

VIGNOLA AND THE GOLDEN SECTION: MILAN ZLOKOVIĆ'S ANALYSIS OF *REGOLA DELLI CINQUE ORDINI*

Like much East European research on Renaissance architecture, Milan Zloković's study about Vignola is little known in the West.¹ Written by a prominent Serbian architect and theorist shortly after World War Two, Zloković's study raises a number of interesting questions and presents an insightful proportional analysis of the system of the five orders that was formulated by Giacomo Barozzi da Vignola in his 1562 *Regola delli cinque ordini*. The most valuable part of Zloković's analysis pertains to his explanation of the proportions of the intercolumniations. More generally, the analysis is interesting since it follows a number of trends contemporary in Renaissance scholarship of its time and illustrates the impact of Modernism on architectural history in the years that followed the Great War.

Theories of proportions after World War Two

Interest in theories of proportions represents an important aspect of architectural writings in the years after 1945. The increased building activity in both Europe and the United States encouraged interest in standardization and theories of proportions. The work of Milan Zloković—a prominent professor of the Belgrade school of architecture—belongs to this context and was motivated by similar interest in the Yugoslav context. Zloković dedicated a number of studies to the development of systems of modular coordination, while his historical studies—about Blondel's Porte Saint-Denis or Vignola's *Regola* reflect this kind of interest as well.² The approach of these studies places them in the tradition of Golden Section—orientated interpretative approaches to architectural theories of proportions that were widespread in the first half of the 20th century and originated from the works of Adolf Zeising and Gustav Theodor Fechner who drew attention to ways the Golden Section ratio appears both in Nature and works of art.³ They were followed by a significant number of authors in the years between the two World Wars.⁴ It should be mentioned that the Golden Section is the ratio between the diagonal and the side of the pentagon; numerically it is the ratio $(\sqrt{5}+1):2$. Its decimal approximation is about 1.6180. It is closely approximated by Fibonacci numbers: if one divides any two neighboring numbers from the list: 0,1,1,2,3,5,8,13,21,34...by each other (each of these numbers is the sum of the previous two,

¹ Milan Zloković, "Геометриска анализа пропорциског склопа архитектонских редова по Вињоли" *Зборник архитектонског факултета универзитета у Београду*, Belgrade 1956. The study came out with an extensive summary in Italian and was briefly summarized once again in Milan Zlokovic, "Interperazione modulare degli ordini di Vignola", *La casa*, Rome 1957, pp. 162 - 169.

² Milan Zloković, "Утицај пропорцијског система Блонделове капије Св. Дени-а на недовољно расветљени проблем пропорција у архитектури" *Годишњак техничког факултета универзитета у Београду*, 1946-1947; also "Геометриска анализа..."

³ Adolf Zeising, "Das Pentagramm. Kulturhistorische Studie", *Deutsche Vierteljahrs-Schrift*, 31.1 (1868) pp.173 - 226, "Ästhetische Studien im Gebiet der geometrischen Formen", *Deutsche Vierteljahrs-Schrift*, 31.4 (1868) pp. 219 - 290, *Der Goldene Schnitt*, Leipzig 1884. Gustav Theodor Fechner, *Vorschule der Ästhetik*, 2 vols., Leipzig 1876.

⁴ Matila Ghyka, *Le nombre d'or*, 2 vols., Paris 1931; Jay Hambidge, *The Parthenon and other Greek Temples. Their dynamic symmetry*, New Haven 1924; Miloutine Borissavliévitch, *La science de l'harmonie architecturale*, Paris 1925, *Traité d'esthétique scientifique de l'architecture*, Paris 1954, *The Golden Number and the Scientific Aesthetics of Architecture*, New York 1958.

starting from 0 and 1), one will get approximations for the Golden Section; the bigger the numbers the more exact the approximation will be. The idea behind most research about the Golden Section was to show that this ratio is dominant in Nature, the organization of living beings and that it also underlies our preferences in the world of the arts. In the writings of some authors - such as Matila Ghyka - this kind of interest received additional mystical intonation. Ghyka devoted hundreds of pages to listing the cases where the Golden Section appears in Nature; his statements often sounded along the lines of what was called the physico-theological argument in metaphysics: certain regularities in Nature, which cannot be explained away otherwise, are taken to indicate the existence of the superior Mind (the *Weltbaumeister*, as Kant would put it) which arranged the Universe.

The stream of Golden Section theorists who limited their interest to the way the Golden Section appears in works of art, especially architecture, had more modest intentions. It was Fechner who first attempted to show, using statistical surveys, that the human mind naturally prefers the rectangles with the Golden Section ratio.⁵ From this directly followed the tendency to look for the Golden Section in works of art and explain our aesthetic preferences by its presence. This kind of investigation became very popular after World War One and especially after the publication of the works of Jay Hambidge.⁶ By the late 1920s and during the 1930s the view that the aesthetic properties of works of art can be reduced to the presence of the Golden Section was widespread and it made a strong impact on some leading figures of the Modernist movement, such as Le Corbusier. Consequently, in the years after World War Two, efforts towards standardization were also often motivated by an interest in the Golden Section. Le Corbusier's *Modulor* is the most widely known attempt to base systems of standardization on the Golden Section.

Zloković's studies on architectural history—no less than his work on modular coordination—belong to this latter tradition. In the study on Vignola Zloković wanted to show the presence of the Golden Section in Vignola's treatise, the *Regola delli cinque ordini*. This immensely influential treatise was first published in Rome in 1563 and consists entirely of Vignola's presentations of the canon of the five orders. Zlokovic did not assume that the ratios Vignola stipulated for the orders were intentionally organized to approximate the Golden Section ratio. Rather, his intention was to show that the systematic application of what he called "artistic intuition" led to the unconscious use of the Golden Section ratio. Zlokovic saw in Vignola

the theorist who, acting as an artist in the first place, managed to adjust his system of modular numbers, in an almost impeccable manner.....to the division according to the "Golden Section".⁷

The attempt to show the presence of the Golden Section ratio in Vignola's opus was thus not meant to suggest that Vignola had any theoretical knowledge of the Golden Section: rather, Zloković argues, Vignola's artistic intuition led him to apply the Golden Section with great exactitude. This argument makes sense considering that in the Preface to his treatise Vignola described his process as purely empirical:

⁵ Fechner, *Vorschule*, vol. 1, pp. 184 and 191. Fechner's experiment has been later repeated a number of times with the same result. See also Huntley, H.E., *The Divine Proportion. A Study in Mathematical Beauty*, New York 1970, p. 64.

⁶ Hambidge, *The Parthenon*.

⁷ "...теоретичар који је првенствено као уметиник - емпиричким путем и на интуитиван начин - успео да саобрази свој систем модуларних бројева на скоро беспрекоран начин недовољно објашњеном принципу непрекидне поделе или поделе по златном пресеку. Zloković, "Геометриска анализа ...", p.38.

...years ago I undertook to arrange the five orders of architecture mentioned above into a short and easily applicable canon. The method I used to achieve this was the following. For instance, when I wanted to include the Doric order in the Canon, I started from the fact that its version in the theater of Marcellus is the most prized example of Doric architecture, so I based the canon of that order on this and accordingly defined its principal parts. If some small part did not fully obey the numerical proportions (since small elements can frequently be changed by the work of stonecutters or for other reasons) I accommodated this in my canon without yielding in important issues, and I made up for this small license by relying on the authority of other Doric buildings, which are also regarded as beautiful and from which I supplied other small parts when I found it appropriate. I made this choice for all the orders - not the way Zeuxis worked with virgins in Croton, but the way my judgment lead me.⁸

Vignola's silence about Vitruvius in this passage is remarkable and quite atypical for the Renaissance. In fact, it can be shown that most Renaissance architectural writings before Vignola predominantly repeated the sizes of the elements of the classical orders stipulated by Vitruvius.⁹ Vignola was the first to radically break with this tradition and his *Regola* is thus particularly appropriate for the argument Zloković wanted to make.

At the same time, Zloković's ambitions were much greater. Zloković was a pivotal figure in the introduction of modernist architecture in Serbia—while, as mentioned, theories of proportions played an important role in the writings of Modernist architects. After 1945, when Modernism became the dominant idiom, theories of proportions provided the theoretical justification for the dismissal of the old systems of ornamentation: if proportions ensured aesthetic qualities of design, then one could argue that it was irrelevant whether a facade was ornamented or not. Ornament was seen as a superficial addition to the facade; the aesthetic qualities of the facade were thought to be based purely on numeric ratios between masses. Proportions between bare volumes were regarded as sufficient to ensure that an unornamented building would be as aesthetically successful as an ornamented one. The attempt to demonstrate the presence of the Golden Section in Vignola's opus is thus part of a very strong Modernist programme. Vignola's treatise was regarded, traditionally, as *the* formulation of the Canon of the five orders. With more than five hundred editions in four hundred years this little book was the quintessence of everything the Modernist Movement rebelled against. Showing the presence of the Golden Section in Vignola's opus thus amounted to saying that classical systems of ornamentation—especially the five orders—need not be applied; instead, it was enough to use the ratios which underlay them.

This kind of argument can often be found in architectural writings from the period. In Anglo-Saxon countries, its equivalent can be seen in the way Rudolf Wittkower's book *Architectural Principles in the Age of Humanism* was received.¹⁰ Wittkower's book—today a

⁸ Giacomo Barozzi da Vignola, *Regola delli cinque ordini*, Rome 1562, plate 3. In the second edition (1572) and other editions derived from it, this was plate 2. For recent English translation and commentary see Giacomo Barozzi da Vignola, *Canon of the Five Orders of Architecture*, New York 1999, trans. and commentary by Branko Mitrović.

⁹ See Branko Mitrović, "Palladio's Theory of the Classical Orders and the First Book of *I quattro libri dell'architettura*", *Architectural History*, 42 (1999), for an account of this phenomenon.

¹⁰ Rudolf Wittkower, *Architectural Principles in the Age of Humanism*, London 1949. For Wittkower's relationship with the Modernist movement see Henry A. Millon, "Rudolf Wittkower, *Architectural Principles in the Age of Humanism*: Its Influence on the Development and Interpretation of Modern Architecture", *Journal of the Society of Architectural Historians*, 31 (1971), 83 - 91 and Alina A. Payne "Rudolf Wittkower and *Architectural Principles in the Age of Modernism*", *Journal of the Society of Architectural Historians*, 53 (1994), pp.322 - 342.

classic of Renaissance scholarship—had a great impact on the Modernist movement when it appeared. The author's original intentions, while he was writing this collection of essays, seem to have been purely scholarly. The book was meant to present a number of topics as they appear in Renaissance architectural theory: central planned churches, anthropomorphism, theory of proportions. Wittkower completely shunned any discussion of the theories of the classical orders (this was surely very attractive for Modernists) and, instead, he provided an account of Renaissance proportional theories based on the harmonic theory: i.e. he suggested that the Renaissance use of proportions was derived from ratios used in musical theory. He managed to provide impressive documentation for his thesis and quote a number of Renaissance sources which claimed that ratios pleasing to the ears are pleasing to the eyes as well. While the study was written as a scholarly work, when it came out it received unexpected interest in professional circles as well. Wittkower argued that there existed principles of Renaissance architecture which had nothing to do with the use of the classical orders or ornaments but rather pertained to ratios between bare walls or antropomorphic representation. At a time when architects had too much work to do and hardly enough time for extensive drafting of facade ornaments, a theory which said that bare modernist facades were designed according to the same principles as those of Palladio or Bramante was by all means welcome. It justified abandoning the classical orders as well as the rise of modernist architecture which occurred in those years. A typical formulation of this approach can be found in Colin Rowe's well-known article "The Mathematics of the Ideal Villa".¹¹ Rowe pointed there to certain proportional similarities between the ratios of the structural grids of Palladio's villa Malcontenta and Le Corbusier's villa in Garches and claimed that they were "fundamental". The article was to become renowned in the Modernist movement, intensively quoted and reprinted many times. The line of argument taken by Rowe is implicitly present in Zloković: theories of proportions can justify the modernist dismissal of the classical orders, since aesthetic properties of a building are constituted through proportions between bare walls. If ornaments, such as the classical orders, contribute aesthetically, it is because they possess certain proportions (the Golden Section). A building which has the same proportions will result in the same aesthetic effect even if it has no ornaments whatsoever. In this context, Zloković's analysis of Vignola's system of the orders is a strong formulation of such a Modernist program. Zloković did not discuss one, two or eight Renaissance ville but the most influential Renaissance formulation of the system of the orders. Unlike Wittkower, who based his argument on eight case studies of Palladio's buildings, Zloković did not target individual buildings but rather the very heart of the classical tradition: his aim was to show the presence of the Golden Section in the most revered formulation of the canon of the orders.

Zloković's analysis of Vignola's system of the orders

Zloković's analysis of Vignola's system of the orders pertains to the relationship between the main elements of the orders, especially Vignola's system of intercolumniations. An important aspect of this approach is the attempt to take intercolumniation instead of the diameter (or radius) of the column as the unit from which all other elements are defined.¹² The analysis is limited to the situation when columns are free-standing (not engaged in a wall) and without pedestals. It thus covers the most elementary case of the composition of columns. Since Vignola defined the main proportions of the Corinthian and Composite order as identical, the

¹¹ Collin Rowe, "The Mathematics of the Ideal Villa. Palladio and Le Corbusier Compared", *The Architectural Review*, 101 (1947), pp.89-106.

¹² Zloković, "Геометриска анализа", p.41.

analysis really had to deal with four orders: Tuscan, Doric, Ionic and Corinthian. It covered the relationships between the following elements: lower column diameter, intercolumniation, base, shaft, capital, architrave, frieze, cornice and the relationships between their sums: axial distance between columns, total column height and the total height of the entablature. In order to simplify the procedure, Zloković applied the system of division of the lower column radius into 12 parts, which Vignola advocated for the Tuscan and Doric, to the Ionic and Corinthian as well. Vignola divided the lower column radius of the Ionic and Corinthian order into 18 parts, but for Zloković's purposes, the division into 12 parts is more convenient. Vignola introduced the division into 18 parts in order to discuss smaller details of ornaments, but these elements are of minor interest to Zloković.

Zloković embarks on his study by remarking that axial distances between columns are the same in the Corinthian and the Tuscan, and that the axial distance between columns in the Ionic is very close to this as well. Doric order, however, is a special case in this sense. As mentioned, Zloković abandoned the lower column diameter as the traditional module of the theory of orders and proposed using the axial distance between columns instead. Recalculated this way, Vignola's system of orders has the following ratios between the main elements (L is the axial distance between columns):

	Tuscan	Doric	Ionic	Corinthian
column diameter	0.3L	0.267L	0.316L	0.3L
column height	2.1L	2.133L	2.842L	3L
entablature	0.525L	0.533L	0.71L	0.75L

From Vignola's Preface it can be seen that his formulation of the Canon of the orders was based on many years of practical experience. The question is, how to determine the proportional system by which Vignola's ratios should be interpreted. To answer this question, Zloković introduced the claim that the intuitive adjustment of parts normally follows the dynamic-symmetrical (Golden Section—based) model. He proposed the choice between the harmonic model based on whole numbers (equivalent to Wittkower's harmonic theory), irrational static model ($\sqrt{2}$, $\sqrt{3}$) or the Golden Section. Zloković's argument is that systems based on $\sqrt{2}$ or $\sqrt{3}$ are not applicable without the extensive use of the compass and that the same applies to harmonic systems as well, for which reason an interpretation based on the Golden Section is most likely to give successful results. The assumption is that

Vignola's modular numbers, determined onsubjective and empirical basis can be subsumed.....only in the system of infinite division, as the most elastic system.¹³

(“Infinite division” is Zlokovic's technical term for the Golden Section.) The next step is to draw attention to the ratios between the intercolumniation and the lower column diameter. This ratio is $9/4$ in the Tuscan, Corinthian and Ionic and $11/4$ in the Doric. The former can be easily related to the Golden Section as $\sqrt{5}$ or $\phi + 1/\phi$, where ϕ stands for the Golden Section ratio. The latter is reasonably close to $\phi + 3/\phi^2$, but Zloković suggests that one should

¹³ “Вињолини модулари бројеви, утврђени на основу подлога емпирички и субјективно, могу бити увршћени, ако за то има услова, једино у најеластичнији пропорцијски систем - у систем непрекидне поделе.” Zlokovic, " Геометриска анализа "p.41

consider increasing the column diameter for $1/8$, which would give ϕ^2 as a good approximation.

To summarize, Zloković proposes the following interpretation:

- a). For the Tuscan, Ionic and Corinthian, the intercolumniation to diameter ratio is $9/4=2.25$. This can be seen as an approximation of $\sqrt{5} = (\phi + 1/\phi)=2.236$.
- b). For the Doric, Vignola's intercolumniation to column diameter ratio is $11/4=2.75$. This can be interpreted as $\phi + 3/\phi^2=2.764\dots$ Even closer interpretation can be achieved if we assume a somewhat thicker column diameter, which would give $21/8=2.626$ intercolumniation-to-diameter ratio. The latter ratio can be precisely explained as $\phi^2=2.625$.

Starting from these interpretations, Zloković further embarks on an extensive application of the Golden Section—based interpretation of ratios between all major elements of the classical orders as stated by Vignola. There is no need to repeat his extensive deductions here, but it should be pointed out that they open two important questions.

Zloković's point is that the presence of the Golden Section in Vignola's system of the classical orders is remarkable. He ascribed the presence of the Golden Section to "artistic intuition" and was not inclined to see in Vignola a programmatic use of this ratio. The explanation is plausible as long as one believes that the inclination to use the Golden Section is a natural property of the human mind; but many architectural historians would be skeptical about this premise today. An explanation which assumes a systematic conscious application is much more likely to be regarded as credible today. At the same time, ever since Wittkower's *Architectural Principles*, most proportional research on Renaissance architectural theory has relied on the assumption that harmonic theory was the dominant system of proportions during the Renaissance.¹⁴ But this still leaves aside many well-established cases when some other proportional systems seem to have been in use. The two questions Zloković's paper thus raises are:

1. How does the Golden Section-based analysis of Vignola relate to other established cases of the Renaissance use of non-harmonic proportional theories and
2. Whether there may still exist a way to subsume Vignola's use of the Golden Section under the harmonic theory described by Wittkower - in other words, whether the Golden Section can be expressed as a musical ratio along the lines discussed by Wittkower.

Golden Section and the Renaissance

¹⁴ See for instance, Deborah Howard and Malcolm Longair, "Harmonic Proportion and Palladio's *Quattro Libri*", *Journal of the Society of Architectural Historians*, 41 (1982), pp.116 - 143; Paul von Naredi-Rainer, "Musikalische Proportionen, Zahlenästhetik und Zahlensymbolik im architektonischen Werk L.B. Albertis", *Jahrbuch des Kunsthistorischen Institutes der Universität Graz*, 12 (1977), pp. 81-213., Branko Mitrović, "Palladio's Theory of Proportions and the First Book of *I quattro libri dell'architettura*", *Journal of the Society of Architectural Historians*, 59 (1990), pp.279 - 292. Probably the only critic of Wittkower's approach so far has been George Hersey, see George Hersey and Richard Fridman, *Possible Palladian Villas (Plus Some Instructively Impossible Ones)*, Cambridge, Mass., 1992

Traditionally, the most renowned Renaissance formulation of a proportional theory based on the Golden Section was Luca Pacioli's book *De divina proportio*.¹⁵ It is therefore interesting that Zloković, in a short article published in 1956, denied that Pacioli's *divina proportio* was the Golden Section.¹⁶ Zloković wrote his paper after having studied a copy of the 1509 edition of this book. His conclusion was that Pacioli never formulated the Golden Section ratio and was unaware of the relationship between the Golden Section and the construction of the regular pentagon.¹⁷ In Zloković's view, it was probably Serlio who first described the correct construction of the regular pentagon. Zloković was inclined to ascribe the presence of the Golden Section in works of art to artistic intuition; from this point of view, even if there were no documented cases of conscious formulation of the Golden Section in the Renaissance, this would still not undermine his thesis regarding the presence of the Golden Section in Vignola's work. Renaissance architects, in Zloković's view, need not have been aware of the Golden Section in order to use it.

The concept of "artistic intuition", however, seems somewhat less credible today than it was fifty years ago. That there exists a tendency in the human mind which spontaneously produces the Golden Section in works of art is hard to prove. Already by the turn of the century the German formalist aesthetician Adolf Hildebrand had complained that the proportions appropriate for a Doric temple were by no means applicable to a Gothic cathedral; the use of proportions depends on the shape to which they are applied.¹⁸ This means that if the systematic application of the Golden Section is found in a certain work of art, it may still make sense to consider looking for some documentary evidence that would confirm that the author really intended it so. Zloković emphasized that his interests were not historical, but should his analysis prove accurate, it may have significant interest for historians.

Wittkower's approach still leaves many problems when it comes to the proportional interpretation of Renaissance architecture. This applies even to Palladio's work, on which Wittkower's analysis particularly relied. In another paper I have pointed to the presence of triangulation in Palladio's drawing of the Rotonda in his treatise *I quattro libri dell'architettura*.¹⁹ Book Two of this treatise contains Palladio's presentations of forty-four buildings he designed. Palladio systematically indicated room sizes in these drawings and ratios between these dimensions were the main target of Wittkower's analysis in *Architectural Principles*. Wittkower there managed to show that Palladio preferred to use the ratios which corresponded to musical intervals. But there are cases where Wittkower's harmonic-based interpretation is of little use, and the villa Rotonda is probably the best known Palladian edifice to which Wittkower's analysis could not have been applied. The length-to-width ratio of large rooms in the Rotonda is 26/15, which is a very good approximation for $\sqrt{3}/1$. But whereas the triangulation-based interpretation is valid for the

¹⁵ Luca Pacioli, *De Divina Proportio* manuscript 1498, printed in Venice 1509. Modern facsimile of the manuscript, Milano 1982. Reprint of the 1509 edition together with the French translation, Paris 1980.

¹⁶ Milan Zlokovic, "Divina Proportio \neq Sectio Aurea", *Pregled arhitekture*, 1(1954) pp.126 - 127.

¹⁷ To the best of my knowledge Zlokovic is the only scholar who ever denied that Pacioli's *divina proportio* was the Golden Section. Zlokovic's account largely relied on the fact that Pacioli included a caption saying "divina proportio" in an illustration which represented triangulation. In fact, Pacioli discussed different proportional systems and much of his book deals with different regular geometrical bodies; see *Byrna Rackusin*, "The Architectural Theory of Luca Pacioli", *Bibliothèque d'Humanisme et Renaissance*, 39 (1977), pp. 479 - 502. In another paper, following Zloković's article, (Mitrović, "Palladio's Theory of Proportions...") I have similarly claimed that *divina proportio* was not the Golden Section. My later insights, however, have not confirmed that view; Pacioli's Chapter VII gives the definition of the Golden Section (p.60 of the Paris 1980 reprint); Chapter XVIII explains this ratio on pentagon (p.69 of the same reprint).

¹⁸ Adolf Hildebrand, *Das Problem der Form*, Straßbourg 1918, p.27.

¹⁹ Andrea Palladio, *I quattro libri dell'architettura*, Venice 1570.

version of the Rotonda Palladio presented in his treatise, it is not applicable to the executed Rotonda. Plans Palladio published in his treatise are often *executed* buildings and in the Rotonda, as built, the ratio between length and width of larger rooms is not $\sqrt{3}/1$ but 1.587/1, very close to the ratio in the smaller rooms, 1.602/1. (In the *I quattro libri* Rotonda, the length/width ratio of smaller rooms is the arithmetical mean between length and width of larger rooms.) Also, the 1.58/1 ratio from the larger rooms in the Rotonda is the ratio between the inner height of the dome and the radius of the central room. The question is, whether 1.58/1 can be interpreted as an approximation of the Golden Section. The first to suggest so was Saveliev in 1936, but his article, published in *Архитектура СССР*,²⁰ remained generally unknown in the West. His work was based on Bertotti—Scamozzi's surveys which had at that time recently been translated into Russian.

Another example of a ratio close to the Golden Section in Palladio's executed buildings is the room length/width ratio in the villa Godi in Lonedo. The entrance hall of that villa has a length/width ratio which is an extraordinarily precise approximation of the Golden Section. ($l/w = 1.6185$; the Golden Section is 1.6180).²¹

As for his treatise, *I quattro libri dell'architettura*, Palladio comes closest to the use of the Golden Section in the plan of the villa Mocenigo/Marocco, where the length-to-width ratio of one of the rooms is $26/16 = 1.625$.²² At the same time, the ratio 1.58/1, which appears in the executed Rotonda, is a notorious problem for the proportional interpretation of *I quattro libri* room length-to-width ratios. There are four buildings in Palladio's treatise in which some form of this proportion appears:²³

Antonini / Udine	12'6''/8'	1.5625
della Torre / Verona	30'/19'	1.5789
Capra / Vicenza	27'/17'	1.5882
Valmarana / Lisiera	27'/17'	1.5882

and the 1.58/1 length/width ratio from the executed Rotonda is obviously a member of this group. Whether one should follow Saveliev's approach and treat these ratios as approximations of the Golden Section is debatable, but this hypothesis cannot be easily dismissed.

In any case, there are indications that the use of the Golden Section in the Renaissance was not limited to Vignola. More importantly, in Palladio we are dealing with proportions of *rooms* which are not perceived accurately but only in perspective. The Golden Section ratio between the length and width of a room cannot be perceived the same way as the Golden Section ratio between vertically standing elements of the orders. Palladio did not discuss the Golden Section, (neither did he mention harmonic proportions for that matter) but if he used it, this could not have been unintentional. An important point regarding Zloković's thesis that the use of the Golden Section is the product of the application of "creative intuition": this explanation works for the elements of orders and ratios which are directly perceived, but has much less plausibility when it comes to those ratios which are perceived under angle or in perspective.²⁴

²⁰ Савельев, Л. "Пропорции виллы Ротонда" *Архитектура СССР*, Moscow, 6-1936, p.57.

²¹ Paul Hofer, *Palladio's Erstling*, Basel / Stuttgart, 1969, p.31 - 34.

²² Palladio, *I quattro libri*, p.157.

²³ *ibid.*, pp.100, 108, 118, 162.

²⁴ The debate about the way proportions are perceived is an old one. See Branko Mitrović, "Objectively Speaking", *Journal of the Society of Architectural Historians*, March 1993 for a general summary of this problem; and Branko Mitrović, "Paduan Aristotelianism and Daniele Barbaro's Commentary on Vitruvius' *De*

Harmonic theory and the Golden Section

The next question to consider is whether the Golden Section can be in some way subsumed under to the harmonic system described by Wittkower. Wittkower related Renaissance discussions of architectural proportions to the long tradition which equated musical intervals with numerical ratios: if the ratio between string lengths on a monochord is 2/1, this gives the octave, 3/2 the fifth and so on. The discovery of this physical phenomenon was historically ascribed to Pythagoras; ever since classical antiquity it was combined with a much wider complex of speculations about the way these ratios pervaded the Universe (*harmonia mundi*), determined the movements of heavenly spheres (*musica mundana*), the structure of the human body and so on. Music, from this point of view, was not reducible to audible music, but encompassed the entire rational structure of the world. Renaissance musical treatises typically devote multiple chapters to the discussion of such issues as numerology, movements of the heavenly bodies and astrology. Wittkower suggested that this was the context in which one should understand Renaissance statements that the ratios which are pleasing to the ears are pleasing to the eyes as well. For Renaissance theorists, the application of ratios equivalent to musical intervals ensures that the architect's work participates in the Divine forces that have organized the world; they ensure that architecture is part of *harmonia mundi*.

The question of, whether the Golden Section ratio can be interpreted within a harmonic system is thus reduced to the question whether it is possible to find a musical ratio which would approximate the Golden Section ratio. Musically, the Golden Section ratio falls between the minor sixth and augmented fifth. One should be also aware that the Renaissance was a period of intensive experimenting with different tuning systems. Saying that the Golden Section falls close to a minor sixth or augmented fifth pertains therefore to those ratios which correspond to the minor sixth or augmented fifth in some of the tuning/temperament systems used in the Renaissance. Wittkower's account depended on the ratios defined by the so-called Pythagorean tuning, but this was not the only tuning system in use during the Renaissance. Here are the corresponding ratios of some of these systems:

just tuning:	minor sixth	1.600
equal temperament:	minor sixth	1.587
Pythagorean tuning:	minor sixth	1.6018
	augmented fifth	1.5802
meantone temperament:	minor sixth	1.600
	augmented fifth	1.5625
Zarlino's 2/7 comma temperament:	minor sixth	1.603

This illustrates the small differences in different tuning and temperament systems; however, one should bear in mind that these differences were often audible, especially if instruments were tuned according to different systems and played together.

The fact that the Golden Section ratio is very close to that of the minor sixth led to an interesting debate in the 1950s and 1960s. A circle of proportional theorists around Hans Kayser, tried to deny the relevance of the Golden Section for the arts and reduce it to a

architectura", *The Sixteenth Century Journal*, September 1998, for a summary of Renaissance debates about this problem.

musical interval. Rudolf Haase was probably the theorist who was the most direct in this sense.²⁵ His intention was to deny the importance of the Golden Section in the arts,²⁶ and he wanted to do this by expressing the Golden Section ratio as a kind of minor sixth. He remarks that the minor sixth, which is $8/5$, cannot be expressed at the same time as $128/80$ ($8/5 = 128/80$) because of the syntonic comma, and that a correction is necessary, so the minor sixth is taken to be somewhat smaller than $128/80$, i.e. $128/81$. He goes on to advocate a slightly *greater* ratio than this, namely $128/79 = 1.62025$, in order to get a good approximation for the Golden Section (1.61803).²⁷

Haase's attempt to eliminate the preconceptions about the Golden Section thus results actually imposing the Golden Section in musical tuning as well. The minor sixth he suggested would be audibly sharper than the one in just tuning, which, in turn, is sharper than most of the minor sixths in other tuning/temperament systems, and musical theorists would hardly be very happy with it. The sharpest minor sixth among the Renaissance tuning systems listed above is that in Zarlino's $2/7$ comma temperament ($1.603/1$); the just-tuning one comes next ($1.600/1$). Both are audibly flatter than the $1.62/1$ Golden Section minor sixth that Haase suggested. Haase's attempt thus shows that reducing the Golden Section to a musical interval is not likely to give convincing results. In those cases, where we encounter the use of the Golden Section in the Renaissance, this cannot be explained away as a derivation from the minor sixth / augmented fifth of the harmonic theory.

Conclusion

Zloković's study about Vignola thus raises a number of problems interesting even today. The belief that all Renaissance proportional theories can be explained by harmonic ratios has been widespread ever since the publication of Wittkower's *Architectural Principles*. The point I have tried to make is that this is not always the case even with Palladio, and it was Palladio's opus on which Wittkower largely founded his argument.

This further raises the question of the theoretical background of the use of the Golden Section in the Renaissance. As mentioned earlier, references to the Golden Section in Renaissance texts are rare. It apparently did not have such appeal to Renaissance theorists as was the case with harmonic theories. Its relation to the construction of the regular pentagon, and its discussion in Euclid's elements, however, indicates that interest in the Golden Section could have been derived from geometrical studies. The way the Golden Section appears as a ratio between room dimensions in Palladio's work, in a situation where it would be perceived only in perspective, suggests that it was consciously applied at least in some cases. Furthermore, we have seen that its use during the Renaissance cannot be explained away by subsuming it under harmonic theory. The presence of the Golden Section in Renaissance architectural works is thus an interesting problem and one hopes that future surveys of Renaissance buildings may throw more light on it.

²⁵ Rudolf Haase, "Der Goldene Schnitt als harmonikales Problem", *Symbolon*, Basel 1968, vol. 6. 212ff. Also: "Der mißverständene Goldene Schnitt", *Zeitschrift für Ganzheitsforschung*, 1975, p.240. See also Hans Kayser, *Lehrbuch der Harmonik*, Zurich 1950, p.112.

²⁶ Haase, "Der Goldene Schnitt..." p.227.

²⁷ *ibid.*, p.216.