:1.618...) in medieval architecture.[71]

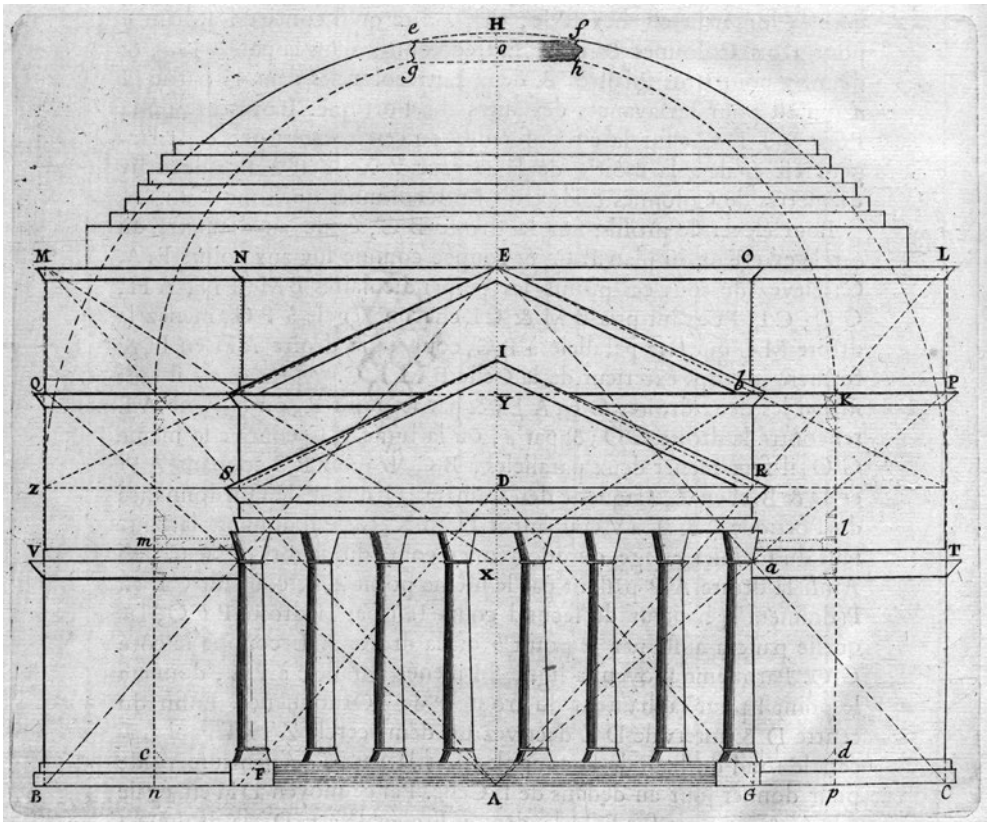

Fig. 6. The Pantheon, Rome, elevation with regulating lines. François Blondel, *Cours d'architecture enseigné dans l'Académie royale d'architecture* (Paris, 1675-83), 2:V.ix.752. Photo: Typ 615.75.219 v. 2, Houghton Library, Harvard University.

These four categories of expression blended with particular fervor in France during the second decade of the 20th century, in the discussions of several avant-garde groups composed of artists and others, including Section d'Or (Golden Section; also called Groupe de Puteaux), Les artistes de Passy, and Art et Liberté. Among the various members and officers of these groups were August Perret, Paul Valéry, Amédée Ozenfant, Gino Severini, Pablo Picasso, and Charles-Édouard Jeanneret-Gris, the future Le Corbusier.[72] Out of this early 20th-century French cultural context, augmented by German and other influences, eventually emerged Le Corbusier's Modulor, a proportional system of the 1940s that combined all four of the above-noted categories of expression of the ambiguously quantitative/qualitative notion of proportion.[73] Out of this context also belatedly emerged, in 1951, the Milan conference, which for some of the older participants such as Severini and Le Corbusier must have carried a rather nostalgic air of reunion, albeit in a dramatically different, post-war world (Fig. 2).[74]

The mystical agenda of the Milan conference

Dominated by the conspicuous participation of Le Corbusier and Wittkower, and given augmented prestige by the contributions of other leading intellectuals including Sigfried Giedion, Matila Ghyka, Pier Luigi Nervi, Andreas Speiser, and Bruno Zevi, the 1951 conference gave voice to a spiritual yearning on the parts of the organizers and participants for the development of a unified, orderly basis for the arts and sciences as a pathway toward the reformation of society and, ultimately, recovery from the trauma

of World War II.[75] In his introduction to the abridged proceedings of the conference, Fulvio Irace describes this yearning as follows:

> In 1951 the conference *De Divina Proportione* was proposed as an ecumenical council of men of arts and sciences, convened to determine the rules of the spirit that were to govern the new areas of democratic reconstruction.[76]

In the same publication James S. Ackerman—as of this writing the only living contributor to the 1951 conference and also a contributor, via video interview, to the 2011 Leiden conference—similarly notes a spiritual dimension to the conference:

> The interest that arose in 1951 was perhaps born, in a Europe that was still searching to recover from the devastation of the war, from a desire to return spirituality to the arts and to life through the geometry of a pure architecture, free of ornament and consisting of rectangular surfaces and openings.[77]

Ackerman later notes that the manner in which the conference participants approached their subject, if not the idealism that motivated them, marked the beginning of a new scholarly seriousness in the study of proportion:

> Before that time [1951] it [proportion] really hadn't become a reliable [area of] study. There was a lot of mysticism around it. Some of the mystics were part of the conference too, which is only fair, but it was really the end of the mystical phase and the [beginning of the] effort to set it onto reliable, academic, practical grounds.[78]

Only tangentially, however, did the conference engage the academic study of the history of proportional systems. Those contributors who incorporated historical observations with supportive textual references into their presentations, in particular Wittkower and Giedion, only did so in support of the overwhelmingly mystical, reformist agenda of the conference, which Giedion rather grandiosely described as "revolutionary."[79] Wittkower, one of the conference organizers, justified that agenda in his opening remarks by decrying as "an illusion" what he saw as the predominant contemporary attitude toward artistic production based on "...the nineteenth century idea that the artist, in his creative act, should be guided only by his personal intuition...." On the contrary, he declared, "...the search for harmony and order is a basic part of human nature."[80] Such harmony and order, he believed, transcended the individual, and had the potential to be perceived collectively, by all human beings.

Indeed, for Wittkower and the other conference participants, a general notion of proportional order, which could be manifested in proportional systems and which they called the *divina proportione* (the divine proportion), after Luca Pacioli's 16th-century book of that title (1509), constituted a kind of demiurge, existing independently of human culture but occasionally interacting with it. Seemingly endowed with agency and thus more assertive than a passive set of Platonic ideals, the *divina proportione*, these participants believed, periodically appeared in history, demanding expression in the arts and compelling human beings to serve as its sometimes unwitting collaborators toward some mysterious but ultimately beneficent purpose. Thus Giedion provocatively asked in his conference paper, "...can we assert that the *divina proportione* has made

its appearance again?," and obliquely answered in the affirmative, citing as examples Le Corbusier's Modulor and "...the difference between the static proportions of the past and the dynamic proportions of the present epoch...."[81] Even the thirty-two-year-old Californian and recently discharged US Army enlistee James S. Ackerman got into the spirit of the conference, alongside his elder European colleagues, concluding his summary analysis of the Cathedral of Milan proportions by interpreting the various geometrical schemes documented in the cathedral archives as medieval expressions of the "Divina Proportione."[82]

Wittkower shaped the conference around the goal of identifying an appropriate expression of the *divina proportione* in the arts for the modern age. Since "...the artist reflects the culture in which he lives," he posited, the central objectives of the conference were, first, to answer the question "What is the character of our culture..." in light of "...the substitution of the absolute measure of space and time with the new dynamic space-time relationship..." introduced by Einstein?; and, second, to determine what effect this substitution "...has and will have on proportion in the arts...."[83] Thus, at the Milan conference Wittkower played the role of the activist-historian, applying his historical knowledge toward the purpose of influencing rather than merely studying history. Through the conference he strove to encourage artists and architects of the time to develop new proportional systems that would reflect the contemporary modern condition, to use those proportional systems in their creative works, and to see themselves as the torch bearers of a dynamic, centuries-long tradition of proportional exploration that had been, in his view, temporarily interrupted by misguided 19th-century attitudes toward creative production.[84]

In his 1960 essay "The Changing Concept of Proportion," Wittkower reveals his disappointment with the 1951 conference, lamenting that it had failed to advance its reformist agenda with tangible results. He also reveals his belief that proportional systems constituted not merely opportunities for aesthetic expression, but moral imperatives. The Milan conference, he notes, "...brought together philosophers, painters, architects, musical historians, art historians, engineers and critics from many countries." These thinkers and practitioners had gathered because, he continues, "...they agreed on one point: that some kind of controlling or regulative system of proportion was desirable." The conference nevertheless "...fizzled out...," he claims, "...without making an appreciable impact on the younger generation."[85] The true depth of his disappointment, however, becomes apparent as his essay continues.

"The bankruptcy of the Milan meeting...," Wittkower inveighs, "...was publicly sealed at a historic meeting of the Royal Institute of British Architects...where a debate took place on the motion 'that systems of proportion make good design easier and bad design more difficult'—a motion that was defeated with forty-eight voting for and sixty voting against."[86] This "bankruptcy" was for Wittkower not merely intellectual, but moral. In the essay he appeals for a return to the high ideals of the failed conference, advocating adherence in contemporary art and design to "absolute" and "universal" values based in "thought" rather than "sensations," lest modern society succumb to ignoble pragmatism and opportunism. Wittkower continues:

> In most periods of history artists were convinced that their specific system of proportion had universal validity. These systems derived their all-embracing character from thought processes rather than from sensations. It is now two hundred years since the belief in absolute values was shaken, perhaps for all time; it can surely not be won back by an act of majority decision. As long as a broad foundation for a resurrection of universal values is lacking, one cannot easily predict how the present dilemma can be resolved. The very formulation of the motion put before the R.I.B.A. meeting shows that we have left far behind the realm of the absolute, and are submitting to pragmatic and opportunistic motivations.[87]

With the emphasis of martial and religious metaphors ("won back" and "resurrection," above), a rather militant-evangelical Wittkower here presents a moral choice between good and bad: design with proportional systems is based on thought and thus reason, and is therefore good; design without proportional systems is based on aesthetic judgments that are in turn based only on stimuli received by the senses in the absence of thought, and is therefore bad. He goes on to lament the "...quick rise and easy victory of abstract expressionism...," which he deprecates as "splash-and-dribble style," and the "absolute subjectivism" that he believed characterized the state of society nearly a decade after the Milan conference, and that he considered antithetical to the use of proportional systems.[88]

With these comments Wittkower takes his place in a long line of similarly-minded thinkers. He might have fit in comfortably, for example, with those who in 1750 Alexander Gottlieb Baumgarten anticipated might have raised objections to his proposed new field of aesthetics on the basis that "...impressions received from the senses, fantasies, emotional disturbances, etc., are unworthy of philosophers and beneath the scope of their consideration."[89] In earlier centuries Wittkower might have found sympathetic company with François Blondel or Daniele Barbaro.

This tendency to think of proportional systems, and the buildings that contain them, as good because they are based on mathematics, and the absence of proportional systems as less good, if not outright bad, because it leaves the architect's whims unfettered, is still common today. Indeed, this tendency, along with the proportional aestheticism of which it is a symptom, carries the risk of encouraging moral-aesthetic judgments of architecture, along the lines of Wittkower's above-quoted comments of 1960 pertaining to the Milan conference. If buildings that contain proportional systems are good according to beauty-in-proportion believers, can buildings that lack them ever be as good, of equal overall value, and more than merely "pragmatic" and "opportunistic?" Such proportional aestheticism could lead some scholars to believe that all good buildings must necessarily have interesting proportional systems, and to insist on finding them even where they do not exist. As the Old Sacristy of San Lorenzo suggests, however, many good buildings may very well lack interesting proportional systems, and that lack constitutes valuable historical information rather than grounds for censure.[90]

Belief-based proportional systems

Prior to the advent of modern structural engineering, architects and builders used what we may call "belief-based proportional systems" to determine key dimensions of their works in terms of local units of measure. They did so in the belief, which could never be based on the certainty of verifiable outcomes, that these proportional systems would confer upon their works particular desirable yet unmeasurable qualities.[91] The kinds of qualities that such proportional systems conferred included a general condition of order that was integral to pre-engineering notions of structural stability and beauty, which in Italy was called *ordine*.[92] After the advent of engineering a new type of proportional system arose, which we may call "certainty-based," since proportional systems of this type are based on the measurable, scientifically verifiable certainty of guaranteed outcomes. Nevertheless, examples of the old belief-based proportional systems—still unscientific, illogical, and unable to provide the certainty of guaranteed outcomes—continued to flourish, though to a lesser extent, alongside them. In acknowledgement of this variety, we may define an architectural proportional system as:

> a set of geometrical, numerical and/or arithmetical correspondences between important dimensions throughout a building or major part thereof, intended by the architect to imbue built form with desirable qualities, physical or otherwise.[93]

Note that in order to satisfy this definition, either kind of proportional system (belief-based or certainty-based) must consist of a set of *intentional* correspondences. This definition thus excludes complex geometrical constructions that historians might overlay onto drawings, photographs or computer models of buildings (Fig. 6), unless those overlays can be convincingly demonstrated, through building (or historic drawing) measurements or other evidence, to represent the architect's intentions.[94] This definition thus furthermore assumes that proportional systems cannot wander into architecture of their own volition, without the architects' knowledge, as for example golden sectionists have tended to believe.[95] Since unintentional patterns of geometry and number can always be found in architecture, the preceding definition distinguishes between mere physical description of the object, which might include such patterns, and the scholarly identification and analysis of the creative intentions of the architect.[96]

The use of certainty-based proportional systems is standard practice today, in the forms of structural engineering size specifications (which must be combined with specifications for materials, techniques and other construction factors), standardized sets of dimensions for building components (in terms of the meter or the foot), zoning regulations (such as floor area ratio) and other conventions, but these are not the kinds of proportional systems of primary interest to us here.[97] Engineering specifications, dimensional standardization and zoning formulae, as certainty-based proportional systems, are designed to guarantee measurable, practical outcomes, repeatedly and predictably. The proportional systems of primary interest to us here are decidedly impractical and not founded on the certainty of guaranteed outcomes.[98] These belief-based proportional systems either date to the pre-engineering period prior to 1742–1743 or, if later, retrogressively retain the technological innocence of that earlier

period, together with some degree of the metaphysical orientation that characterized much of the thinking of that period.[99]

The differences between belief-based and certainty-based proportional systems can be rather subtle. For example, upon first consideration one might think that the San Lorenzo nave arcade bay proportional system, which is a pre-engineering proportional system, guarantees the outcome that a root-2 rectangle will be inscribed in the space between the column shafts (Fig. 3, left), and that therefore at least in this respect it is no different than any typical engineer's specification from the post-1742–1743 period. Upon closer consideration, however, we can see that this proportional system is thoroughly belief-based rather than certainty-based, for two reasons. First, it does not in fact guarantee the physical presence of the root-2 rectangle in the nave arcade bays—indeed, this rectangle is not physically present there at all—and, second, this root-2 rectangle could serve no practical purpose whether it were present or not. This rectangle only exists as *an idea* in the minds of observers who understand that the horizontal distance between the column plinths, and the intended height of the column shafts, not including the astragals (which in this basilica are physically integral with the capitals), together correspond to the proportions of an *imagined* root-2 rectangle. To mentally perceive this rectangle observers must disregard not only the significant curvilinear gaps between the sides of this imaginary rectangle and the surfaces of the column shafts and bases (Fig. 3), but also the construction error that caused the column shafts to have been made slightly too tall to mark the top of this imaginary rectangle.[100]

Furthermore, the root-2 rectangle in question could not have *guaranteed* any of the outcomes that the architects, probably both Dolfini and Brunelleschi, hoped to achieve by specifying it, which surely consisted of more than simply creating a root-2 rectangle as an end in itself.[101] These architects might very likely have intended, for example, that it would confer *ordine*, specifically including structural stability (see above). Today, however, we know that it is scientifically impossible for a root-2 rectangle *per se* to establish structural stability in architecture; and that neither *ordine* nor other notions of beauty, being subjective qualities, can ever be guaranteed. Engineering or zoning specifications, conversely, being based on immutable scientific and municipal laws (the latter being immutable at least for the duration of construction), guarantee predictable and measurable outcomes such as structural stability (when used in conjunction with other specifications, as noted above) or conformance with established building regulations.

An illuminating example of an early conflict between belief-based and certainty-based proportional systems is found in the 1867 edition of Gwilt's *Encyclopedia of Architecture*. Gwilt promotes what he calls the "interaxal system," a grid proportional system that he openly borrowed from Jean-Nicolas Louis Durand's *Preçis des leçons d'architecture* of 1802-1805. Durand's proportional system still represented the belief-based approach, and Gwilt defended it against the then new, engineering-based technology of cast iron, which threatened to deprive Durand's system of the structural justification with which Gwilt associated it.[102] Gwilt writes:

> Not the least important of the advantages resulting from the method of designing just submitted to the reader is the certain symmetry it produces, and the prevention, by the use of these interaxal lines on each floor, of the architect falling into the error of false bearings, than which a greater or more dangerous fault cannot be committed,

> more especially in public buildings. The subterfuge for avoiding the consequence of false bearings is now a resort to cast iron, a material beneficially enough employed in buildings of inferior rank; but in those of the first class, wherein every part should have a proper point of support, it is a practice not to be tolerated.[103]

Thus, according to Gwilt, not only does the interaxal system provide a "certain symmetry," by which Gwilt evidently means a kind of comprehensive beauty similar to Perrault's *symmetrie*, but it ensures that walls and columns will always be stacked directly atop other walls and columns, in a system of structural support that Gwilt finds more satisfactory than one that has columns bearing on transfer beams of cast iron, even though the two systems could be made equally strong. Similar to Wittkower's above-quoted objections of 1960 to any neglect of belief-based proportional systems in favor of artistic intuition, Gwilt considers the replacement of a belief-based proportional system with an engineer's certainty-based one (i.e., the mathematical specifications for the cast iron members) to be morally unacceptable. The interaxal system, Gwilt maintains, provides structural support that is "proper," while cast iron provides the same degree of support but only though "subterfuge." For Gwilt, the engineer's cold calculations, which merely satisfy the practical objective of making a building stand up, can never distinguish architecture—i.e., buildings of "the first class"—from mere "buildings of inferior rank" or, for that matter, from pure works of engineering such as bridges.[104] Gwilt's protestations notwithstanding, 19th-century engineers indeed succeeded in robbing belief-based proportional systems of their one ostensibly practical purpose, that of ensuring structural stability, by fulfilling that purpose effectively and reliably using proportional systems based on the science of physics, which the old proportional systems based on the mysticism of metaphysics never could do.

The advent of engineering, however, brought about only a partial demise of belief-based proportional systems in architecture. Since such systems, like those used in the designs of the Cathedral of Milan and the basilica of San Lorenzo, never had any more influence over structural stability than magic or prayer, the advent of engineering merely proved what many architects already knew—that in determining the sizes and dispositions of crucial structural members an architect could use all the proportional systems he wanted, but in the end, in the words of the 16th-century Spanish architect Rodrigo Gil de Hontañon, he could only use "...his own judgment... and dare to have confidence."[105] The advent of engineering thus robbed belief-based proportional systems of their always-questionable claims to have helped ensure structural stability, but did not touch the only purpose that such proportional systems have ever fulfilled successfully—that of imbuing buildings with meaning. Some of that meaning may be considered aesthetic, for example, when observers thought about proportional systems in order to help themselves make sense of sense perception, or when architects used proportional systems to establish certain forms like entasis that they considered to be beautiful; and some may be considered metaphysical but not necessarily aesthetic, such as when observers thought about proportional systems to help themselves imagine architecture as a reflection of a larger, macrocosmic order that, in the words of Alfred W. Crosby, "lay beyond the scrim of reality."[106]

Belief vs. practice

Contemplation of the macrocosmic order that lay beyond the scrim of reality was not for everyone, and most pre-engineering architects probably used belief-based proportional systems without associating them with beliefs that were nearly as metaphysical as the kind Crosby describes above, who addresses a more general context not specifically focused on proportional systems. Indeed, Anthony Gerbino and Konrad Ottenheym, in their studies in the present volume, independently conclude that in the 17th century and earlier periods, with some notable exceptions most architects probably had little interest in, nor much understanding of, such beliefs, and instead thought of proportional systems as practical design tools integral to long-established architectural practices.[107] Palladio and da Vignola, for example, in their extremely limited comments on possible analogies between proportional systems and musical harmony, merely indicate a general awareness of such matters, and that others of their day had studied them, but devote the vast majority of their own attention to more earthly concerns of architectural practice.[108] In da Vignola's case one of those concerns is his attempt to use proportional systems to establish architectural beauty through *correlation*—that is, by recording the proportions of selected ancient Roman buildings widely considered beautiful in his day, and encouraging his contemporaries to use those proportions in their own works for the purpose of creating similar beauty.[109] Da Vignola's belief in the power of proportional systems to contribute to architectural beauty is illogical, for it fails to acknowledge the myriad factors that together contribute to perceptions of architectural beauty, perhaps including certain acceptable ranges of proportions-as-ratio for particular architectural elements as established by custom, but by no means limited to them.[110] His belief is not fully metaphysical in character, however, as is Alberti's stated belief in the powers of proportional systems to create architectural beauty through *causation*, or, through the sheer metaphysical power of numbers.[111]

Thus as an alternative to Wittkower's collectivist interpretation of architectural theory, according to which virtually everyone in any given period thought in exactly the same way, and according to which the extreme views of non-architect mystics such as Francesco Giorgi (or Zorzi) can serve as reliable stand-ins for the views of pragmatically-inclined architects such as Palladio, da Vignola, Serlio, and Alberti (considering *De re aedificatoria*, Books I to XIII, and X), we may observe that at any given moment in history two rather loosely defined and occasionally overlapping, parallel strands of belief pertaining to proportional systems can be identified, one more pragmatic in character and the other more metaphysical. In the pragmatic strand are the beliefs that proportional systems contributed various degrees of structural stability and *ordine* to architecture—beliefs held, for example, by the first three aforementioned Renaissance architects, plus Alberti, depending on how we think about him.[112] In the more metaphysical strand are the beliefs that proportional systems link architecture to the pure beauty, the macrocosm or the divine, such as, continuing with Renaissance examples, those of Barbaro and Giorgi, plus Alberti if we consider *De re aedificatoria*, Book IX. Indeed, the beliefs and intentions of most pre-engineering architects and builders can probably be identified with the pragmatic strand; while those of unusually learned architects, clerics, and other intellectuals, with the metaphysical strand. As noted above, furthermore, some extraordinary thinker-practitioners such as Alberti

and Le Corbusier can be interpreted as occupying either strand, depending on which aspects of their work we consider.

Of course, the character of the various beliefs within each strand can be expected to have varied considerably across time and geography. Thus Pennethorne's beliefs, for example, were no doubt quite different from Giorgi's, even though both, according to this interpretation, contributed to the metaphysical strand. Nevertheless, Pennethorne's may be considered more closely related, through a continuous succession of metaphysically oriented thinkers from the 19th back to the 16th centuries, to Giorgi's beliefs than to Palladio's, whose more pragmatic orientation associates him with the pragmatic strand that also stretches from the Renaissance into the 19th century, but was manifested by more pragmatically oriented thinkers such as Alison and Knight.

And so the two parallel strands of belief continued, progressing out of the 19th century and into the 20th. In September 1951 the metaphysical strand passed forcefully through Milan, though the pragmatic strand was also present.[113] In June 1957 both strands passed through the R.I.B.A. meeting moderated by Pevsner, though we have seen that the pragmatic strand appears to have been slightly more vigorous, at least in light of the 60–48 vote against the beauty-in-proportion belief system. When interpreting these strands of belief we must exercise due caution, for there is reason to question the depth of beliefs to be found among those thinkers we may associate with the metaphysical strand. British architectural journals from the late 1950s, after all, despite the sizable minority of the R.I.B.A. vote, are not flooded with articles about belief-based proportional systems in practice. In architecture the demands of practice have always tended to hold esoteric beliefs in check—while not necessarily eliminating them—which is why most practitioners in history have tended to align primarily with the pragmatic strand, even while occasionally professing sympathy with the metaphysical strand.

While the parallel strands continue today, true metaphysicians who search for today's *divina proportione* in the geometry and mathematics of all manner of architectural design strategies constitute a small minority of theoreticians and practitioners. New developments in computational design capabilities, however, are opening what may be a new phase in the history of proportional systems that could cause the parallel strands to become increasingly intertwined. Computational design is allowing architects unprecedented control over certainty-based proportional systems that for the past 150 years have been the nearly exclusive domains of engineers and other specialists.[114] Parametric modeling and other design methods are now allowing architects to solve complex problems of design, custom fabrication of building components, and construction, while simultaneously exploring new avenues of aesthetic expression. Formal exploration and creative problem-solving can play variously dominant roles in these computational design processes.[115] These new certainty-based proportional systems are essential to the design process, rather than mere corrective appliqués such as regulating lines, because to ever-increasing degrees they *are* the designs. The metaphysical strand of belief-based proportional thinking may yet be reinvigorated in this new design environment that is so steeped in complex geometrical and mathematical operations that encourage the production of new kinds of architectural forms that have few historical precedents.[116]

Architects have always had the artistic license to explore whatever pragmatic or metaphysical inclinations they may choose, but architectural historians need to strive for objectivity in order to interpret this creative production accurately. The study of proportional systems in the history of architecture presents a rich variety of subject matter, very important among which is the exploration of the meanings they communicate. Scholars have to take care to examine these proportional systems, and the meanings they originally communicated, as historical artifacts created to serve as objects of belief, while avoiding any temptation to have them serve as objects of their own beliefs. Some of the following essays examine proportional systems composed of proportions-as-ratio, or, sets of proportions as measurable, verifiable products of artistic production. Others examine proportion-as-beauty, from historical or historiographical viewpoints. The distinction between proportion-as-ratio and proportion-as-beauty outlined in this introduction is intended to help readers distinguish between historical and aesthetic approaches to understanding proportional systems, and to avoid ambiguity by keeping these two approaches strictly separated.

The essays

The essays presented in this volume provide explorations of current scholarly thinking on the varied problem of proportional systems in the history of architecture, with emphasis on developments in northern Europe, Italy, and Greece. They invite a reinvigorated discussion of this broad topic extending beyond these regions and these pages. The preceding introduction examines the inherent contradiction between proportion-as-ratio and proportion-as-beauty that resides within the word "proportion," and the long history of this contradiction. As a manifestation of a general human impulse to conjoin the imagined with the observed, the abstract with the measured, and the ideal with the contingent, this contradiction has many guises. Some of these guises are explored in the six essays that form Part II of this volume, which focuses on ways in which proportional systems have been, and can yet be, understood as conceptual tools for pondering various intellectual or visual conundrums pertaining to architecture.

Mario Curti (Chapter 2) discerns a common undercurrent in the long history of proportional systems in the form of a recurring conflict between canons and nature. This conflict, he contends, is driven by the inevitable incongruities between what the "champions of ideal proportions" have sought and the imperfect reality of the world as it is. Indeed, such incongruities can be found between the ideals of these champions and natural phenomena such as optical perspective distortions or the non-scalable nature of the strength of materials, or between an observer's expectations of the way architecture should be and its imperfect reality. Thus **Caroline van Eck** (Chapter 3) proposes that proportional systems are constructs of the mind, invented to help people "...make sense of, and judge, the objects of sense perception." In this role, she argues, proportional systems have helped to resolve conflicts between expectations of normative classical forms and occasionally jarring deviations therefrom, such as those that have long perplexed viewers of Michelangelo's San Lorenzo Ricetto (of the Laurentian library). Through analysis of the Ricetto and its reception over time, van Eck proposes that the assumption of proportional systems constitute one of two strategies—the other being anthropomorphic projection—by which human beings

have made unfamiliar architectural appearances comprehensible. In an appendix, van Eck provides an English translation of a previously unpublished essay of 1933 by **Rudolf Wittkower**. Here the German scholar and influential post-World War II champion of van Eck's first strategy unexpectedly explores van Eck's second strategy by attempting to explain the experience of architecture in terms of movement and animation.[117] **Sigrid de Jong** (Chapter 4) continues this exploration of historical encounters between the normative and the deviant in her analysis of the 18th-century reception of the proportions of the Paestum temples. By probing the notion of the "primitive" she shows how proportions interpreted aesthetically (proportions-as-beauty) have carried meanings just as rich and varied as those interpreted geometrically and numerically (proportions-as-ratio).

Anthony Gerbino (Chapter 5) probes another potential contradiction in the study of proportional systems by revisiting the fundamental question of whether, or to what degree, early modern architects were interested in championing notions of Platonic, ideal proportions, or whether they saw proportional systems primarily as practical design tools. Were they Platonists, as Wittkower has influentially contended, or is it time for scholars to reevaluate the mental habits of early modern architects? **Stephen Murray** (Chapter 6) and **Marvin Trachtenberg** (Chapter 7) present two original modes of understanding the possible mental habits of pre-modern architects, with an emphasis on the medieval period. Murray proposes that medieval builders "plotted the future"—with the full multivalence of the word "plot" left intact—by stretching chords, turning compasses, and hatching schemes, all the while using proportional systems as design tools and vessels of symbolism. Murray in a sense also plots the future of his own research by revisiting his decades-old survey of Beauvais Cathedral, which he undertook using manual tools of mensuration, this time using computer-enabled, laser scanning technology. In addition to confirming his earlier proportional observations, his new surveys reveal a new array of contradictions between ideal proportional intentions and actual structural conditions. Trachtenberg develops his notion of building-in-time to propose that medieval and Renaissance proportional systems typically developed, conceptually and physically, in an iterative process of what he terms "concatenate planning." He furthermore proposes that a new kind of contradiction took up residence within the notion of proportion when Leon Battista Alberti proposed an inflexible system of ideal proportions that would, according to Trachtenberg, "tie proportions in knots," contrary to traditional concatenate planning.

While Part II focuses on ways of conceptualizing proportional systems, Part III focuses on ways in which they have been used in architectural design. **Elizabeth den Hartog** (Chapter 8) explores early Gothic number symbolism, an often controversial topic due to the difficulty of establishing intentionality in buildings that invariably contain diverse arrays of numbers, such as numbers of bays and numbers of columns, whether intended to be symbolic or not. Based on her wide-ranging research den Hartog concludes with judicious caution that such symbolism was indeed often "more likely than not" intentional, in light of the prevalent number culture of the period. **Lex Bosman** (Chapter 9) examines another common numerical device in pre-modern proportional systems by proposing a new history for the module that includes the material of construction as an unexpected protagonist. While highlighting potential contradictions between written theory and actual practice—and thus continuing the theme of contradiction that runs through this entire collection of essays—Bosman

explores ways in which ancient Roman and Renaissance architects might have determined the sizes of their modules, and whether they were even fully responsible for making these decisions. The Roman system of delivering column shafts in standard sizes and the possible demise of this system during the Renaissance, Bosman argues, may have exerted decisive influence over the determinations of modules.

Mark Wilson Jones (Chapter 10) and **Franco Barbieri** (Chapter 11) continue the exploration of modular design methods before and after the periods covered by Bosman, respectively. In his study of the Parthenon proportions Wilson Jones proposes, like Bosman, that the predetermined dimensions of materials, in this case recycled column drums from the pre-Parthenon, played a critical role in determining the module size. Indeed, he finds that the Parthenon proportions are overall modular in character—or, "modulated"—and as such, based whenever possible on simple ratios related to the dimensions of the triglyph frieze in a subtle variety of ways. Through analysis of previous studies, furthermore, he maintains a healthy skepticism of overly complex theories that lack modulated consistency. If the modular proportions of the Greeks survived as "echoes" in Vitruvius's *De architectura* as Wilson Jones suggests, by the time of Vincenzo Scamozzi's *L'idea dell'architettura universale* of 1615 architects had an accumulated clatter of modular design theories ultimately based on interpretations of Vitruvius to sort through. Barbieri shows us how Scamozzi sorted through them in the latter's meticulous, deductive analysis of the proportions of columns, windows, rooms, and other architectural elements. Scamozzi's systematic method reflects Galilean scientism, while also acknowledging individual judgment and changes in fashion, as exemplified by the taller and more elongated proportions that he recommends over Palladio's choices. Similar to the observations of other authors in this volume, Barbieri notes numerous instances in which Scamozzi confronts contradictions between his preferred ideal proportions and the necessary accommodations to the contingencies of practice. Nevertheless, Scamozzi's eventual abandonment of the orders and their proportional systems in his later works evidences his restless idealism, and his first steps toward Enlightenment thinking.

Steps toward Enlightenment thinking and insights into the uses of proportional systems in practice are also evident in the next three essays, which importantly contribute to the hitherto under-studied subject of historic uses of proportional systems in the Low Countries. These studies shed new light on what appears to have been a distinctly pragmatic approach to proportion that, beginning in the 16th century, assimilated into the northern European context an incursion of Vitruvius-influenced Renaissance texts from Italy. **Krista De Jonge** (Chapter 12) shows how Pieter Coecke van Aelst, among others, produced publications gauged to appeal to artists trained in the Gothic culture of design, and that introduced new notions of proportion and the orders in ways that were graphically comprehensible in both numerical and geometrical terms. Coecke, she notes, thereby strove to "...establish a new, universally understood terminology of architecture." **Konrad Ottenheym** (Chapter 13) reveals a different kind of pragmatic approach that perhaps also aspired to universal applicability in his studies of Dutch architectural drawings from the 17th century. These drawings reveal an emphasis on frameworks consisting of grids or occasionally more complex geometrical constructions, and whole number dimensions expressed in local units of measure. In these drawings we see basic proportional frameworks serving as a strict design system that for most practitioners was probably devoid of metaphysical association.

Ottenheym, however, documents a fascinating—though apparently rare—exception in a poem by Constantijn Huygens, which associates symmetry in architecture with that of the human body and thus, in Huygens's words, of "...the most beautiful creature of God." **Jeroen Goudeau** (Chapter 14) proposes a direct link between this largely pragmatic, grid-centric architectural theory of the Dutch 17th-century milieu, and the major developments of proportional theory in late 18th-century France. By proposing that the theoretical works of urban design and architecture by Nicolaus Goldmann may have profoundly influenced the development of the grid-based compositional method of the French architect and instructor at the École Polytechnique in Paris, Jean-Nicolas-Louis Durand, Goudeau greatly enhances our understanding not only of 17th-century Dutch architectural theory, but also of an aspect of Durand's work that would play such a critical role in the development of 20th-century modernism.

Robert Bork (Chapter 15), with his graphic analyses of the often complex "dynamic unfolding" of geometrical constructions in the Gothic design process, appropriately completes Part III of this volume and initiates Part IV, which addresses new approaches to studying old sources. Like the other authors in Part III, Bork demonstrates how proportional systems appear to have been used in architectural design. His method is quite novel, notwithstanding any superficial resemblances between his geometrical overlays and those of many of his oft-maligned predecessors.[118] Bork ensures precision by using digital scans of surviving Gothic-period drawings combined with overlays made with AutoCAD drafting software. His many new findings drawn from well-known sources, and his bold, reconstructive approach of getting into the minds of the Gothic master masons, are all grounded in the historical and historiographical contexts of Gothic design.

The first two essays in Part IV extract valuable new information from much-studied monuments using recent three-dimensional digital measuring technologies. **Andrew Tallon** (Chapter 16) begins with a concise introduction to fundamental laser scanning principles and vocabulary. He then demonstrates how laser scans can be used to analyze the proportions of large Gothic cathedrals, usefully noting that such scans can "...tell you where you stand" with regard to particular hypotheses, but cannot interpret the data for you. Indeed, those who might fear any potentially tyrannical effects of laser surveying on the study of proportional systems will be reassured by Tallon's flexible approach and accommodatingly inconclusive conclusion indicating that the builders of the Cathedral of Saint-Étienne in Bourges may—or may not, depending on how one interprets the data—have intended the cross-section proportions to conform to an equilateral triangle. **Gerd Graßhoff** and **Christian Berndt** (Chapter 17) use laser scans from the Digital Pantheon project to analyze the proportions and entasis of the Pantheon portico columns in unprecedented detail. Their meticulous analysis of this data leads them to two remarkably specific conclusions: first, that the proportions of the columns are consistent with design methods noted in two ancient sources, Vitruvius's *De architectura* and the construction drawings discovered at Didyma; and second, that the final profiles of the column shafts were applied in slightly different ways by two different workshops after the roughed-out shafts were delivered to Rome.

The next three essays in Part IV extract new information from documentary sources using traditional tools of scholarly inquiry in original ways. **Francesco P. Di Teodoro** (Chapter 18) examines the numerous sketches of sacred buildings in Leonardo da Vinci's manuscript known as Ms. B by drawing and analyzing accurate

geometrical diagrams interpolated from da Vinci's sketches. Di Teodoro thus gains new insights into da Vinci's working methods, such as his emphasis on floor plans as starting points of design, and certain relationships between various drawings that have not previously been noted. **Sara Galletti** (Chapter 19) uses proportion as a point of entry into Philibert de L'Orme's *Premier tome de l'architecture* of 1567. Using the topic of proportion to probe the intellectual development of de L'Orme's treatise, Galletti determines that the French architect developed his particular theory of "divine proportions" during the composition of his treatise. She pieces together the various traces of this theory throughout the treatise in order to reveal new insights into this important work of Renaissance architectural literature, such as the order in which the various books were written, the evolving scope of the work, and the nature of the author's own intellectual development. **Maarten Delbeke** (Chapter 20) extends our understanding of Claude Perrault's relationship with Vitruvius' *De architectura* both by illuminating some lesser known of his rather aggressive commentaries on this ancient treatise, found in footnotes to his translation of 1673, and by showing how Perrault's own thinking on proportion was influenced by Vitruvius despite his disagreements with the ancient author.[119] Delbeke shows how Perrault transposes Vitruvius's notions of the expertise of the architect to judge and previsualize, into a 17th-century socio-political context in which the notion of expertise colluded with that of authority in ways that intimately tied judgments of architectural proportion to monarchic power.

Part V presents the perspectives of four singular figures in the history of architecture—Le Corbusier, Hans van der Laan, Rudolf Wittkower, and James S. Ackerman—on proportional developments of the 20th century. **Jean-Louis Cohen** (Chapter 21) contributes new insights into Le Corbusier's Modulor—that unique five-way fusion of the notions of module, the golden section, regulating lines, man as the measure, and proportional aestheticism. Cohen presents new evidence drawn from the archives of the Fondation Le Corbusier and elsewhere that helps to illuminate Le Corbusier's various intellectual sources, thoughts and activities that contributed to his creation of the Modulor proportional system and system of measurement. The appendices to his essay contain two previously unpublished essays by **Le Corbusier**, in English translation and the original French: "A Timely Book" (1927), and "Regulating Lines" (1934). **Caroline Voet** (Chapter 22) explores the life and work of an idiosyncratic contemporary of and counterpoint to Le Corbusier, the Dutch Benedictine monk and architect Dom Hans van der Laan. By contrast with the entrepreneurial, fame-seeking, and ever self-reinventing Swiss architect who authored bestselling books to promote his Modulor, the modest van der Laan quietly developed his own complex numerical proportional system called the "Plastic Number," which predates the Modulor, as a mode of meditation and design inspiration related to his Benedictine beliefs and lifestyle. His proportional writings and distinctive oeuvre of monastic and residential work continue to attract a devoted following among architects today.

Rudolf Wittkower may be considered another counterpoint to Le Corbusier, for as **Francesco Benelli** (Chapter 23) argues based on newly accessed documents from Columbia University's Wittkower Archive, the German historian and the Swiss architect both developed new proportional conceptions for architecture based on similar anthropomorphic and metaphysical premises, and did so for the similar purposes of promoting their respective architectural points of view. Benelli's revelations of the rather adversarial and distant relationship between these two principal figures of

the 1951 Milan conference, as well as his detailed insights into Wittkower's working methods, sets the stage for an interview with **James S. Ackerman** (Chapter 24), who reflects on the legacies of Wittkower, Le Corbusier, and the 1951 Milan conference of which he was a participant, among other topics.

With regard to Wittkower's legacy, it is perhaps prescient that six of our authors—Francesco Benelli, Krista De Jonge, Anthony Gerbino, Marvin Trachtenberg, Caroline van Eck, and the present author—adopt highly critical positions. These new contributions, together with the previous contributions of Robin Evans, George Hersey and Richard Freedman, Deborah Howard and Malcolm Longair, Branko Mitrović, Alina Payne, Manfredo Tafuri, and others represent an increasing contextualization of Wittkower's writings on architectural proportional systems as artifacts of the mid-20th century. They thus indicate the waning influence of these writings today, and highlight the new opportunities before us to reconceive the subject matter of this volume. This volume concludes (Chapter 25) with a synthesis of the findings presented in these chapters, in the form of a proposed set of ten principles to serve as guidelines and points of debate for continued study of proportional systems in the history of architecture.

Notes

[1] In the preparation of this introduction I have benefited from the thoughtful comments of Anthony Gerbino, Caroline van Eck, and Mark Wilson Jones. This introduction is a revision of: Matthew A. Cohen, "Introduction: Two Kinds of Proportion," *Architectural Histories* 2(1) Art. 21 (2013), in the Special Collection "Objects of Belief: Proportional Systems in the History of Architecture," edited by Matthew A. Cohen and Maarten Delbeke. DOI: http://doi.org/10.5334/ah.bv. The 2011 conference was titled: "Proportional Systems in the History of Architecture: An International Conference Hosted by Leiden University, March 17–19, 2011," and was organized by Matthew A. Cohen, Eelco Nagelsmit and Caroline van Eck. The speakers were: James S. Ackerman (via pre-recorded video interview), Francesco Benelli, Robert Bork, Lex Bosman, Howard Burns (keynote), Jean-Louis Cohen, Matthew A. Cohen, Mario Curti, Sigrid de Jong, Krista de Jonge, Elizabeth den Hartog, Sara Galletti, Anthony Gerbino, Jeroen Goudeau, Gerd Graßhoff, Volker Hoffmann, Frédérique Lemerle, Emanuele Lugli, Stephen Murray, Werner Oechslin, Konrad Ottenheym, Andrew Tallon, Marvin Trachtenberg, Caroline van Eck, Caroline Voet, and Mark Wilson Jones.

[2] The 1951 conference had two titles: "Il Primo Convegno Internazionale sulle Proporzioni nelle Arti," and the subtitle "La divina proportione." It was held from September 27–29, 1951 as part of the ninth Triennale di Milano, in the Palazzo dell'Arte. Three publications report the contents of the conference: Wittkower, "International Congress on Proportion in the Arts," 52–55; an anonymous article titled "Il primo convegno internazionale sulle proporzioni nelle arti"; and Cimoli and Irace, *La divina proporzione: Triennale 1951*. Of them, "Il primo convegno" names the most speakers and other contributors, but Cimoli and Irace publish the largest selection of texts of the papers, many of them abridged. Of the thirty-two *relazioni* and *communicazioni* presented at the conference, Cimoli and Irace publish twenty-five, and "Il primo convegno," fourteen. The following list of participants (retaining all titles and spelling) is derived from the latter: James Ackermann (sic), Arch. Cesare Bairati, Arch. Max Bill, Luigi Cosenza, Prof. Dekkers, Dott. Gillo Dorfles, Prof. Giusta Nicco Fasola, Scultore Lucio Fontana, Dott. Charles Funck-Hellet, Arch. Ignazio Gardella, Prof. Matila Ghyka, Prof. Sigfried Giedion, Mad. Carola Giedion-Welker, Prof. Hans Kayser, Arch. Mario Labò, Le Corbusier, Arch. Carlo Mollino, Gino Levi Montalcini, Ing. Pier Luigi Nervi, Prof. Roberto Papini, Prof. Giovanni Ricci, Prof. Salvatore Caronia Roberti, Arch. Ernesto N. Rogers, Arch. Alfred Roth, Arch. Piero Sanpaolesi, Pittore Gino Severini, Prof. Andreas Speiser, Prof. Eva Tea, Dott. Adrien Turel, Pittore Georges Vantongerloo, Prof. Rudolf Wittkower, and Arch. Prof. Bruno Zevi. The following participated in a panel discussion on the third day of the conference: Arch. Annoni, Prof. Caronia, Ing. Enrico Castoldi, Dott. Melino, Arch. Moretti (Luigi Moretti?), Arch. Pasqué, and Arch. Sotsas junior. At the end of the conference the following were nominated and unanimously elected to serve on the "Comitato internazionale di studio sulle proporzioni nelle arti" (in the order listed in "Il primo convegno"): Le Corbusier (President), Arch. Phillip Johnson, Arch. Ernesto N. Rogers, Arch. Josè Luis Sert, Prof. Andreas Speiser, Prof. Rudolf Wittkower, Scultore Berto Lardera, Dott. Mario Melino and Signora Carla Marzoli ("Il primo convegno," 119–121). According to Wittkower the name of this committee was the "Comité Interna-

tionale pour l'Etude (sic) et l'Application des Proportions dans les Arts et l'Industrie Contemporains," and its purpose was to organize a second conference on proportion in the arts to be held in New York in 1953, which never took place (Wittkower, "International Congress on Proportion in the Arts," 55). On the Milan conference, see also Mattei, "Geometria e struttura," 257–269.

3 The announcement for the Leiden conference stated: "The purpose of this conference is to frame a rigorous new scholarly discussion of this subject [proportional systems in the history of architecture], and in the process, to help define appropriate methods, standards and limits for it. The conference will explore this subject during any period, and from both historical and historiographical points of view." For the stated purposes of the Milan conference, see Wittkower's opening comments quoted below, page 27.

4 According to Mainstone, "The first recorded application of...[the present theories of equilibrium, deformation and strength] in structural practise in 1742–43 may be said to mark the birth of the present art of structural design." This comment is in reference to a structural analysis undertaken in those years of cracks in the dome of St. Paul's Cathedral in London. Mainstone, "Structural Theory and Design Before 1742," 303.

5 Cf. the opening paragraph of Pevsner, *Outline of European Architecture*, 23 and 25: "A bicycle shed is a building; Lincoln Cathedral is a piece of architecture.... [T]he term architecture applies only to buildings designed with a view to aesthetic appeal," though I expand here upon Pevsner's formulation, even beyond his concluding sentence that the history of architecture is a history "...primarily of spatial expression," by proposing that a defining quality of architecture is its capacity to communicate iconographically. Proportional systems have served some limited visual purposes in history, such as helping to maintain certain stylistic conventions, but such purposes were mere conveniences rather than primary functions. Corinthian column proportions look Corinthian, for example, because their proportions-as-beauty fall within a particular normative range established by custom (a range that can be quite large), whether or not a proportional system was used to establish them. A proportional system for the design of columns can communicate iconographically, however, when it can be identified as participating in a particular ideology of proportion, such as, for example, Vitruvius's, or Alberti's, or da Vignola's column proportions. On the potential use of proportional systems to maintain stylistic conventions, see Cohen, *Beyond Beauty*, 26-31, and the Conclusion to this volume (Chapter 25), pages 538-539.

6 The prescribed proportions for streets and lots imposed by the governing authorities of Florentine new towns (Friedman, *Florentine New Towns*), are different than modern urban design guidelines for building morphology in that they appear not to have been intended primarily to produce practical outcomes such as health and safety. The same may be said of the urban design guidelines for the architecture of late medieval Florence noted by Trachtenberg, *Dominion of the Eye*. On the importance of harmonic proportions in medieval conceptions of beauty as expressed in urban design, see Flanigan, "The Ponte Vecchio," 9.

7 The term "paradigm" here follows the fourth definition in the *Oxford English Dictionary Online*, which generalizes Thomas S. Kuhn's definition to apply to non-scientific disciplines, such as architectural history, as well as scientific ones. Kuhn, *The Structure of Scientific Revolutions* (1962), 10. The *OED* thus defines "paradigm" as "a conceptual or methodological model underlying the theories and practices of a science or discipline at a particular time; (hence) a generally accepted world view." For Kuhn's brief acknowledgement of the applicability of his paradigm theory to art history, see Kuhn, *The Structure of Scientific Revolutions* (1970), 121. See also Cohen, *Beyond Beauty,* 36 n. 41.

8 Wittkower, *Architectural Principles* (1949); Wittkower, "Systems of Proportion," 9–18; Wittkower, "The Changing Concept of Proportion," 199–215; and Cohen, *Beyond Beauty*, 36–51. The term "Wittkower paradigm" as used here is independent of Payne's undefined reference to "Wittkower's paradigm." Payne, "Rudolf Wittkower and Architectural Principles," 332; and Payne, *Rudolf Wittkower* (2011), 46–50.

9 The term "proportion" is used here in the cursory sense of "proportion-in-general," leaving intact all the ambiguities that result from combining the notions of "proportion-as-ratio" (proportion as a quantitative, mathematical ratio, such as 1:2), "proportion-as-beauty" (a qualitative aesthetic assessment of an identified object), and "proportional system" (a set of quantitative proportional correspondences), as discussed in Cohen, *Beyond Beauty*, 19-24, and below, pages 17 and 30.

10 These anecdotal observations of common opinions today about beauty and proportional systems are similar to those reported by Edward Lacy Garbett in the 19th century (see below, pages 24-25) and Claude Perrault in the 17th century with regard to architects' opinions, as in Perrault's comment (italics added): "…what *most architects* claim when they would have us believe that what creates beauty in the Pantheon…is the proportion of that temple's wall thickness to its interior void, its width to its height, and a hundred other things that are imperceptible unless they are measured and that, even when they are perceptible, fail to assure us that any deviation from these proportions would have displeased us." Perrault, *Ordonnance des cinq espèces de colonnes*, v–vi; Perrault, *Ordonnance for the Five Kinds of Columns*, 49–50; and cf. Perrault, *Les dix livres d'architecture,* 105 n. 7. On the

risks of claiming to know what "most architects" thought at any point in the early modern period, see Gerbino, "Were Early Modern Architects Neoplatonists?," Chapter 5 herein, pages 113-114. See also the opinion polls of 1672 and 1957 discussed in note 86, below.

[11] See, however, Mark Wilson Jones's contribution to this volume (Chapter 10), and note 19 below. In the scientific literature, conversely, numerous attempts have been made to determine whether a natural human proclivity generates universal aesthetic preferences for particular proportional ratios in the visual arts (not specifically architecture). For a sampling of such studies, see Cohen, *Beyond Beauty*, 285. Recently, Cinzia Di Dio, Emiliano Macaluso and Giacomo Rizzolatti used functional magnetic resonance imaging (fMRI) to observe localized regions of brain activity in test subjects who were shown sets of proportionally-manipulated photographs of classical and Renaissance figure sculptures, and asked to judge them aesthetically. Di Dio, Macaluso and Rizzolatti "The Golden Beauty." The authors' claim that their fMRI images demonstrate not merely that certain areas of the brain activate when performing certain tasks, but the existence of an objective beauty based on the golden section, appears to be an example of a current tendency in the fields of neuroscience and psychology to make, according to Senzeni Mpofu, "…overly enthusiastic claims about fMRI's credibility in explaining social science phenomena." Mpofu, "Debunking Science: fMRI"; and similarly, Satel and Lilienfeld, *Brainwashed*. Also of concern is that the authors use these scientific tools in combination with a limited understanding of art history and aesthetic theory. Thus, regardless of the authors' interpretation of their fMRI data, this study is compromised at the outset by the authors' unsupported assumptions that 1) "it is...rather implausible to maintain that beauty has no biological substrate and is merely a conventional, experientially determined concept" (p. 8); 2) test subjects who are "...naïve to art criticism..." would also be naïve to other cultural factors that might subjectively influence their opinions about art, or indeed about this particular experiment (p. 1); and 3) the golden section "...is considered to represent the ideal beauty..." (pages 1 and 8). The authors associate the latter assumption with linear overlays that they applied to a photograph of the Greek Doryphoros sculpture by Polykleitos, dividing the height of this figure at the navel into two main parts, the relative proportions of which they claim correspond to the golden section, without any reference to verifiable measurements of the actual sculpture, or to the issue of photographic distortion (p. 2). The authors thus bring 19th century pseudo-scientific golden-sectionism into a 21st-century, peer-reviewed scientific journal. These and other methodological shortcomings (including the lack of sufficient engagement with recent literature on art history and aesthetic theory) provide ample reason to doubt the authors' conclusion that the brain activities observed in their fMRI scans affirmatively answer their main research question of "...whether there is an objective beauty, i.e., if objective parameters intrinsic to works of art are able to elicit a specific neural pattern underlying the sense of beauty in the observer" (p. 8). This study thus serves both as an example of the difficulty—and perhaps futility—of applying scientific tools to the study of subjective aesthetic judgments, and as a reminder that scientific training is not necessary for the critical evaluation of such studies. For similar, arbitrarily golden-sectioned images of the human figure found in numerous unscientific and unscholarly publications of a metaphysical orientation, see for example Zeising, *Neue Lehre von den Proportionen,* especially 282, Fig. 188; Hagenmaier, *Der Goldene Schnitt*, 29; Doczi, *The Power of Limits,* 104–105; and Le Corbusier, *Le Modulor,* ch. 2. On the 19th-century origins of aesthetic claims pertaining to the golden section, see Payne, "Rudolf Wittkower and Architectural Principles," 327 n. 30; Van der Schoot, *De ontstelling van Pythagoras*; Frings, "The Golden Section in Architectural Theory," 9–32; Herz-Fischler, *A Mathematical History*, 167-169; Padovan, *Proportion*, 304-323; and Curti, "Canons of Proportion," Chapter 2 herein, pages 65 and 67.

[12] See, for example, the numerous survey text claims that a perceived beautiful (or "harmonious") appearance of the basilica of San Lorenzo in Florence results from proportional systems (Cohen, *Beyond Beauty*, 18). In a 2008 television documentary, Jeffrey Hurwit states: "The Parthenon, like a statue, exemplifies a certain symmetria; a certain harmony of part to part, and of part to the whole. There is no question that the harmony of the building, which is clearly one of its most visible characteristics, is dependent upon a certain mathematical system of proportions" (Glassman, *Secrets of the Parthenon*, time marker 35, 11-30). In scholarly publication, however, Hurwit offers a more subdued articulation of this position with no overt reference to visual ramifications of proportional systems, noting that the Parthenon "…is remarkable, above all, for the harmony of its carefully calculated proportions and for its so-called refinements." Hurwit, *The Acropolis in the Age of Pericles*, 118. Similarly, in his 1980 film on Andrea Palladio, James S. Ackerman remarks: "In Palladio's work, it is the refinement of proportions—a fixing of precise ratios of length to width to depth and height—that gives one a sense of equilibrium in and around his buildings." Ackerman and Terry, *Palladio*; and cf. Ackerman and Cohen, "Proportional Systems in the History of Architecture," Chapter 24 herein, page 520 n. 20. In scholarly publication, however, Ackerman posits more cautiously: "Palladio's view of architecture as natural philosophy helps to explain unique qualities in his design, especially a subtlety of proportion, composition and equilibrium, that have been praised through the centuries but seldom examined critically," and, after quoting Sylvio Belli's *On Proportions and Proportionality*: "Palladio applied a similar aesthetic to designs that give much more importance to proportional relationships than those of earlier Renaissance architects." Ackerman, *Palladio*, 160-161.

[13] Cf. Cohen, *Beyond Beauty*, 24. Although some degree of uniformitarianism is implicit in much research in archaeology and the social sciences, there remains little agreement about how or when this assumption can be reliably applied in these fields, or if it is even logically valid. (Trigger, *A History of Archaeological Thought*, 29 and 416; Trigger, "Prospects for a World Archaeology," 2; Bailey, "Hunter-gatherer behaviour," 3; and Wallace, *Contradictions of Archaeological Theory*, 101.) Uniformitarianism—the belief that essential qualities of human behavior in the present correspond to those throughout history and prehistory—is typically associated with inferences about social structures, economic strategies and cognitive abilities (Bailey, as above). Any attempt to apply uniformitarian principles to aesthetic preferences, however, would seem to be particularly questionable due to the difficulty of describing such preferences objectively, in a manner that includes all applicable sensory stimuli; and due to the dramatic developments in aesthetic theory since the eighteenth century that have arguably altered human perception. Regardless of one's opinions on this matter with regard to proportion, however, any uniformitarian assumptions must be stated explicitly in order to avoid us/them ambiguity.

[14] Cohen, *Beyond Beauty*, 281–287.

[15] Thus, in the example of the San Lorenzo nave arcade bays, several key dimensions, when expressed in terms of the 15th-century Florentine *braccio*, end in the fraction $^{2}/_{3}$. When separated out from the rest these numbers imply the Boethian number progression 1, 5, 9, 13, 17. These numerical relationships are not visible. They can only be understood mentally. See Cohen, *Beyond Beauty*, 52–111; and Cohen, "How Much Brunelleschi?" 18–57.

[16] Cf. Herrmann's quotation of François Blondel quoting Claude Perrault, probably from one of the latter's unpublished *mémoires*, "...that proportions 'cannot be seen, and therefore, cannot be the cause of a sensible effect such as the pleasure which beauty gives us'" (Herrmann, *The Theory of Claude Perrault*, 133). By this Perrault probably means that minute differences between similar proportions cannot be seen, as in his assorted comments collected in Herrmann, *The Theory of Claude Perrault*, 136-137. It follows, therefore, that no proportion can ever be precisely identified through visual analysis alone.

[17] Cf. note 16, above, and Perrault's assertion that "...in architecture there are, strictly speaking, no proportions that are true in themselves..." (Perrault, *Ordonnance for the Five Kinds of Columns*, 54); "...à proprement parler, dans de l'Architecture de proportions véritables en elles-mesmes..." (Perrault, *Ordonnance des cinq espèces de colonnes*, xiv). See also Cohen, *Beyond Beauty*, 281 and 284–285.

[18] See also the discussion below (p. 33) on the limitations of correlation, as in the belief that measurements of the proportions of buildings considered to be beautiful can be used in the designs of new buildings in order to create similar beauty.

[19] Wladyslaw Tartarkiewicz goes so far as to propose that "...the general theory of beauty formulated in ancient times [, which] declared that beauty consists in the proportions of the parts…" or more narrowly, "…that the relationship of parts which produced beauty could be numerically expressed[,]…might not unreasonably be called the Great Theory of European aesthetics." (Tartarkiewicz, "The Great Theory of Beauty," 167). Regarding my occasional spiritual-aesthetic enjoyment of buildings, historic or modern, while contemplating dimensions and proportional systems as an architect rather than architectural historian, I admire a kind of beauty that I believe results from an architect's intense consideration of a design that leads to precise dimensional adjustments, whether in response to outside contingencies such as site constraints or the self-referential logic of a belief-based proportional system. Sometimes I even believe I can distinguish a building that has resulted from such intensity from one that has not. This is a different kind of beauty-in-proportion belief than the one implied by Hurwit and Ackerman in the informal space provided by educational films and interviews (see note 12, above). Both kinds deserve respect as genuine human values, but both must also be acknowledged as subjective and fundamentally illogical—which is why the preceding reflections are presented in the first person singular. Such aesthetic interpretations, being untestable and unprovable, belong to the realm of architectural criticism (or perhaps merely pure enjoyment) rather than architectural history, the latter of which needs to be based on scholarly and scientific methods. When it enters the scholarship on architectural proportional systems the aesthetic question invariably constitutes but an unresolvable (because subjective) distraction that draws scholarly energy away from the centrally important problems of how to identify the proportional systems of the past based on verifiable historical evidence, and how to determine their originally-intended meanings. In clarifying these thoughts I have benefited from a correspondence with Mark Wilson Jones. On the distinction between belief-based and certainty-based proportional systems, see above, and note 99 and its related discussion below.

[20] Pevsner, "Report on a Debate," 456–457.

[21] Pevsner urges a "cautious" response to Wittkower's harmonic interpretation of Palladio's buildings, thus demonstrating that beauty-in-proportion preconceptions and critical thinking about other issues pertaining to architectural proportional systems are not mutually exclusive. Pevsner, "Report on a Debate," 467.

22 The *Oxford English Dictionary Online* refers to taste as "the sense of what is appropriate, harmonious, or beautiful; especially: discernment and appreciation of the beautiful in nature or art; specifically: the faculty of perceiving and enjoying what is excellent in art, literature, and the like" ("taste, n.1," entry 8a). This definition merely implies the notion of *sensus communis* (common sense, or communal assent), which is explicit in the definition of taste by Kant, *Kant's Critique of Judgment*, 169–170, quoted below (see note 31). Like Kant's definition, this one emphasizes taste as a judgment rather than merely a pleasurable sensory experience.

23 Harrison, Wood and Gaiger, *Art in Theory: 1648–1815*, 489. Cf. *Oxford English Dictionary Online*, "æsthetic" (heading A.1): "Of or pertaining to sensuous perception, received by the senses." This definition is accompanied by a single example of usage, from the late 18th century. Cf. note 24, below.

24 *Oxford English Dictionary Online*, "æsthetic" (heading A.2.). This definition is accompanied by four examples of usage from the 19th century.

25 On empathy theory see: Vischer, "On the Optical Sense of Form," 102–112; Wölfflin, "Prolegomena to a Psychology of Architecture," 167–171; Scott, *The Architecture of Humanism*; and Langfeld, *The Aesthetic Attitude*; de Jong, "Subjective Proportions," Chapter 4, page 106 herein; and the conclusion to this volume, Chapter 25, Principle 1.

26 Ackerman, "'Ars sine scientia nihil est'"; and Wittkower, *Architectural Principles* (1949).

27 See, for example, Billings, *An Attempt to Define the Geometric Proportions*; Penrose, *An Investigation*; Henszlmann, *Théorie des proportions*; Gwilt, *The Encyclopedia of Architecture*; Pennethorne, *The Geometry and Optics of Ancient Architecture*; Thiersch, "Die Proportionen in der Architektur," vol. IV, section 1.2, 38–77; von Stegmann and von Geymüller, *Filippo di Ser Brunellesco*, I:18; Marquand, "A Study in Greek Architectural Proportions," 521–532; Gardner, *The Parthenon*; Borissavliévitch, *La science de l'harmonie*; and Hambidge, *The Elements of Dynamic Symmetry*, a reprint of the 1926 edition, based on lectures delivered around 1916 and published in the journal *The Diagonal* in 1919 and 1920. Mystically-inclined studies also continued after 1949, for example, Bairati, *La simmetria dinamica*; Borissavliévitch, *Le nombre d'or*; Des Corats, *La proportion égyptienne*; Funck-Hellet, *De la proportion*; Jouven, *Rythme et architecture*; and Doczi, *The Power of Limits*. For an approach to architectural proportion that focuses on the concept of stability, or *résistence*, see Lebrun, *Théorie de l'architecture grecque et romaine*, 19–23; and Lebrun, "Applications du principe de stabilité," 205–227. For an extensive but not comprehensive bibliography of proportion literature up to 1958, see Graf, *Bibliographie zum Problem der Proportionen*. For an addendum to Graf's bibliography, see Borsi, *Per una storia della teoria delle proporzioni*, 119–155.

28 Wittkower continued to develop and promote these theoretical generalizations in subsequent publications; in particular, Wittkower, "Systems of Proportion"; Wittkower, "The Changing Concept of Proportion"; and Wittkower, *Architectural Principles* (1962), appendix 4, retained in the 1971 and 1988 editions.

29 Wittkower quoting Kenneth Clark's review of *Architectural Principles*. Wittkower, *Architectural Principles* (1949 and 1962), preface, v. Note that Wittkower, *Architectural Principles* (1962 and 1971), introduction, n.p., refers to this passage by Clark as his "...intention in a nutshell," while Clark had merely called it a "result" of Wittkower's book (Clark, "Humanism and Architecture," 65).

30 See Abrams, "Art-as-Such," 8–33 (I thank K. Michael Hays for introducing me to this source); and *Oxford English Dictionary Online*, "æsthetic," B.4: "Of or pertaining to a late 19th-century movement in England of artists and writers who advocated a doctrine of 'art-for-art's-sake,' also known as the 'aesthetic movement.'"

31 Kant, *Kant's Critique of Judgment*, 173; and later in the same page: "Taste is then the faculty of judging *a priori* of the communicability of feelings that are bound up with a given representation (without the mediation of a concept)." Kant's stipulation that taste involve judgment of "universally communicable" qualities of feelings is related to his notion of "Taste as a kind of *sensus communis*," or "common sense" (Kant, *Kant's Critique of Judgment*, 169–170). *Sensus communis* for Kant is not a form of universal, metaphysical beauty (nor "positive beauty," discussed below), which would contradict the notion of judgment, but rather a presupposition that renders judgments communicable to others. "The common sense," John Hicks explains, "must be assumed [in order] to be able to agree about what the feeling is in the first place" (Hicks, "Sensus Communis," 111). Regarding Kant's stipulation that taste involve judgment "without the mediation of a concept," Hicks observes: "Kant ...asks us to approach artworks formally, on their own terms, and resists interpretations that would instrumentalize their content for the purposes of cultural critique, politics, or philosophy itself" (Hicks, "Sensus Communis," 110).

32 See, for example, Wittkower's reaction to the Milan conference discussed below, pages 28-29.

33 For a definition of a three-part Wittkower paradigm, see Cohen, *Beyond Beauty*, 36–51.

34 Wittkower, "Systems of Proportion," 15.

35 For classical proportions, see Gwilt, *The Encyclopedia of Architecture*, 893–921, which comprises Book III: "Practice of Architecture," Chapter II: "Principles of Proportion"; and for Gothic proportions,

Gwilt, *The Encyclopedia of Architecture*, 963–1020, which comprises Book III: "Practice of Architecture," Chapter IV: "Medieval Proportion," Section 6.

[36] Cohen, *Beyond Beauty*, 47. Wittkower's use of the *Kunstwollen* concept in this context appears to have been inspired by Panofsky's 1921 study of human proportions (translated as Panofsky, "The History of the Theory of Human Proportions").

[37] Wittkower, "Systems of Proportion," 16.

[38] Wittkower, "Systems of Proportion," 17.

[39] Responding to my "equal partners" interpretation reiterated here, Angeliki Pollali proposes that the writings of Francesco di Giorgio Martini "…invest [Wittkower's medieval geometry vs. Renaissance number predilection] with a certain qualified validity." Pollali, "Design Method," 32. Pollali's interpretation of these writings, however, is in fact not inconsistent with the equal partners interpretation. According to Pollali, "Design Method," 37 (italics are Pollali's): "Francesco determines an arithmetical module to approximate incommensurable ratios; the architect's aim would be to abandon geometry and adopt a numerical system of proportions." Nevertheless, she notes, Francesco is merely "…attempting to establish a *correspondence* between a geometrical and a numerical system," and furthermore, "...geometry remains Francesco's basic tool." Thus, even if Francesco indeed favors arithmetic to the point of striving to "abandon geometry" as Pollali suggests, according to Pollali he in fact does not succeed and instead makes equal use of geometry and number. Cf. Gerbino's opinion that Francesco saw geometry and number as "complementary" (Gerbino, "Were Early Modern Architects Neoplatonists?," Chapter 5 herein, pages 121-122); and Cohen, *Beyond Beauty*, 36–51, and ch. 6.

[40] Wittkower, "Systems of Proportion," 16; cf. Cohen, "Ten Principles," Chapter 25, page 548 n. 68 herein.

[41] Cohen, *Beyond Beauty*, 17–18 and 281-287.

[42] Le Clerc, *A Treatise of Architecture*, 1:29. Cf. Le Clerc, *Traité d'architecture*, 39: "Par proportion, on n'entend pas ici un rapport de raison à la maniere des Geometres; mais une convenance de parties, fondée sur le bon goût de l'Architecte." For a similar use of this term in Italian from the 16th century, see van Eck's quotation of Cosimo Bartoli in Chapter 3, p. 73 herein. On proportion-as-ratio see Cohen, *Beyond Beauty*, 21.

[43] Cohen, *Beyond Beauty*, 21–24.

[44] Perrault, *Ordonnance for the Five Kinds of Columns*, 50-51. "Car il y a deux sortes de proportions, dont l'une qui est difficile à apperçevoir consiste dans le rapport de raison des parties proportionnées, tel qu'est celuy que les grandeurs des parties ont les unes aux autres ou avec le tout, comme d'etre la septiéme, la quinzieme ou la vingtiéme partie du tout. L'autre proportion qui s'appelle Symmetrie en françois, et qui consiste dans le rapport que les parties ont ensemble à cause de l'égalité & de la parité de leur nombre, de leur grandeur, de leur situation, & de leur ordre, est une chose fort apparente, & dont on ne manque jamais d'appercevoir les deffauts, ainsi qu'il se voit au dedans du Pantheon, où les bandeaux de la voute ne rapportant pas aux fenestres qui sont au dessous, causent une disproportion, & un manque de symmetrie que chacun peut aisement connoitre." Perrault, *Ordonnance des cinq espèces de colonnes*, vii. Cf. Vitruvius: "Symmetry is a proper agreement between the members of the work itself, and a relation between the different parts and the whole general scheme, in accordance with a certain part selected as standard. Thus in the human body there is a kind of symmetrical harmony between forearm, foot, palm, finger, and other small parts; and so it is with perfect buildings." Vitruvius, *The Ten Books on Architecture*, 14.

[45] See the preceding note.

[46] Perrault's critique of the Pantheon misalignments continued a tradition of dissatisfaction going back to the 15th century. Francesco di Giorgio Martini and Antonio da Sangallo the Younger produced sketches correcting this perceived flaw. For images, see Wilson Jones, *Principles of Roman Architecture*, 188-189. Other critics included Michelangelo, Andrea Palladio, and Antoine Desgodets, while Gian Lorenzo Bernini may have been a rare supporter. Marder, "Bernini and Alexander VII," 628-645; Wilson Jones, *Principles of Roman Architecture*, 188-190; Marder, "The Pantheon After Antiquity," 145-153; and Marder, "The Pantheon in the Seventeenth Century," 296-329. In 1976 MacDonald noted that the misalignment "…adds a certain restlessness to the design," but expressed uncertainty as to its rationale. MacDonald, *The Pantheon*, 72. Loerke's analysis of 1990 concludes that the Pantheon architect intended the interior to be read as "discrete horizontal layers" for iconographical and aesthetic reasons, the dome constituting one layer. Loerke, "A Rereading of the Interior Elevation," 35-43. He thus prepared the way for Wilson Jones's appreciative aesthetic reading that the misalignment "…contributes to the indefinable, but none the less palpable, impression that the dome hovers over the drum as opposed to weighing it down." Wilson Jones, *Principles of Roman Architecture*, 191.

[47] Herrmann notes that "if Perrault had not gone further than making a distinction between positive and arbitrary qualities of beauty, there would hardly have been much opposition," for no one at

the time questioned the existence of positive beauty. The part of his theory that "was unheard of," Herrmann continues, was his inclusion of proportions in the category of arbitrary beauty. Herrmann, *The Theory of Claude Perrault*, 138–139. Note that while a strict reading of Perrault's remark: "…beauty has hardly any other foundation than *fantaisie*…" ("…les veritables regles du beau & du parfait dans les Edifices: car la Beauté n'ayant guere d'autre fondement que la fantaisie"; Perrault, *Les dix livres d'architecture*, Preface, v) with which Herrmann prominently opens his Chapter II: "Proportions and Beauty," might seem to contradict Perrault's later embrace of the notion of positive beauty, Herrmann plausibly interprets this passage as a "blueprint" for Perrault's later inquiries into architectural theory, which emphasize the need for rules in every sphere of human activity—rules that notably include architectural proportional systems. This early passage thus seems to anticipate Perrault's later, more completely developed contention that perceived beauty *in architectural proportions*—not merely beauty in general—has no other foundation than *fantaisie*, and that such capricious beauty is not the same as positive beauty. Thus, eleven years later Perrault writes: "…the proportions of architectural members do not possess a beauty that has a foundation as positive as the condition of natural things, or as the beauty of musical harmonies that please due to a definite and immutable proportion that does not depend on *fantaisie*" (Perrault, *Les dix livres d'architecture*, 106 n. 12: "…les proportions des membres d'Architecture n'ont point une beauté qui ait un fondement tellement positif, qu'il soit de la condition des choses naturelles, & pareil à celluy de la beauté des accords de la Musique, qui plaisent à cause d'une proportion certaine & immuable, qui ne dépend point de la fantaisie"). See the quotations of these passages in Herrmann, *The Theory of Claude Perrault* 31 and 40, though with incorrect citations.

So strong and widespread was the beauty-in-proportion belief system in Perrault's day that Perrault's radicalism, such as it was, according to Herrmann provides one explanation for Perrault's *lack* of influence on contemporary architectural theory, apart from the lively debate with Blondel that his ideas engendered. Herrmann, *The Theory of Claude Perrault*, 140, notes: "Perrault's unorthodox opinions were brushed aside" by his contemporaries, who greeted them with "incredulity." He furthermore notes that Perrault's inclusion of proportions in the class of arbitrary beauty was as "futile" as Edmund Burke's later claim "...that 'proportions are not the cause of beauty.'" Herrmann, *The Theory of Claude Perrault*, 139, quoting Burke, *A Philosophical Enquiry*, 91. Thus according to Herrmann's interpretation, it would seem that no serious challenge to the beauty-in-proportion belief system ever had a chance of making it out of either the 17th or 18th century with any significant following. Cf. discussion of Wittkower's "Break-away" theory, below.

[48] In his *Ordonnance des cinq espèces de colonnes*, Perrault occasionally seems to struggle to reconcile his own distinction between arbitrary and positive beauty in relation to architectural proportional systems, as in his comments regarding ancient Roman proportions: "ancient usage is not so much pleasing in itself as pleasing because it is linked to other positive, natural, and reasonable beauties that make it pleasing by association, so to speak." Perrault, *Ordonnance for the Five Kinds of Columns*, 54 ("les beaux Ouvrages des Anciens...dans lesquels aussi cette maniere ne plaist pas tant par elle-mesme que parce qu'elle est jointe à d'autres beautez positives, naturelles & raisonnables, laquelles, s'il faut ainsi dire, la font aimer par compagnie." Perrault, Ordonnance des cinq espèces de colonnes, xiii); and in his comments regarding his own proposed proportional system for the orders that is based on the arithmetical means of comparative measurements of ancient Roman examples: "even though in architecture there are, strictly speaking, no proportions that are true in themselves, it still remains to be investigated whether it is possible to establish probable mean proportions that are founded on positive reasons but that do not stray too far from those that are accepted and in current use." Perrault, *Ordonnance for the Five Kinds of Columns*, 54-55 ("...& que par consequent il n'y a point, à proprement parler, dans l'Architecture de proportions veritables en elles-mesmes; il reste à examiner si l'on en peut établir de probables, & de vray semblables fondées sur des raisons positives, sans s'éloigner beaucoup des proportions reçuës & usitées." Perrault, *Ordonnance des cinq espèces de colonnes*, xiv).

In his footnotes to his translation of Vitruvius published in 1684, Perrault again struggles to reconcile these two kinds of beauty, as in his claim that even though most architects of his day believe that the proportions of the orders presented by Vitruvius are "...something natural..." ("...quelque chose de naturel..."), he believes these proportions are established "...by a consent among architects..." ("...par un consentement des Architects..."), and are preferred not because they possess positive beauty, "...but only because these proportions are found in works that have other kinds of positive and convincing beauty, such as those of material and correctness of execution, and thus these proportions are approved and appreciated even though they contain nothing positive themselves" ("...mais seulement parce que ces proportions se trouvoient en des ouvrages, qui ayant d'ailleurs d'autres beautez positives & convaincantes, telles que sont celles de la matiere & de la justesse de l'execution, ont fait approuver & aimer la beauté de ces proportions, bien qu'elle n'eust rien de positif." Perrault, Les dix livres d'architecture, 105 n. 7). He makes a similar comment in a later footnote, using the term "veritable beauté." Perrault, *Les dix livres d'architecture*, 80 n. 16. Thus Perrault seems reluctant to separate the arbitrary beauty that he associates with architectural proportions completely from positive beauty. Cf. Pérez-Goméz, *Architecture and the Crisis of Modern Science*, 32; and Herrmann, *The*

Theory of Claude Perrault, 132. On the comparison between beauty and mathematical theorems in relation to Platonism, see Mitrović, *Serene Greed of the Eye,* 29-30.

[49] See Alberti's comments: "But judgment[s] with regard to beauty are not determined by opinion, but rather by an innate faculty of the mind.... For there is in the forms and figures of buildings certainly a natural excellence or perfection that excites the spirit and is immediately felt." Alberti, *De re aedificatoria*, IX.v, opposite fol. y: "Ut vero de pulchritudine iudices, non opinio, verum animis innata quaedam ratio efficient.... Est enim in formis profecto et figuris aedificiorum aliquid excellens perfectumque natur. quod animum excitat evestigioque sentiatur." This innate or natural beauty is among the factors contributing to Alberti's notion of *concinnitas* which, according to Caroline van Eck, Alberti introduces "...as a work of research, selection, and inquiry into the factors that produce beauty, both in nature and in art." Van Eck, "The Structure of *De re aedificatoria* Reconsidered," 286, in reference to *De re aedificatoria* 9.15.

[50] Perrault, *Ordonnance for the Five Kinds of Columns*, 50: "I call beauties based on convincing reasons those whose presence in works is bound to please everyone, so easily apprehended are their value and quality. They include the richness of materials, the size and *magnificence* of the building, the precision and cleanness of the execution, and *symmetrie*, which in French signifies the kind of proportion that produces an unmistakable and striking beauty" ("j'appelle des beautez fondées sur des raisons convaincantes, celles par lesquelles les ouvrages doivent plaire à tout le monde, parce qu'il est aisé d'en connoistre le merite & la valeur, telles que sont la richesse de la matiere, la grandeur & la magnificence de l'Edifice, la justesse & la propreté de l'execution, & la symmetrie qui signifie en françois l'espece de Proportion qui produit une beauté evidente & remarquable." Perrault, Ordonnance des cinq espèces de colonnes, vi–vii). Cf. note 47, above.

[51] Kant, *Kant's Critique of Judgment*, 185; see also note 31, above.

[52] On Perrault's interest in, applications of, and contributions to the developing scientific knowledge of his day see Gerbino, *François Blondel*, 118-147; Herrmann, *The Theory of Claude Perrault*, 70–94 and 193–198; and Picon, *Claude Perrault,* 29–102. See Monod's related conclusion that "…the occult [i.e., alchemy, astrology and ritual magic] was not killed off by science or the Enlightenment. On the contrary, it coexisted with them, borrowed from them and was rarely the object of attacks from scientific or enlightened writers." Monod, *Solomon's Secret Arts*, 346.

[53] Although the degree of Perrault's influence would be difficult to ascertain, it is notable that in 1952 Louis Hautecœur, in his "Préface" to Borissavliévitch, *Le nombre d'or*, 5–6, describes an active debate in his own day about architectural proportional systems "...between defenders of objective beauty and defenders of subjective beauty" ("...débat entre défenseurs de la Beauté objective et défenseurs de la Beauté subjective..."), or, terms that correspond to Perrault's positive and arbitrary beauty, respectively. Objective beauty, Hautecœur notes, is "...independent of man himself..." ("...indépendant de l'homme même...") while subjective beauty is "...a creation of man" ("...une création de l'homme"). Herrmann, *The Theory of Claude Perrault*, 150, notes that discussions of Perrault's "dual nature of beauty" actively continued in the 18th century often under different names than Perrault's positive and arbitrary beauty, such as *idées* as opposed to *sentiments*, but always with the aim of saving absolute (i.e., positive) beauty from being undermined by the growing notion of the relativity of taste. Consistent with both this practice and the terms of the debate Hautecœur reports, Picon, *Claude Perrault*, 153, interprets Perrault's distinction between arbitrary and positive beauty as a difference between an appeal to the senses (arbitrary) and to reason (positive): "L'ordonnance d'une façade peut en effet parler aux sens ou à la raison selon son raffinement plus ou moins grand et le degré de culture du spectateur qui la contemple." The recent study by Di Dio, Macaluso and Rizzolatti "The Golden Beauty," indicates that interest in this debate is still active today. See note 11, above.

[54] Gerbino, "Were Early Modern Architects Neoplatonists?," Chapter 5 herein, page 116 and 118.

[55] On Blondel's defense, see Gerbino, *François Blondel*, 148–165 and 173–178; and Herrmann, *The Theory of Claude Perrault*, 131–145.

[56] Blondel, *Cours*, 5:738–739. "Ces beaux Edifices anciens & modernes nous peuvent encore servir de regles pour ce sujet, par les belles proportions que leurs parties ont entr'elles & à leur tout, & qui sont, comme nous avons dit, cette agreable harmonie qui donne tant de plaisir aux yeux" (Blondel, *Cours d'architecture,* V.v.738); and "Et ces trois grandeurs, sçavoir la largeur du tout, la hauteur sous le toit & la largeur de l'avant-corps sont en continuelle proportion Harmonique suivant ces nombres 6, 4, 3" (Blondel, *Cours d'architecture*, V.v.739).

[57] Blondel, *Cours d'architecture*, 5:759.

[58] Such as, for example, Perrault's argument against any analogy between visual and musical beauty in part because pleasing architectural proportions are more variable than pleasing musical proportions (Perrault, *Ordonnance des cinq espèces de colonnes*, i–v; and Perrault, *Ordonnance of the Five Kinds of Columns*, 47–49). See also notes 10, 16 and 17, above; and Gerbino, "Were Early Modern Architects Neoplatonists?," Chapter 5 herein, p. 117. For Herrmann's assessment that Perrault's *Ordonnance* was "not generally a success" in achieving what it set out to do, see Herrmann, *The Theory of Claude Perrault*, 130–189; and note 47, above .

[59] Wittkower, *Architectural Principles* (1949 and 1952), 124–135; and Wittkower, *Architectural Principles* (1962 and 1971), 142–154.

[60] In contrast to the serious academic tones of Perrault and Blondel, for example, Robert Morris cannot contain his excitement in the second volume of his *Lectures*, occasionally asking forgiveness as he digresses into "...a kind of poetick Rhapsody," as in his poem that begins (italics are Morris's): "Proportion! *When I name that* pleasing *Word*, *// In silent contemplative Raptures lost*, *// All* Nature *seems to start, and say*, 'Tis here.'" Morris, *Lectures on Architecture*, 2:221, cf. 184–186, 188–191, 200, 205–207, 209, 210–212, 215–216, and 221–223.

[61] Wittkower, *Architectural Principles* (1949 and 1952), 131, and 134 with note 2; and Wittkower, *Architectural Principles* (1962 and 1971), 150, and 153 with note 4.

[62] Cf. Branko Mitrović's rejection of "collectivist methodology," or the "collectivist fallacy," the widespread influence of which in architectural and art history he ascribes to the impact of Erwin Panofsky and Wittkower, among others. Mitrović notes: "Collectivist fallacy systematically applied and thus turned into a methodology, assumes that the totality of an individual's experience is collective-determined. Typically, a historian who adopts this approach ascribes certain beliefs to a collective, and then infers that every individual participating in the collective must share these beliefs. Such a historian first claims to know what ideas an individual belonging to a certain collective...ought to have had and then imposes this interpretation on all individuals classified into that context." Mitrović, *Serene Greed of the Eye*, 21.

[63] Wittkower, *Architectural Principles* (1949 and 1952), 134; and Wittkower, *Architectural Principles* (1962 and 1971), 154.

[64] See for example works listed in note 27, above.

[65] Wittkower refers to: Hogarth, *Analysis of Beauty*, 1953; Hume, *A Treatise of Human Nature*, 1739, and *Of the Standard of Taste*, 1757; and Burke, *A Philosophical Enquiry*; in Wittkower, *Architectural Principles* (1949 and 1952), 131–132; and Wittkower, *Architectural Principles* (1962 and 1971), 150–151. Monod, *Solomon's Secret Arts*. The tradition of occultism may also have contributed to creating a sympathetic environment for the beauty-in-proportion belief system within the neo-Palladian movement, of which Robert Morris and Lord Burlington were leaders each in his own way (see note 60, above). For mid-19th-century English beauty-in-proportion literature, see for example the following three books by David Ramsay Hay: *The Orthographic Beauty of the Parthenon Referred to a Law of Nature* (Edinburgh and London: William Blackwood and Sons, 1853); *The Harmonic Law of Nature Applied to Architectural Design* (Edinburgh and London: William Blackwood and Sons, 1855); and *The Science of Beauty, As Developed in Nature and Applied in Art* (Edinburgh and London: William Blackwood and Sons, 1856). For Herrmann's characterization of Burke's efforts to convince his contemporaries that "proportions are not the cause of beauty" as futile, see note 47, above.

[66] Garbett, *Rudimentary Treatise*, 38.

[67] Pennethorne, *The Geometry and Optics of Ancient Architecture*, 4.

[68] Pennethorne, *The Geometry and Optics of Ancient Architecture*, 45. Cf. Morris's comment: "Wherever Harmony resides, either in Numbers, or Nature, it immediately strikes the imagination, by some Attractive or Sympathizing Property." Morris, *Lectures on Architecture*, 1, Dedication.

[69] Another term that often accompanies "harmony" is "symmetry."

[70] Blondel, *Cours d'architecture*, V.ix.752.

[71] See note 11, above. The seemingly religious devotion that the golden section has sometimes inspired since the 19th century is evident in *The Society of the Golden Section Newsletter*, published in Chicago from November 1975 to May 1983. The eponymous, now-defunct organization promoted the golden section philosophy and drawings of the Swiss-born American architect Abel Faidy, a self-described follower of Jay Hambidge, Matila Ghyka, and Le Corbusier. According to the society's Executive Director, Diana Faidy, writing in the first issue of the newsletter, the society was formed "...to promote specific knowledge of the golden section and encourage employment of its disciplines, so that a new order, harmony and symmetry may pervade the design fabric of man's needs and the total environment [may] become a symphony of harmonic spatial relationships, a Unity achieving ultimate coherence within a mathematical order." Faidy, "Executive Director's note," 1; and for Abel Faidy's biographical information, *The Society of the Golden Section Newsletter* (first issue as above), 1–2. For a similar attitude toward the golden section, see Doczi, *The Power of Limits*.

[72] Laurent, "Quand Auguste Perret," 61–78; Loach, "Le Corbusier and the Creative Use," 185–215; and "Jeunes Peintres ne vous frappez pas!" 1–2. I thank Judi Loach for sharing her insights into these groups with me. On the possible influence of Paul Valéry's *Eupalinos ou l'architecte* of 1921 on this French cultural scene and its interpretations of proportion, see Curti, "Canons of Proportion," Chapter 2, page 68 n. 1 herein.

[73] On these German and other influences, see Jean-Louis Cohen, "Le Corbusier's Modulor and the Debate on Proportion in France," Chapter 21 herein. Note that the name Modulor combines the

contemporary interest in modules with the French name for golden section, *section d'or*.

74 A similar conference but with a more general focus was held in Paris in 1937. For the proceedings containing 150 abstracts and papers, see *Deuxième Congrès International*. In his review of these proceedings in the *American Journal of Sociology* of 1939, John T. Mueller notes that while provocative as a series, "...many of the papers do not justify their scientific appellation." Mueller, Review of *Deuxième congrès,* 153.

75 See note 2, above.

76 "Nel 1951 il convegno *De Divina Proportione* si era proposto come l'ecumenico concilio degli uomini delle arti e delle scienze chiamato a deliberare le regole dello spirito che avrebbero governato le nuove aree della ricostruzione democratica" Irace, "La difficile proporzione," 17.

77 "L'interesse che suscitò nel 1951 forse nacque, in un'Europa che cercava ancora di riaversi dalle devastazioni della guerra, dal desiderio di restituire spiritualità alle arti e alla vita attraverso le geometrie di un'architettura pura, priva di ornamenti e costituita da superfici e aperture rettangolari." Ackerman, "Ricordi della Nona Triennale," 34.

78 Ackerman and Cohen, "Proportional Systems in the History of Architecture," Chapter 25 herein, page 513.

79 Giedion, "Il tutto e la parte," 75.

80 Wittkower, "Finalità del Convegno," 47.

81 Giedion, "Il tutto e la parte," 73-74. Le Corbusier uses the term "divina proportione" in this manner in his 1927 essay "Un livre opportun," published in Jean-Louis Cohen, "Le Corbusier's Modulor," Chapter 21, Appendix, 1 herein.

82 Ackerman, "Le proporzioni nell'architettura gotica," 51. In 2007 Ackerman noted that in Milan in 1951, due to his young age and the authoritativeness of the middle-aged men who dominated the conference, he "felt like a sergeant assisting in a meeting of generals." Ackerman, "Ricordi della Nona Triennale," 21-22.

83 Wittkower, "Finalità del Convegno," 47.

84 Thus Wittkower noted at the end of his conference paper, which addressed historical issues pertaining to the medieval and Renaissance periods: "This examination of a purely historical character can, I believe, provide a wise lesson for current problems" ("Questa disamina di carattere puramente storico può, credo, impartire una saggia lezione sui problemi attuali"). Wittkower, "Alcuni aspetti della proporzione," 49.

85 Wittkower, "The Changing Concept of Proportion," 210.

86 Wittkower, "The Changing Concept of Proportion," 210; and Pevsner, "Report on a Debate," 456–463. Wittkower's dismissal, based on the results of this vote, of the beauty-in-proportion belief system as a significant cultural phenomenon of the time is another example of his denial of pluralism in European attitudes toward architectural proportional systems (see above, note 62 and related discussion), for a 60-48 vote against the belief that proportional systems create beauty in architecture indicates that nearly half of the RIBA meeting participants were beauty-in-proportion sympathizers, if not believers. The 1957 RIBA vote had a notable parallel, though a different outcome, in two meetings of the Académie Royale d'Architecture in January 1672, during which members considered the question of "whether a positive rule for it [proportion] existed or whether it was arbitrary," and a majority voted to affirm that "a positive beauty existed in architecture." Herrmann, *The Theory of Claude Perrault*, 32.

87 Wittkower, "The Changing Concept of Proportion," 210.

88 Wittkower, "The Changing Concept of Proportion," 210-211.

89 Baumgarten, "Prolegomena" to his *Aesthetica*, translated and quoted in Harrison, Wood and Gaiger, *Art in Theory: 1648–1815*, 490. To this hypothetical objection Baumgarten replies in part "that the philosopher is a man amongst men and it is not good for him to think that so great a part of human perception has nothing to do with him."

90 Cohen, *Beyond Beauty*, 140-145.

91 By associating the word "certainty" with verifiable outcomes, it is here distinguished from Ackerman's reference to "classical certainty," which implies confident yet unverifiable certainty. Thus, belief-based proportional systems contributed to "classical certainty" because the adherents of belief-based proportional systems were certain in their convictions, even if those convictions were based on unverifiable and unscientific beliefs. See Ackerman and Cohen, "Proportional Systems in the History of Architecture," Chapter 25 herein.

92 The concept of *ordine* appears to be similar to the concept of *Gerechtigkeit* ("correct proportions") that the master mason Mathes Roriczer uses in his discussion of the proportions of a Gothic pinnacle. Shelby, *Gothic Design Techniques,* 32–33. On the concept of *ordine*, see Cohen, *Beyond Beauty*, 270–276.

[93] In this definition, numerical correspondences are the numerical qualities of integers as revealed, for example, in number progressions, while arithmetical correspondences are relationships between numbers that are revealed through simple calculation. In response to the different contexts in which they appear, the definition provided here is slightly modified from a previously published definition of a proportional system as "a set of geometrical, numerical or arithmetical correspondences between important dimensions throughout a building or major part thereof, conceived prior to the advent of modern structural engineering in the mid-18th century, and intended by the architect to imbue built form with desirable qualities, physical or otherwise." Cohen, *Beyond Beauty*, acknowledgements page and 22. See also comments on the distinction between a system of measure and a proportional system in the conclusion to this volume, Chapter 25, page 538.

[94] For an example of such a demonstration see Bork, "Dynamic Unfolding," Chapter 15 herein. For additional criteria for distinguishing intentional proportions from coincidental ones, see Cohen, *Beyond Beauty*, 59–60; Cohen, "How Much Brunelleschi?" 19–21; and Fernie, "A Beginner's Guide," 229-237.

[95] See for example the comment of Emma C. Ackermann, "The Golden Section," 263: "Whenever, in the products of art or manufacture, there is no equal division, (symmetry), the artist or workman unconsciously employs the proportions of the golden section. Irregular inequality and capricious division is disagreeable to both eye and hand; and the proportion[s] of the golden section seem to be the only acceptable ones."

[96] Since even consistent, deliberate-looking proportional patterns can be coincidental, distinguishing intentional proportions (proportions-as-ratio) from coincidental ones may be considered one of the central challenges of the study of architectural proportional systems. Indeed, coincidental occurrences of highly-ordered structures must be expected in architecture, as in geometry and mathematics. This phenomenon is aptly illuminated by Rudolf Arnheim, who notes, "only in a world based exclusively on the chance combination of independent elements is an orderly pattern a most improbable thing to turn up; in a world replete with systems of structural organization, orderliness is a state universally aspired to and often brought about." Arnheim, *Entropy and Art*, 37. For a mathematical analysis of this phenomenon, see Fischler, "How to Find the 'Golden Number,'" 406–410.

[97] Cf. note 6, above.

[98] For an identification of six purposes of belief-based proportional systems, none of which may be considered practical, see Cohen, *Beyond Beauty*, 25–35.

[99] On the significance of 1742–1743, see note 4, above. Thus, to summarize four of the new terms presented in this introduction, there are two kinds of proportion: proportion-as-ratio (quantitative) and proportion-as-beauty (qualitative); and two kinds of proportional systems: belief-based (metaphysical) and certainty-based (scientific). Belief-based proportional systems can be based on either proportions-as-ratio or proportions-as-beauty, singly or in combination—these are the "anything goes" proportional systems. Certainty-based proportional systems are only based on the verifiability of proportions-as-ratio. Note that Le Corbusier worked with engineers who used various certainty-based proportional systems (such as engineering specifications for concrete and steel construction) in order to ensure the structural stability and code compliance of his buildings, and that those engineers in all likelihood ignored his belief-based Modulor in practice.

[100] Cohen, *Beyond Beauty*, 104–111; and Cohen, "How Much Brunelleschi?" 33-37.

[101] On the conclusion that the church prior Matteo Dolfini appears to have designed the San Lorenzo nave arcade bay proportional system but died before he could realize it, and that Brunelleschi inherited it from him, and modified it to varying degrees for use in both the basilicas of San Lorenzo and Santo Spirito, see Cohen, *Beyond Beauty*, 185–207, which expands upon Cohen, "How Much Brunelleschi?" 41–44.

[102] Durand, *Précis des leçons d'architecture*. Whether or not Durand himself believed that his grid-based proportional system assisted in establishing structural stability, he promoted the system in the *belief* that the grid was somehow beneficial to architecture, a belief for which there can be no scientific basis. It may thus be considered a belief-based proportional system.

[103] Gwilt, *The Encyclopedia of Architecture*, 894–895.

[104] Cf. Pevsner's remarks in note 5, above.

[105] "…Su solo albedrio … por ciertas lineas ortogonales lo hacen y se osan encomendar a ello." This comment was made in the context of determining the proportions of a Gothic buttress for the purpose of ensuring structural stability. Quoted in Kubler, "A Late Gothic Computation," 146. Thus it appears that proportional systems as records of constructive experience, such as builders' rules-of-thumb, could not be relied upon to ensure or even increase the odds of structural stability. On the ineffectiveness of proportion-as-ratio for this purpose see also Curti, "Canons of Proportion," Chapter 2 herein, page 65; and the conclusion to this volume, Chapter 25, note 44.

[106] Van Eck, "The *Composto Ordinato*," Chapter 3 herein; Grasshoff and Berndt, "Decoding the Pantheon Columns," Chapter 17 herein; and Crosby, *The Measure of Reality,* 46-47.

[107] Gerbino, "Were Early Modern Architects Neoplatonists?" Chapter 5 herein; and Ottenheym, "Dutch Seventeenth-Century Proportional Design Systems," Chapter 13 herein. Manfredo Tafuri concurs, concluding that during the Renaissance "…architects were not particularly interested in metaphysical speculation," and that their initial status, with few exceptions, as artisans is too often overlooked by scholars. Tafuri, *Interpreting the Renaissance*, 16. Caroline van Eck, furthermore, notes that Michelangelo had "…little demonstrable interest in the Platonic legitimation of proportional systems…." Van Eck, "The *Composto Ordinato*," Chapter 3, herein, pages 76, and 88 note 13.

[108] See da Vignola's comment (author's translation): "…just as every one of our senses delights in this proportion, and the displeasing things fall outside of it, as the music theorists have well and judiciously proven in their science…" ("quanto ogni nostro senso si compiaccia in questa proporzione, e le cose spiacevoli essere fuori di quella, come ben provano li musici nella loro scienza sensatamente"). Da Vignola, *Regola delli cinque ordini d'architettura*, Prefazione, n.p.; and Palladio's similar comment (author's translation): "just as the proportions of voices are harmony to the ears, so those of measurement are harmony to the eyes, which according to their habit delights to a great degree, without it being known why, apart from those who study to know the reasons of things" ("…perciochè, secondo che le proportioni delle voci sono armonia delle orecchie così quelle delle misure sono armonia degli occhi nostri, la quale secondo il suo costume sommamente diletta, senza sapersi il perchè, fuori che da quelli che studiano di sapere le ragioni delle cose," as transcribed in Zorzi, *Le chiese e i ponti di Andrea Palladio*, 88; and with slight differences in Palladio, *Scritti sull'Architettura*, 123). Cf. Palladio's similar comments in Palladio, *I quattro libri dell'architettura*, iv. Wittkower, conversely, influentially interpreted these brief and ambivalent references to musical harmony by da Vignola and Palladio as proof of these architects' wholehearted commitments to a neo-Platonic worldview rooted in a belief that musical harmonic proportions created beauty in architecture. Cohen, *Beyond Beauty*, 33–35.

[109] Da Vignola, *Regola delli cinque ordini d'architettura*, Prefazione, n.p.

[110] Another example of one of these myriad factors is cultural association, as when government buildings from the Fascist period in Italy are considered by some to be unsightly due to their historical associations, even when they display plausibly classical scale and proportions.

[111] Regarding Alberti's belief in causation, see his comment that those "...numbers by means of which the harmony of voices is very pleasing to the ear, are the same numbers that please the eyes and the spirit" ("Hi quidem numeri, per quos fiat ut vocum illa concinnitas auribus gratissima reddatur, hidem ipsi numeri perficiunt, ut oculi animusque voluptate mirifica compleantur"; Alberti, *De re aedificatoria*, IX.v, yii [verso]). Tafuri, however, doubts the depth of Alberti's metaphysical commitment, noting that his musical analogy "…assumes a functionalist implication," followed as it is by Alberti's note that he will dwell on the topic only so long as it is "…of use to architecture." Tafuri, *Interpreting the Renaissance*, 16.

[112] In the pre-engineering period, the notions of structural stability, beauty and *ordine* all overlapped. Since structural stability constituted such a pressing, pragmatic need that at best could be satisfied only some of the time, primarily through the experience and skill of the builders, availability of high-quality materials, and luck, the then-interrelated notions of structural stability, beauty, and *ordine* can in this context be considered to have had pragmatic intentions. Proportional systems did not contribute to structural successes, but most architects and builders probably thought they did (see note 105, above.) The motivations of architects who have used belief-based proportional systems during the post-engineering period, conversely, may be assumed to have been more mystically oriented because, with the availability of modern structural engineering to ensure structural stability, the motivations for using such proportional systems cannot have been pragmatic. On collectivism, see Mitrović, note 62, above.

[113] See Ackerman's interpretation of the Milan conference as "...the end of the mystical phase..." of the study of proportional systems, and the beginning of the "...effort to set it onto reliable, academic, practical grounds." Ackerman and Cohen, "Proportional Systems in the History of Architecture," Chapter 25 herein, page 513.

[114] See Robin Evans's analysis of the perceived shift in the locus of geometrical innovation from architecture to engineering, where it has remained until very recently. Evans, *The Projective Cast*.

[115] Thus in their survey of recent developments in the use of mathematics in architecture, Jane Burry and Mark Burry note of the projects they present: "there is a natural division between those in which the primary mathematical constituent is an idea, and those where mathematics is first and foremost positioned as a problem-solver. In some, the two roles are balanced or combined, and in all, the mathematical idea or problem-solver is also instrumental in the design process and to the form of the architectural outcome." Burry and Burry, *The New Mathematics of Architecture*, 13.

[116] Two excellent sources for sampling the great variety of attitudes and approaches to the uses of geometry and mathematics in architecture today are the journals *Architectural Design* (London) and the *Nexus Network Journal* (Turin).

[117] Compare Wittkower, *Architectural Principles* (1949) with Wittkower, "The Problem of Movement in Mannerist Architecture" (1933) published in van Eck, "The *Composto Ordinato*," Chapter 3, Appendix, herein.

[118] See Murray, "Plotting Gothic" Chapter 6 herein page 129.

[119] On Perrault's now well-known disagreements with Vitruvius on the matter of proportion in relation to the notions of arbitrary and positive beauty, expressed in footnotes to his 1673 translation of *De architectura*—comments that represent an unusual departure from his otherwise close commentaries inserted for clarification purposes only—see Gerbino, *François Blondel*, 150-152.

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