B X DE WET ESSAY

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THE REFINEMENTS ON THE PARTHENON

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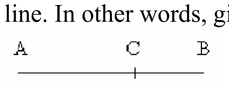
Do the structural refinements on the Parthenon, particularly the repetition of the 4:9 ratio and the use of the "golden section"[1] in the façade of the building, make it more beautiful than it would be in the absence of architectural subtlety? Does the Greek approach to proportion reflect universal facts about human perception of beauty, or is it based on mystical attachment to certain numbers and proportions?

The almost imperceptible attention paid to the structure of the Parthenon makes it an ingenious construction both in the context of Ancient Greek art and science, and in the history of architecture as a whole. While features like the curvature of the stylobate and entablature, entasis and inclination of columns (and corresponding tapering of opposite walls) are found in somewhat cruder form on earlier Doric temples (Carpenter 1970:120) and are fairly obviously designed to counter optical illusions and create a sense of unity and grace, the insistence on certain ratios is more difficult to explain. According to the Roman architect Vitruvius — who wrote during a period very similar in its aesthetic values to that of Ancient Greece — the human body exhibits a definite system of proportion. The head, for instance, appears to constitute exactly one tenth of the height of a man. Thus, he supposed (making a leap from anatomy to architecture . . .), the dimensions of buildings should be determined with similar precision to ensure the most pleasing visual effect. (Vitruvius, Chapter I, Book III.) While Vitruvius does not refer to the "golden section"[2] in his *Ten Books on Architecture*

1. Apparently discovered by Pythagoras or the Pythagoreans (although sources differ – some attributing it to the Ancient Egyptians), the golden section is a rectangle constructed from two portions of a line where the ratio between the shorter and the longer is the same as that between the longer and the length of the whole line. In other words, given straight line AB, C is a point on the line such that BC/AC=AC/AB, as follows:



   This proportion is designated φ, and is approximately equal to 0,618033988 ($\sqrt{5}/2-1/2$, to be exact). (Dudley Underwood, www.maa.org/reviews/golden. html.) Thus, a rectangle with dimensions based on phi will have a breadth of 0,618033988 if its length is 1. The relation phi has acquired particular significance in art and architecture (and music – which is beyond the scope of this essay) as it has been thought historically to embody a special aesthetic balance between height and width. When applied to the front of the Parthenon it has been found to contain the façade from the base of the stylobate to the tip of the pediment (www.mcs.surrey.ac.uk/ Personal/R.Knott/Fibbonacci/fibInArt.html).
2. That is not to suggest that either Vitruvius or the Greeks did not know about the golden section, or "division in mean and extreme ratio", as it was then known – the mathematics of which, as we have seen, were discovered considerably earlier. The term, however, was only coined in the early 1800's (Dudley Underwood, www.maa.org/ reviews/golden.html). Vitruvius' silence on the subject, however, suggests that

(Morgan 1914), the detail with which he describes other structural ratios — such as those between the width of an (Ionic[3]) column, its height, the dimensions of the base and capitol and so on (Vitruvius, Chapter V, Book III) — reveals the significance attached to numbers and evokes the spirit of a time in which beauty was thought to be an exact, mathematically attainable quantity. Indeed, even modern scholars have considered proportions to be "carriers of forces"; the golden section in particular displaying a "lively inherent tension" between the solidity of the square and the implicit motion of a rectangle (Arnheim 1977:221). In this essay, however, I shall argue that it is more naïve idealism than any facts about human cognition that led the Greeks and others to favour certain architectural relations. For whilst certain approximate shapes or proportions may be considered more visually appealing than others by the vast majority of people — and might indeed represent extrinsic standards of beauty — the idea that such quantities could be determined exactly is far-fetched. Rather, perhaps, it is the blindness of Greek rationalism and wonderment at the newly discovered and much mysticised mathematics that supported their faith in aesthetic absolutism.

While it is debatable whether the Greeks specifically designed the façade of the Parthenon to fit into a golden section, the repetition of the 4:9 ratio suggests both deliberation and that a certain significance was attached to this value. Indeed, so great was the need to adhere to this system of proportion that the corner interaxials are markedly contracted, creating an unnatural and disconcerting effect, and one that is atypical on a Doric temple (Dinsmoor 1950:161). This feature raises the issue of another influence on the design of the Parthenon: that of conservatism in Ancient Greek art and partiality for what had become architectural norms — and the contrasting desire to innovate and impress. For although the Parthenon has some classic Doric characteristics, the novelty of the octastyle façade combined with the strict observance of the formula for the dimensions of the base[4] is what necessitated the unusually shortened angle interaxials — and thus metopes as well (Ibid) — so further breaking with convention. Thus, the conformism revealed in the overall regularity of the building and its obviously Doric form is in tension with the urge to revolutionise. And the precision displayed by the careful application of the 4:9 ratio in the construction of various different aspects of the temple implies an obstinacy that could be read as a sort of conservatism. Why Iktinos (or perhaps Perikles) chose this particular fraction, and repeated it with such alacrity, is a somewhat esoteric question similar to that of the intent behind the predilection for proportions displayed by the Ionian style of architecture (see footnote 3). It may be best explained simply as the symptom of the quixotic belief that beauty and affect can be calculated and constructed, and that this was a formula for a beautiful construction.

It is curious, then, that the other — and perhaps more successful — refinements on the Parthenon function because of their subtlety and imprecision. For while Iktinos diligently repeated one proportion in five different aspects of the temple, there are equally studied gaps in the accuracy of some of its application — for instance, in the slight variation in the distance between columns (Carpenter 1970:125). And the curvature of so many of the lines of

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it may have been modern architects who "pasted" the golden section over the Parthenon and found a "fit" that had not been put there deliberately; I shall examine this possibility further later on in this essay.

3. Whilst the Parthenon is largely a Doric temple, the inclusion of Ionic features in its design, as well as the strong Ionian influence on both the style and atmosphere of Athenian art in the fifth century BC implies that proportion would have had an equally important role in its structure. Nevertheless, the Parthenon does not exhibit the rigid formulae of the Ionic Order – beyond the repetition of the 4:9 ratio (Carpenter 1970:125).
4. One of the principles on which the design of Greek temples from as early as 540 BC were based was that the ratio of the height to the width should be equal to that of width to length (Cuomo 2001:9).

the building constitutes quite a different variety of enhancement — having been devised, not for technical exactness, but to produce a certain subjective effect on the observer: "to be adapted to the eye . . . [and] give a character of purpose, almost life . . ." (Gardner 1905, in Dinsmoor 1950:164). This desire for a sense of organicism in architecture represented a development from the rigidity of archaic forms.[5] Thus, the recognition of the limitations of straight lines and meticulous order paradoxically accompanied a system of proportion that involves just the sort of fastidiousness that it implicitly defies. Of course, it is important to remember that much rigorous calculation went into the design of so many curves (Carpenter 1970:126) and the effect, as has been noted above, is by no means one of irregularity or coarseness, but rather of sophistication and gravity. In other words, by opposing the optical illusions, for example, of concavity in the base and columns by creating a faint outward curve, the effect produced is one of straightness and solidity (Dinsmoor 1950:169). A subtly different hypothesis is that the curves were designed, not to counter perceptual distortions, but rather, through their almost subliminal effect on the viewer, to create an impression of animation and authenticity (Carpenter 1970:126). (These two views, however, are not mutually exclusive, and I am inclined to assume a middle position — that the Parthenon's refinements were intended both to combat optical illusions and produce a particular effect.) Thus, although the exact purpose of this class of refinement remains a contentious issue, the essence of its intent is unquestioned: that of visual excellence. It is by no means equally clear, however, that the imposition of a single mathematical system to disparate components of a building could produce a similar result.

The aesthetic here, then, is theoretical, and is perhaps the consequence of a style of thought that attached special or mystical significance to the idea of number, and to certain mathematical symbols, which were regarded as bearers of cosmic unity.[6] Both Plato[7] and the Pythagoreans have been associated with this approach (Cuomo 2001:30), which might be seen to have left its mark on architecture and art in the strict deployment of ratios and formulae. Indeed, Plato regarded the former as "a superior art" for the specious reason (to modern thought, at least) that it makes "frequent use of measures and instruments, which give it high accuracy" (in *Philebus*, Ibid, p.9) — in other words, he assumes that precision engenders beauty, or is itself an aesthetic feature (even if not directly perceptible to the senses). And the multiple meanings of the word for "beautiful", καλος, which is also "good" and (more significantly) "correct", suggest that in Ancient Greece the attribute of beauty was regarded as a quantifiable end.[8] In the post-Renaissance world, however, this view has generally been supplanted by one in which beauty is subjective, incalculable and immeasurable. Theorists like Fechner and Weber who performed surveys of peoples' visual experiences of different shapes[9] did not find that any of the "classical" proportions — such as

5. It is important to remember, however, that while these refinements might be seen to represent an approach that is more lively and fluid than the archaic one, it does not necessarily imply acknowledgement of subjectivity in the perception of art.
6. www.cyberspacei.com/jesusi/inlight/philosophy/western/Pythagoreanism.htm
7. Although Plato postdates the building of the Parthenon, he is a useful source on both common and expert knowledge of mathematics, and some of his views may be similar to those that influenced earlier architectural ideas. In addition, his connection to the Pythagorean School, which began much earlier, suggests historical continuity in thought. (Cuomo 2001:25.).
8. www2.uiah.fi/projects/metodi/155.htm
9. There is even, apparently, a recently established internet poll to determine common opinion on the relative dimensions of the most beautiful rectangle – at http://homepage.esoterica.pt/~madureir (Dudley Underwood, www.maa.org/ reviews/golden.html)!

the golden section (which will be discussed shortly) — were considered particularly beautiful in comparison to others (Underwood[10]). And, while the perception and nature of beauty are extraordinarily difficult — if not impossible — to gauge, the idea that it could be inherent in specific formulae, numbers or shapes seems (to the modern mind, at least) just plain fanciful. In a culture that was notorious for neglecting the empirical method, however, the simplicity and security of what I shall call the idealistic view of beauty would no doubt have held great appeal.

Indeed, its attractiveness lingers on in the continued attachment to relations like the golden ratio — which some still cite as an instance of intrinsic beauty. Interestingly, it is commonly (although not unanimously) believed that this proportion was discovered by the Pythagoreans — who, as we have seen, were also distinguished by their belief in the divine significance of number.[11] It might be, then, that a theoretical mood that embraced a metaphysic in which number was seen as a foundation of reality also facilitated discoveries like the golden section. To proponents of the idealistic model of beauty, the golden section represents a tidy piece of evidence for a connection between what human beings experience as attractive and the mathematical attributes of objects. For the number phi, one might argue, is both surprisingly neat in its calculation and range of numerical presentations,[12] and surpassingly varied in its application.[13] The connection between a pleasing nugget of mathematics and innate aesthetic value, however, is sorely lacking and can only be supplied by mysticism. Indeed, evidence suggests that the idea that the golden section might also constitute an aesthetic artefact did not arise until the 1800's (Knott 1996–2004). In other words, it seems probable that the Ancient Greeks did not even regard the golden section as being especially beautiful or a possible base for aesthetic constructions. Rather, it is contemporary academics that, in an attempt to explicate the superlative beauty of the Parthenon, seek golden rectangles in its design — and invariably find them, admittedly somewhat roughly placed, as Knott points out (Ibid).

A curious topic, then, is whether, in the absence of deliberation, the very near approximation of a golden rectangle formed by the façade of the Parthenon — and the appearance of other ratios approaching phi in the temple[14] — makes it more beautiful than it would otherwise be. In other words, did the Greeks coincidently hit upon a good formula? While, as noted above, it seems foolish to presume any correlation between specific numbers or proportions and human perception of beauty, much of Greek art — which embraced just this sort of connection — is widely considered to be especially beautiful. Perhaps, therefore, the Greeks had a point, for it does not seem beyond the bounds of possibility that there be general principles governing visual appeal: in the case of architecture, symmetry, roughly balanced proportions, subtle irregularity, faintly curving surfaces . . . (of course, it is equally

10. Ibid
11. The Renaissance writer, Luci Pacioli even referred to the golden section as the "divine proportion", because its irrationality, which made it "occult and secret", linked it to a god which, he supposed, shared those qualities (O'Connor and Robertson, www-gap.dcs.st-and.ac.uk/~history/HistTopics/Golden_ratiohtml#s18).
12. For instance, $\varphi = 1 + 1/\varphi$ (i.e. 1/0,61803…=1,61803…, or φ is equal to its reciprocal plus 1), and $\varphi^2 = \varphi + 1$ (Dudley Underwood, www.maa.org/reviews/golden.html).
13. Apart from its use as a supposed "formula for beauty" in art and architecture, the golden section has numerous different uses in, for example, geometry, trigonometry and – as noted above – music theory (Ron Knott 1996–2004, www.mcs.surrey.ac.uk /Personal/R.Knott/Fibbonacci/fibInArt.html).
14. For instance, the golden section is supposed to appear in the ratio of triglyph to metope length, entablature to pediment height and others (Ibid).

plausible that such conceptions of beauty are culturally shaped and do not represent universal or extrinsic standards.) The analogous question of whether the Parthenon would be considered equally beautiful without the refinements in its surfaces is perhaps best answered by comparing it to earlier, less delicately planned Greek temples. And indeed, none of these is quite so renowned or deeply studied as the Parthenon — although it is impossible to gauge whether this is because of its superior geographical position, the importance that has been attached to it since antiquity, the deliberation that we know went into its planning or innate beauty.

BIBLIOGRAPHY

Arnheim, R 1977. *The Dynamics of Architectural Form*. London: University of California Press.

Author unknown 2004. *Arteology: The Beauty of Artefacts* [12/04/2004]. www2.uiah.fi/projects/metodi/ 155.htm).

Author unknown. *Pythagoreanism*. cyberspacei.com/jesusi/inlight/philosophy/western/ Pythagoreanism.htm.

Carpenter, R 1970. *The Architects of the Parthenon*. Middlesex: Penguin Books: Middlesex.

Cuomo, S 2001. *Ancient Mathematics*. London: Routledge.

Dinsmoor, W B 1950. *The Architecture of Ancient Greece: An Account of its Historical Development.* London: B T Batsford Ltd.

Knott, R 1996-2004. *Fibonacci Numbers and the Golden Section in Art, Architecture and Music*. [2004]. www.mcs.surrey.ac.uk/Personal/R.Knott/Fibbonacci/fibInArt.html.

Morgan, M H (trans.) 1914. *Vitruvius: The Ten Books on Architecture*. New York: Dover Publications Inc.

Underwood, D 2001. Review of Walser, H, The Golden Section (translated by Hilton, P & Pederson, J, Mathematical Association of America) [2001] www.maa.org /reviews/golden.html.