Michael J. Ostwald | *Under Siege: The Golden Mean in Architecture*

Michael Ostwald briefly describes the Golden Mean and its history before examining the stance taken by a number of recent authors investigating the Golden Mean in architecture. He addresses the theories of Husserl, Derrida and Ingraham, who separately affirm that tacit assumptions about the relationship between geometric forms and other forms – say geometry and architecture – must be constantly questioned if they are to retain any validity.

Introduction

Edmund Husserl's *Origin of Geometry* was originally written as an appendix to his *The Crisis of European Sciences and Transcendental Phenomenology*. Significantly, in the *Origin of Geometry* Husserl examines geometry from a historical perspective not a mathematical one. For Husserl the elevation of geometric forms to transcendental status (as, for example, the basis of universal beauty) presupposes the connection between such forms and some "ideal" or "original" form. An example of this is found in Vitruvius, who maintains that the Euclidean circle and square are perfect for the generation of architecture because they approximate the geometry of the spreadeagled human body – a body made in the image of God.¹ Similarly, as a "golden" spiral generated from the diagonal of a half-square approximates both the shape of a nautilus shell and the distribution pattern of seeds in a sunflower it is presumed to be connected to the essence of nature.² In both cases the geometric sign (the square and circle) or proportional set (the Golden Mean) is significant for its mimetic relationship to some other form, not for any intrinsic property. While Husserl does not deny that geometric signs and sets contain intriguing mathematical properties, their historic significance outside of mathematics must, for him, be governed by "objectivity" or else they will lose any and all connection to the historic ideal.

In 1962 Jacques Derrida wrote a lengthy introduction to Husserl's *Origin of Geometry*, in which he similarly maintains that the search for connections between geometry and historic forms (which include architectural as well as philosophical or epistemological forms) must be tempered with an awareness of the inherent futility of such an endeavour.³ This is not to suggest that such enterprises should never be undertaken, but rather that they must occur with due recognition of the fundamental difficulties involved. The architectural theorist Catherine Ingraham echoes this sentiment in her detailed philosophical analysis of the role of the line and geometry in architectural representation.⁴ Ingraham, who examines lines traced on drawings,

photographs and maps, argues that any analysis of this kind must take due account of what she calls the “burdens of linearity”⁵: the problems that beset all attempts to relate geometry to architecture.

Ultimately Husserl, Derrida and Ingraham separately affirm that tacit assumptions about the relationship between geometric forms and other forms – say, geometry and architecture – must be constantly questioned if they are to retain any validity. What is interesting about this position is that it resonates with the stance taken by a number of recent authors investigating the Golden Mean in architecture. This paper briefly describes the Golden Mean and its history before summarising some of these arguments in an attempt to both inform the reader and to respond to Husserl’s and Derrida’s solicitations.

Golden Proportions?

Explanations of the Golden Mean typically commence with a brief description of the Fibonacci sequence. An equally simple definition, which is often paraphrased in various texts is as follows. If a line AB is divided by a point C such that the ratio of the whole line AB to the longer segment AC is equal to the ratio of the longer segment AC to the smaller segment CB then the ratio $AB:AC$ (and also $AC:CB$) is known as the Golden Mean (ϕ or $\phi\hat{h}$).⁶ If the length of AB is 1.000 then the Golden Mean is approximately 1.618.

Such “divine” or “golden” systems of proportions first became the subject of serious scholarship in the fifteenth century in the work of Luca Pacioli.⁷ In the seventeenth century Johannes Kepler described the knowledge of these proportional systems as essential to the appreciation of art and nature. Indeed, Kepler could be seen to be at least partially responsible for propagating many studies of geometrically defined aesthetic systems that were undertaken in the following two hundred years. By the nineteenth century, despite the protestations of John Ruskin, the practice of tracing lines on drawings of facades in order to uncover invisible proportional systems had become commonplace.⁸ Heinrich Wölfflin’s pioneering analysis of Renaissance and Baroque churches set the standard for this approach to the formal analysis of proportion in plan and facade. By the mid-twentieth century, when Rudolf Wittkower published his influential *Architectural Principles in the Age of Humanism*, art and architectural historians were tracing the Golden Mean in countless historic buildings, paintings and sculptures.⁹ Not only was this practice not limited to historic buildings but comparative analyses began to be undertaken from one period to another. One seminal example of this kind of research is Colin Rowe’s 1947 essay “The Mathematics of the Ideal Villa”, which traces parallel proportional systems in the work of Palladio and Le Corbusier. In the aftermath of the publication of Rowe’s research, the Golden Mean enjoyed a popular resurgence in architectural practice as a universal aesthetic panacea (neither Rowe’s intent, nor, ironically, actually supported in his paper).

Throughout the thirty years that followed symposiums held in America, Canada and Europe called for the Golden Mean to be recognised as underlying a universal system of beauty. However, throughout the seventies a small but growing number of criticisms of its role in architecture emerged. Notably, one of the first of these is contained in Rowe’s 1973 addendum to “The Mathematics of the Ideal Villa”. In this text Rowe criticises the “Wölfflinian” search for proportional systems noting that “its limitations should be obvious”.¹⁰ He goes on to enumerate these limitations concluding that the practice of tracing proportional systems in architecture

“cannot seriously deal with questions of iconography and content ... and, because it is so dependent on close analysis if protracted [such analysis] can only impose enormous strain upon both its consumer and its producer”.¹¹ Rowe’s change of heart reflects a growing awareness in this field of study that the relationship between geometry and architecture is neither so predictable nor so static as often thought. During the eighties and early nineties a small but growing number of conferences and symposia began to more openly criticise the hegemony of the Golden Mean. Most recently, in June of 1998, the role of the Golden Mean in architecture was hotly debated at a conference in Mantua in Italy. This conference, the second in a series begun in Florence in 1996, was entitled “Nexus: Architecture and Mathematics”.

At the centre of much of the debate at the 1998 Nexus conference was a controversial paper by Frascari and Ghirardini which argues that mathematicians and historians have been over-zealous in their attempts to uncover the Golden Mean in architecture. In contrast, the mathematician Vera de Spinadel took the more common stance of accepting that the Golden Mean is the geometric basis for many historic architectural works and the theologian Gert Sperling rejected Frascari’s and Ghirardini’s thesis in his geometric and numeric analysis of the Pantheon.¹² While many other important issues were raised at the Nexus conference in Mantua it is this debate surrounding the validity of the Golden Mean that is particularly noteworthy.

Marco Frascari and Livio Volpi Ghirardini’s paper “Contra Divinam Proportionem” commences with the claim that “[a] golden or divine magnifying glass that distorts rather than clarifies has been applied to everything in the name of aesthetic and mystical impulses.”¹³ For Frascari and Ghirardini the search for the Golden Mean has been carried out by fanatics (ironically dubbed by them the “faithful”) who have ignored the reality of architecture and the construction process to find the Golden Mean in almost every famous building from antiquity to the present day. Frascari and Ghirardini explicitly criticise the tradition, arising from the German philosopher Adolf Zeising and the mathematician Siegmund Gunter, which traces the Golden Mean over photographs of historic buildings and objects. Frascari and Ghirardini argue that “[w]ithout any doubt Zeising and Gunter were very skilful at measuring pictures, but it is clear that neither of them had ever measured a building”.¹⁴ Architecture must be measured with both a degree of mathematical precision and with an appreciation of the innate dimensional accuracy of its material form. Stone, metal and brick all possess different capacities to retain a finished dimension. “In metrical terms, every constructive part of building has its geometric order: masonry, in decimeters; wood carpentry, in centimeters; metal works, in millimeters. Every part is exactly approximate.”¹⁵ When buildings are measured without such an appreciation of the materiality of architecture the search for the Golden Mean is invariably meaningless. For Frascari and Ghirardini the Golden Mean must therefore remain an “untamable and intangible measure since, in order for it to be real and efficient, it must be explicitly exact. However architecture does not permit this categorical exactness because there are always mitigating factors such as play in the joints and the density of materials.”¹⁶

The measurement of architecture is always problematic because, as architecture can never provide an “exact” Golden Mean, any argument must be derived from approximate dimensions. The result of this reliance on imprecise dimensions is that arguments for the presence of the Golden Mean in architecture are often completely inconsistent in their use of measured dimensions. For example, the dimensions of one wall of a building could be measured from the

floor to the ceiling and a second wall from the floor to the base of the cornice. The argument might then be made that both are perfect examples of the Golden Mean. This is plainly an inconsistent and flawed method yet it is all too common in arguments surrounding proportional systems in architecture. One case in point is the Pantheon which has been measured many times including a very recent and highly detailed survey. Yet, scholars analysing the Pantheon too often use these highly accurate dimensions only when they suit their own arguments and ignore them when they do not.¹⁷ Masi's analysis of the "Pantheon as an Astronomical Instrument" even talks about "exact" dimensions such as "9m" or "30 ft" as if the two approximate measurements are somehow identical!¹⁸

A related problem arises when over-precise measurements are used and complex and hermetic arguments are proposed to explain tiny inconsistencies in construction. Thus a "square" panel of tiling that actually has one side 1.6 millimetres shorter than the other, is described as an attempt by the master mason to hide the Golden Ratio within the walls of a building. In a recent book Paul-Alan Johnson criticises such methods in some detail. "The equation of geometrical with architectural figures," he argues, "is only what we choose to make of it. ... Precision *per se* is not enough no matter how satisfying it is for the analyst."¹⁹ All measurements must be treated with consistency and due regard for the dimensionality of the materials being measured. Scholars, in this hybrid field where architecture and mathematics meet, too freely use those measurements of buildings which suit their arguments and simply ignore those that do not. The main problem is, as Frascari and Ghirardini identify, "for the ϕ believers, any point is good for making the point."²⁰

A further problem arising from the reliance on approximate dimensions is that there are well-documented proportional systems which have been used in architecture throughout history that are sufficiently close to the Golden Mean that they may seem interchangeable with it. As Frascari and Ghirardini explain, a common proportional system utilised by architects relies on the ratio 5 : 3 (or approximately 1.66...) which, owing to the limits of materials and the craft of building, is readily mistaken for the Golden Mean (or approximately 1.618). Frascari and Ghirardini also discuss many examples wherein the documented ratio employed by architects and builders is 5 : 3 (or 8 : 5) and suggest that these proportions may better explain those measured in buildings than the proportions of the Golden Mean. Pierre von Meiss reiterates this line of argument in his *Elements of Architecture* noting that the "Golden [Mean] is very close to the ratio of 5 : 8" and that "Le Corbusier [even] takes the credit for reducing the Golden [Mean] to rational numbers applicable to architecture."²¹ Robin Evans's recent book examines this same concept in detail describing how Le Corbusier initially tried to use the Golden Mean to generate ideal architectural proportions but found the results "miserable". Le Corbusier's solution, documented at length in his two volumes of the *Modulor*, was to work with ratios of 5 : 3 or 8 : 5 to overcome the "startling ugliness" of the architectural solutions generated through the use of the Golden Mean. None of which is to suggest that the Golden Mean has never been used in architecture nor that the ratio 5 : 3 is dominant but rather that a more thoughtful, consistent and critical analysis is necessary before any claim regarding proportional systems in architecture can be made. Le Corbusier and Palladio were each familiar with the Golden Mean and there is some evidence to suggest that they each utilised its properties in their designs. However, in the case of the former at least, the overwhelming body of evidence points away from the use of the Golden Mean in

any sustained way. As Evans concludes; “[t]heories of proportion as traditionally formulated ... are quite inadequate to the task of describing complex shapes.” Le Corbusier’s variant of the Golden Mean “lurks behind the wall as if it were responsible for it ... as if it made all of the difference in the world while hardly making any difference at all”.²²

Frascari and Ghirardini’s arguments are also furthered by those of Rocco Leonardis who claims that the very phrase “the Golden Mean” is problematic. For Leonardis the word “Golden” implies that the ratio is somehow rare or especially valuable – neither of which is necessarily true. An apprentice or student with the right tools and a modicum of effort can produce the proportions of the Golden Mean by accident. With a straight edge ruler and a pair of compasses anyone given enough time will generate a pentagram. Producing a pentagram (or some related geometric expression of the Golden Mean) in no way suggests that an amateur geometer understands anything about mathematics. Eminent historian of mathematics Georges Ifrah makes this same point in some detail when he recalls that he:

*...once knew a professor of mathematics who [...] tried to persuade his students that abstract geometry was historically prior to its practical applications, and that the pyramids and buildings of ancient Egypt “proved” that their architects were highly sophisticated mathematicians. But the first gardener in history to lay out a perfect ellipse with three stakes and a length of string certainly held no degree in the theory of cones! Nor did Egyptian architects have anything more than simple devices – “tricks”, “knacks” and methods of an entirely empirical kind, no doubt discovered by trial and error – for laying out their ground plans. They knew, for example, that if you took three pieces of string measuring respectively three, four, and five units in length, tied them together, and drove stakes into the ground at the knotted points, you got a perfect right angle. This “trick” demonstrates Pythagoras’s theorem [...] but it does not presuppose knowledge of the abstract formulation, which the Egyptians most certainly did not have.*²³

Johnson reiterates this view and records that throughout history most architects have only possessed “a rudimentary understanding of geometry and design using more or less straightforward permutations on regular polygons and the circle ... At the risk of oversimplification, for more than two millennia basilica, domed and vaulted structures, have been generated principally by the projection or rotation of three primary figures – circle, rectangle, triangle”.²⁴ Like the “sacred cut” and the “vesica pisces”, the Golden Mean is a simple geometric construct which can be used to shape windows and floor plans, to locate paving patterns and to divide courtyards. That these geometric constructs have been used in architecture throughout the ages is undoubtable. But that these forms represent a more complex awareness of numeric or harmonic symbolism in architecture is debateable. In these rare instances where there is documented evidence that the architect was aware of the Golden Mean and possibly even its mathematics, then a case can be made. In other cases, scholars, whether architects or mathematicians, must be more circumspect.

Conclusion

The interpretation of architecture, like the interpretation of art or mathematics must be undertaken rigorously. Without scholarly rigour simple errors of dimension or geometry can be used to derive an entire thesis that is completely spurious. As an example of this, Evans suggests an examination of two investigations of the proportions of the same facade undertaken by both Wölfflin and Wittkower almost fifty years apart. Fundamentally Evans finds that each of the studies of Alberti's facade for the Santa Maria Novella in Florence rely on "auxiliary lines (imaginary lines) to reveal privileged relations and virtual figures that can not easily be inferred from direct inspection".²⁵ Moreover, it appears that each analysis is traced on inaccurate drawings of the facade, and in addition elements from the third dimension (those which are well behind the facade) are transposed to the same plane. It is no wonder, given these gross liberties, that both Wölfflin and Wittkower are able to propose conflicting and equally credible interpretations of the proportions of Santa Maria Novella.

Rowe presciently argued in 1973 that proportional analysis should only be undertaken where there is clear, visible evidence and even then it should not be misconstrued as representing any powerful proof of a real relationship between geometry and architecture. Like Husserl and Derrida, Rowe is aware of the fundamental inconsistencies present in attempts to connect geometry with some other form. The Nexus conference was not the first conference to raise these issues and it will not be the last; it did however in many ways respond to the calls of Husserl and Rowe.

First published in the NNJ online April 2000

Notes

1. Vitruvius, *The Ten Books on Architecture*, Morris Hicky Morgan, trans. (Cambridge MA: Harvard University Press, 1914), p. 73. [first written circa 13BC.]
2. Robert Lawler, *Sacred Geometry* (London: Thames and Hudson, 1982), pp. 56-57.
3. Jacques Derrida, *Edmund Husserl's Origin of Geometry: An Introduction*. Trans. John P. Leavey Jr. (Lincoln: University of Nebraska Press, 1989). [first edition 1962].
4. This issue is discussed in more detail in Michael J. Ostwald and R. John Moore, "The Mapping of Architectural and Cartographic Faults: Troping the Proper and the Significance of (Coast) Lines," *Architectural Theory Review* (1998), pp. 4-45.
5. Catherine T. Ingraham, *Architecture and the Burdens of Linearity* (New Haven: Yale University Press, 1998).
6. See Steven Vajda, *Fibonacci And Lucas Numbers, And The Golden Section* (New York: John Wiley and Sons, 1989); Charles F. Linn, *The Golden Mean: Mathematics And The Fine Arts* (New York: Doubleday, 1974).
7. Alberto Pérez-Gómez and Louise Pelletier, *Architectural Representation and the Perspective Hinge* (Cambridge MA: MIT Press, 1997).
8. See, for example, the discussion of "right line" in R. John Moore and Michael J. Ostwald, "Choral Dance: Ruskin and Dædalus," *Assemblage*, vol. 32 (April 1997), pp. 88-107.
9. The classic example of this approach is found in Rob Krier, *Architectural Composition* (London: Academy Editions, 1988).
10. Colin Rowe, *The Mathematics of the Ideal Villa and Other Essays* (Cambridge MA: MIT Press, 1976), p. 16. [Rowe's addendum was made in 1973.]

11. Ibid.
12. Vera W. de Spinadel, "The Metallic Means and Design", *Nexus II: Architecture and Mathematics*. Kim Williams, ed. Fucecchio, Florence: Edizioni Dell'Erba, 1998, pp. 143-158; Gert Sperling, "The *Quadrivium* in the Pantheon of Rome", *Nexus II: Architecture and Mathematics*, 127-142.
13. Frascari, Marco and Livio Volpi Ghirardini, "Contra Divinam Proportionem," *Nexus II: Architecture and Mathematics*, Kim Williams, ed. (Fucecchio, Florence: Edizioni Dell'Erba, 1998), 65-66.
14. Ibid., p. 67.
15. Ibid., pp. 68-69.
16. Ibid., p. 69.
17. See the discussion in Sperling, "The *Quadrivium* in the Pantheon of Rome," cited in note 12.
18. Fausto Masi, *The Pantheon as an Astronomical Instrument* (Rome: Edizioni Internazionali di Letteratura e Scienze, 1996), p. 6.
19. Paul-Alan Johnson, *The Theory of Architecture: Concepts, Themes and Practices* (New York: Van Nostrand Reinhold, 1994), p. 359.
20. Frascari and Ghirardini, "Contra Divinam Proportionem", cited in note 13, p. 70.
21. Pierre von Meiss, *Elements of Architecture. From Form to Place* (New York: Van Nostrand Reinhold, 1990), p. 63.
22. Robin Evans, *The Projective Cast: Architecture and its Three Geometries* (Cambridge MA: MIT Press, 1995), p. 292.
23. Georges Ifrah, *The Universal History of Numbers* (London: Harvill, 1998), p. 92.
24. Johnson, *The Theory of Architecture*, p. 358.
25. Evans, *The Projective Cast*, p. 248.

The Author

Michael J Ostwald lectures in architectural history and theory at the University of Newcastle in Australia. He has written extensively on the relationship between architecture and geometry. He is the Book Review Editor for the *NNJ*.