Chapter 55
Golden Proportions in a Great House: Palladio's Villa Emo

Rachel Fletcher

Build them. . .with such proportions that together all the parts convey. . .a sweet harmony.
–Palladio, I Quattro libri, Book IV, Foreword (1997: 213)

Introduction

Among the great houses of the Renaissance is Palladio's Villa Emo at Fanzolo in Northern Italy, built in the late 1550s by Leonardo Emo to realize a family seat in the country. Created originally to support a farming economy in grain, spinning mills and, eventually, maize, or Indian corn, from the New World, the villa until recently belonged to the Emo family for 18 continuous generations and was family farmed. The estate, which consisted of some 300 ha at the time of Palladio, lies on an open plain in Italy's Veneto region, the terrafirma countryside where Venetian Renaissance patricians developed farm retreats to escape the city heat, diversify family holdings, and develop food-producing economies.[1]

Villa Emo is the collaboration of its founding owner Leonardo Emo, architect Andrea Palladio, and fresco painter Giovanni Battista Zelotti. Leonardo's scheme united a diverse community of nobles, landowners, farmers, peasants, craftsmen, and artists about a single site. To support Leonardo's social vision, Palladio

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[1] According to recent scholarship, the patron who commissioned Palladio to build Villa Emo was Leonardo Emo, who died in 1586. He was the grandson of the Leonardo Emo who owned and made improvements to the land in Fanzolo, likely had plans to build on it, and who died in 1539. The date of Villa Emo is uncertain, but is believed to have been built c.1558 (Beltramini 2008: 11; communication with Caroline Emo: October, 2001; May, 2012).

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connected luxurious family quarters to practical farm buildings, then situated the villa complex to face nearby peasant dwellings of the villa's borgo, or hamlet.

Natural Harmony

At Villa Emo, Palladio blended Vitruvian rules of measure with local customs by combining the grace and elegance of classical mathematical proportions with sustainable methods of farm planning and landscape siting. The long arcaded wings flanking the central block derive from vernacular farm dwellings, or *barchesse*, and, prior to modern-day renovations, were fitted with granaries on the first floor, storage rooms on the ground floor, and dovecotes on the outer ends. The villa is situated to promote energy and health and utilizes sun and wind for heating and drying. The entire complex faces approximately 10° east of south, receiving direct solar gain earlier in the winter day. The orientation aligns with the ancient Via Postumia and a landscaped grid of cultivated fields, dating to late Roman times, and with an owner-improved canal and irrigation system introduced prior to Leonardo's occupancy. At one time, water drawn from the Brentella, an artificial canal diverted from the Piave River, serviced the villa's fields on an 11-day cycle and powered mills for grinding corn.[2]

Villa Emo is sited with respect to the cardinal points. Taking into account the 10° solar adjustment, a hill of the distant Asolo range to the rear and an open avenue of poplars planted in front mark north and south, respectively. The spacious colonnades project into the countryside and express east and west. The axes converge at the central block, where lofty rooms on the main floor (*piano nobile*) are decorated with frescoes by Zelotti that depict mythological subjects and scenes of agrarian life. An open corridor extends through the portico and central hall (*sala*), lightening the overall mass and producing an interior to exterior flow.

Palladio's methods for harmonizing buildings with their physical surroundings borrow from rural traditions and local farm customs. The villa's south-facing ramped entry in front may have served as a threshing floor, where grain could be spread in the sun to air and dry.[3] Palladio adopted a number of classical rules for building, originally recorded in *De architectura libri decem* (*Ten Books on Architecture*), the master treatise of ancient Roman author and architect Marcus Vitruvius Pollio. Vitruvius is well known for applying mathematical proportions to a building's measures, but was equally adept at achieving harmony in more pragmatic and natural ways.

[2] Water rights were awarded by 1536 to the senior Leonardo who made improvements to the land (Beltramini 2008: 11; communication with Leonardo Marco Emo Capodilista: December, 1993; Cook (n.d.): 4; Favero 1972: 13–14).

[3] The date of the ramp and its attribution to Palladio are questioned, but its presumed function as a threshing area is in keeping with the owner's agricultural vision. Structural components underneath suggest it is contemporary with the original project (Fondazione Villa Emo Onlus).

Vitruvius recommends running water and moving air for cooling and purification, and orienting different room types to specific light exposures. Winter dining rooms and baths ought to face southwest to receive the early evening light and warmth of the winter's setting sun. An eastern orientation permits bedrooms to receive morning light, prevents the contents of libraries from discoloring and decay, and moderates the temperature of spring and autumn dining rooms as the sun travels westward through the day. Meanwhile, summer dining rooms, studios, and picture galleries face north to avoid the summer heat and take advantage of indirect light protection (Vitruvius 1960: 180–181; Vitruvius 1999: 80, 260).

Inspired by Vitruvius, Palladio promoted similar rules in his own architectural masterwork *I quattro libri dell'architettura* (*The Four Books on Architecture*). The owner's house should connect to farm buildings by long colonnades that provide undercover passage, shade, and fuel wood protection. Haylofts should open to the south or west to prevent fire and fermentation. Wine cellars exposed to indirect eastern or northern light prevent the wine from weakening. Storerooms and granaries should be elevated, well vented, and face north to stay wind cooled and dry. Threshing floors should be spacious and face south for full sun exposure (Palladio 1997: 123). At Villa Emo, storerooms along the *barchesse* open to the south, but the loggias are sufficiently wide to accommodate wind cooling and shade protection.

Harmony in Number

In addition to these vernacular methods for integrating built forms and the natural landscape, harmony appears mathematically in the villa's dimensions. In fact, there are two distinct versions of Villa Emo—the plan that Palladio published in *I quattro libri* and the villa he actually built and that survives today. The discrepancy between the two was known as early as the 1770s when Ottavio Bertotti Scamozzi published *Le fabbriche e i disegni di Andrea Palladio* and attempted to reconcile the built and published versions of Palladio's works (Bertotti Scamozzi 1976: 75–76).

Palladio's published plan of Villa Emo is measured in Vicentine feet, or *piedi*, and describes a central block that consists of a 27×27 central hall, or *sala*, and additional rooms of 12×16, 12×27, 16×16, and 16×27 framing the hall and portico (16×27) (Fig. 55.1).

Various chambers in the wings measure 12, 24, and 48 *piedi* across. Rudolf Wittkower, interpreting Italian humanist and architect Leon Battista Alberti, and classical scholar Francis M. Cornford, commenting on Plato's *Timaeus*, have identified these measures in a mathematical system of harmony that is consistent with the whole number ratios of musical consonance. The numbers of music emerge when harmonic and arithmetic means are applied to the geometric sequences 1, 2, 4, 8 and 1, 3, 9, 27 that comprise the Platonic *lambda*.[4]

[4] The numbers in each series are multiplied by the number six (Plato 1948: 66–72; Wittkower 1971: 110–111).

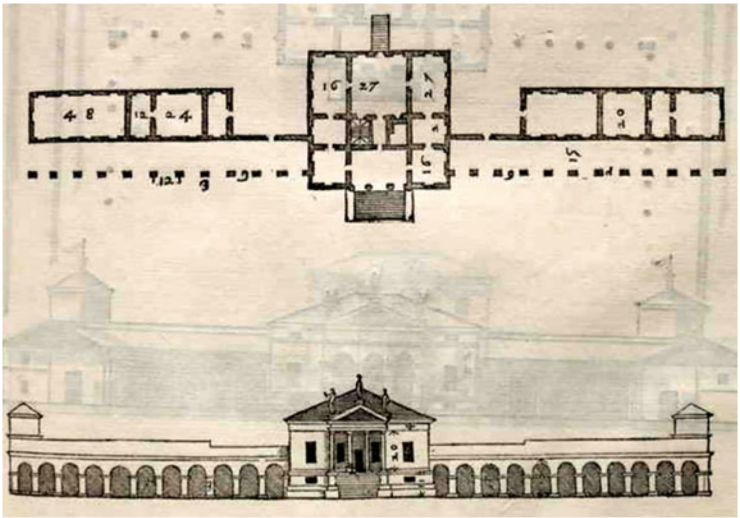

Fig. 55.1 Plan and façade elevation of Palladio's Villa Emo by Andrea Palladio, 1570. Image: Palladio (1570: II, xiiii, 55)

Alberti, whose *De re aedificatoria* (*On the Art of Building in Ten Books*) was the first architectural treatise of the Renaissance, revived the ancient theories of Vitruvius, Plato, and the Pythagoreans, and translated these numbers of musical consonance into spatial ratios and proportions: "The very same numbers that cause sounds to have that *concinnitas*, pleasing to the ears, can also fill the eyes and mind with wondrous delight" (Alberti 1988: 305). Thus evolved architectural rules for orchestrating a building's individual measures and harmonizing the parts with the whole.

At Villa Emo, Wittkower explains that the chambers in ratio 16:27 would be viewed as a compound ratio generated from 16:24:27 and comprised of 16:24 and 24:27. In music, this translates to a fifth (16:24 or 2:3) and a major tone (24:27 or 8:9). The 12 $\times$ 27 room would read 12:24:27, or an octave (12:24 or 1:2) and a major tone (24:27 or 8:9). Meanwhile, the measures of 12, 24, and 48 in the wings express two musical octaves.[5] Lionel March observes still more connections to the *lambda*, and to the Pythagorean 3:4:5 right triangle (March 2001: 96–100).[6]

[5] As Wittkower puts it, the measures would read (24:12:48) or (2:1:4), with 1:4 expressing two octaves (Wittkower 1971: 131).

[6] March's article was written as part of a debate with (Fletcher 2001).

Symmetry and Proportion

The appearance of musical ratios in the measures of Villa Emo reflects the Renaissance quest for order in structure and harmony in measure. From classical times, a quadrivium of mathematical arts codified theoretical mathematics into four distinct studies and provided a basis for order and harmony in numeric terms. One reference to the quadrivium appears in Plato's *Republic*. Besides music, or harmonics, which addresses the laws of audible motion; arithmetic is the theory of pure number; geometry, both plane and solid, conveys the eternal nature of mathematical objects; and astronomy codifies the pure laws of bodies in motion (Plato 1945: 235–250). This fourfold curriculum had far-reaching implications in the classical world and was a cornerstone of Plato's view of creation and doctrine of unity, which he defined as harmonized diversity.

ΑΓΕΩΜΕΤΡΗΤΟΣ ΜΗΔΕΙΣ ΕΙΣΙΤΩ

Inscribed at a later time over the door of Plato's Academy, the school founded by the Greek philosopher in Athens, this phrase from Euclid translates to: "Let no one ignorant of geometry enter." To Plato, mathematical symmetry demonstrated that the universe is alive and endowed with intelligence, purpose, and order, with number essential to its creation and geometric proportion a means of unifying its endless variety. The *Timaeus* (32d) presents a universe "in the fullest measure a living being whole and complete, of complete parts" (Plato 1948: 52). Thus, it is called *kosmos*, the Greek word for "order," "good order" and "form." Before Plato, Pythagoras proclaimed that, "All things accord in number" (Iamblichus 1986: 87).

To most people, "symmetry" is the division of space into identical fragments, as in the bilateral organization of elements in anatomy, or the axial arrangement of crystals where the whole is divided into identical parts and uniformly distributed around a point, line, or plane. But "symmetry" can be synonymous with the quality of harmony that relates unique and individual differences. The Greek for "symmetry" is *symmetria*, which means "suitable relation" and "due proportion." In physiology, it refers to the harmonious working of the bodily functions, producing a healthy temperament or condition. In this context, "symmetry" is synonymous with "proportion," which means "the harmonious relation of parts to each other or to the whole."

Incommensurable Proportions

In addition to the whole number ratios of musical harmony, the *Timaeus* introduces a set of incommensurable ratios that characterize geometry's elementary shapes and achieve proportion in yet another way. Here, Plato's Demiurge, a divine creator and craftsman, organizes the elemental world by endowing fire, air, water, and earth with certain mathematical properties of regular solid bodies. Specifically, the planar faces of different volumes divide into constituent triangles. Two 30°–60°–90° triangles comprise each equilateral triangular face of the tetrahedron, octahedron, and icosahedron, which Plato associates with fire, air, and water, respectively. Two 45°–45°–90° triangles comprise each square face of the hexahedron or cube, which Plato assigns to earth (Plato 1948: 210–218).[7] Briefly mentioned is a fifth construction used "for the whole, making a pattern of animal figures thereon." It is assumed Plato means the dodecahedron, whose 12 pentagonal faces represent the signs of the zodiac and are comprised of 36°–72°–72° isosceles triangles (Euclid 1956: II, 98–99; Plato 1948: 218–219).

The specific connection between these geometric shapes and elementary material particles is not made clear. As Cornford explains, Plato's cosmology is not an exact account of the physical laws of modern science, but rather a poetic statement about the imposition of exact mathematical principles on the sensible world to bring order out of chaos and produce "an intelligent and intelligible design" "made after the likeness of an eternal original" as near as possible (Plato 1948: 30–33, 36, 39).

Together, the tetrahedron, octahedron, icosahedron, cube, and dodecahedron constitute the regular or "Platonic" solids.[8] By describing their constituent triangles, Plato introduces a set of incommensurable ratios that cannot be expressed in whole numbers, but that inhabit the elementary shapes of geometry precisely. The half-side and altitude of any equilateral triangle (or the two sides of a 30°–60°–90° triangle) are in ratio 1:1.7320. . . or 1:√3. The side and diagonal of any square (or the side and hypotenuse of a 45°–45°–90° triangle) are in ratio 1:1.4142. . . or 1:√2. And the side and diagonal of any regular pentagon (or the short and long sides of a 36°–72°–72° triangle) are in ratio 1:1.6180. . . or (1:√5/2 + 1/2). This ratio is commonly known as the "golden mean," "golden section," or "extreme and mean" ratio, and is written $1 : \phi$ (Fig. 55.2).

The incommensurable ratios that characterize these regular geometric shapes have the potential to divide space proportionally, as they replicate through endless divisions and relate one level of subdivision to the next. Twentieth-century artist and scholar Jay Hambidge calls this method of spatial composition "dynamic symmetry," which he observes in the way that root rectangles divide into reciprocals, or smaller rectangles of the same proportion (Hambidge 1967). A 1:√2 rectangle divides continuously into two reciprocals in root-two ratio. The area of each reciprocal is one-half the area of the whole (Fig. 55.3).

[7] Each triangular face divides further into six constituent 30°–60°–90° triangles and each square face divides into four 45°–45°–90° triangles. Thus, the four triangular faces of the tetrahedron contain 24 right triangles. The eight triangular faces of the octahedron contain 48 right triangles. And the 24 triangular faces of the icosahedron contain 120 right triangles. The six square faces of the cube contain 24 right triangles. In this way, Plato is able to pose mathematical formulas that describe how elements transform into one another.

[8] Each regular solid is a convex polyhedron in which: all faces are the same; all faces are regular polygons (squares, triangles, or pentagons); the same number of edges meet at each vertex; and all vertices touch the surface of a circumscribing sphere.

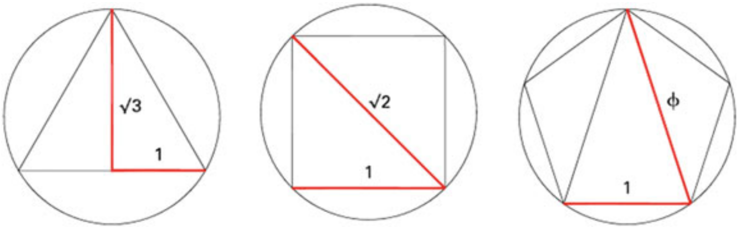

Fig. 55.2 Incommensurable ratios in basic geometric shapes

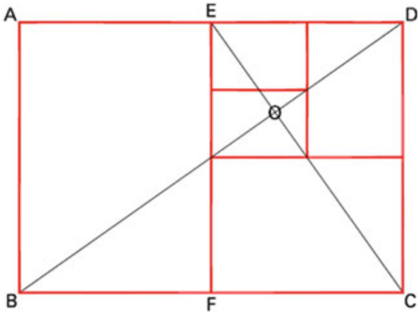

Fig. 55.3 Root-two rectangle and reciprocals

A 1:√3 rectangle divides continuously into three reciprocals in root-three ratio. The area of each reciprocal is one-third the area of the whole (Fig. 55.4).

The rectangle in ratio 1:1 : ϕ is called a whirling square rectangle because it divides continuously into a reciprocal and a square (Fig. 55.5). Harmony is sustained each time the governing incommensurable ratio repeats at a new spatial level.

The Golden Section

The golden mean, or golden section, provides a remarkably efficient way to achieve unity among a diversity of elements, for it increases simultaneously by geometric progression and simple addition. This unique characteristic may account for its appearance in natural form and human anatomy.

The ratio is identified by the Greek letter *phi* ($\phi = \frac{\sqrt{5}+1}{2}$ or 1.618034...), after the Greek sculptor Phidias. It is found when a line divides into two unequal lengths such that the shorter length relates to the longer in the same way as the longer length relates to the whole. If the whole equals 1, the proportion translates to $\frac{1}{\phi^2} : \frac{1}{\phi} :: \frac{1}{\phi}$

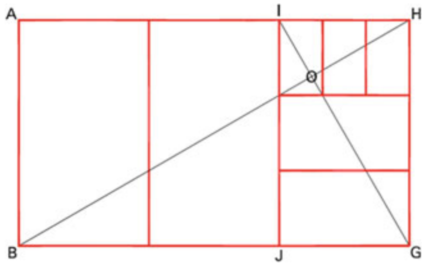

Fig. 55.4 Root-three rectangle and reciprocals

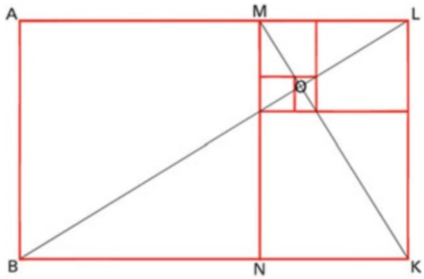

Fig. 55.5 Rectangle of whirling squares

: $\left(\frac{1}{\phi^2}+\frac{1}{\phi}\right)$ or 1. The reciprocal of *phi* ($\frac{1}{\phi}$) equals ($\sqrt{5}/2 - 1/2$) or 0.6180…. The ϕ number sequence increases by geometric proportion ($\frac{1}{\phi} : 1 :: 1 : \phi$) and by simple addition ($\frac{1}{\phi} + 1 = \phi$), since each new term is the sum of the previous two.

$\frac{1}{\phi^3}$	$\frac{1}{\phi^2}$	$\frac{1}{\phi}$	1	ϕ	ϕ^2	ϕ^3…
0.236…	0.382…	0.618…	1.0	1.618…	2.618…	4.236…

Although some do not agree, the extreme and mean proportion frequently appears in nature, from sunflowers, apple blossoms, and daisies in the plant world to spiral shells beneath the seas. Allowing for individual differences, the proportions of the human body demonstrate golden mean geometry. Fingers divide at the joints in golden mean progression. The face generally conforms to a golden mean rectangle. The tradition of rendering the human body divided at the navel in golden ratio dates to ancient Egyptian times and continued in the twentieth century with Le Corbusier's Modulor.[9]

The spiral-like triton shell approaches golden mean proportions, when viewed in cross section. Its central pillar or stem divides continuously in golden ratio, similar to the way that human fingers divide at the joints (Fig. 55.6a, b). Each curved whorl

[9] A condition of the Egyptian system is that a small portion of the crown is subtracted from the total height (Le Corbusier 1980: I: 50–51; Schwaller de Lubicz 1998: 325).

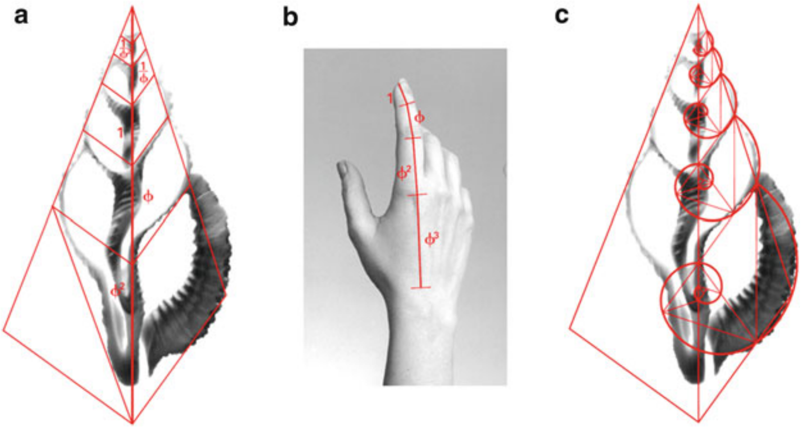

Fig. 55.6 (**a**, *left*) The central pillar of a triton shell divides in golden ratio; (**b**, *centre*) human fingers divide at the joints in golden progression. Photo: George Leisey for Brattleboro Museum & Art Center, Brattleboro, VT; (**c**, *right*) the curved whorls of the shell approximate a portion of the same spiral-like figure

of the triton approximates a portion of the same golden mean spiral-like figure (Fig. 55.6c).[10]

As a mathematical principle, the extreme and mean ratio appears as early as Euclid, if not before (Heath 1981: I, 168). But the origin and history of its use in art and architecture are rigorously debated. Opponents are careful to distinguish *phi* as a mathematical principle from its design application. Marcus Frings argues that the golden ratio does not appear in the canon of proportion attributed to Vitruvius and, therefore, architects and artists of the Renaissance who rediscovered Vitruvian principles are unlikely to have adopted it (Frings 2002: 9–20).

Golden Proportions at Villa Emo

And yet, golden mean proportions appear in the constructed Villa Emo. In 1967, architects Mario Zocconi and Andrzej Pereswet-Soltan completed a definitive survey for the Centro Internazionale di Studi di Architettura Andrea Palladio (C.I. S.A.). The plan and elevation from that survey (Figs. 55.7 and 55.8) provided the

[10] In a true logarithmic or equiangular spiral, a radius vector "makes a constant angle with the tangent to the spiral." For a given angle of rotation, the distance from the pole is multiplied or divided by a specific amount. Each point on the spiral develops from the same center or pole, and the radius vector changes constantly (Sharp 2002: 59–62). The spiral in Fig. 55.6c resembles a logarithmic spiral in ϕ ratio, but its individual arcs develop from different points and the radius vector remains constant until a new arc is taken.

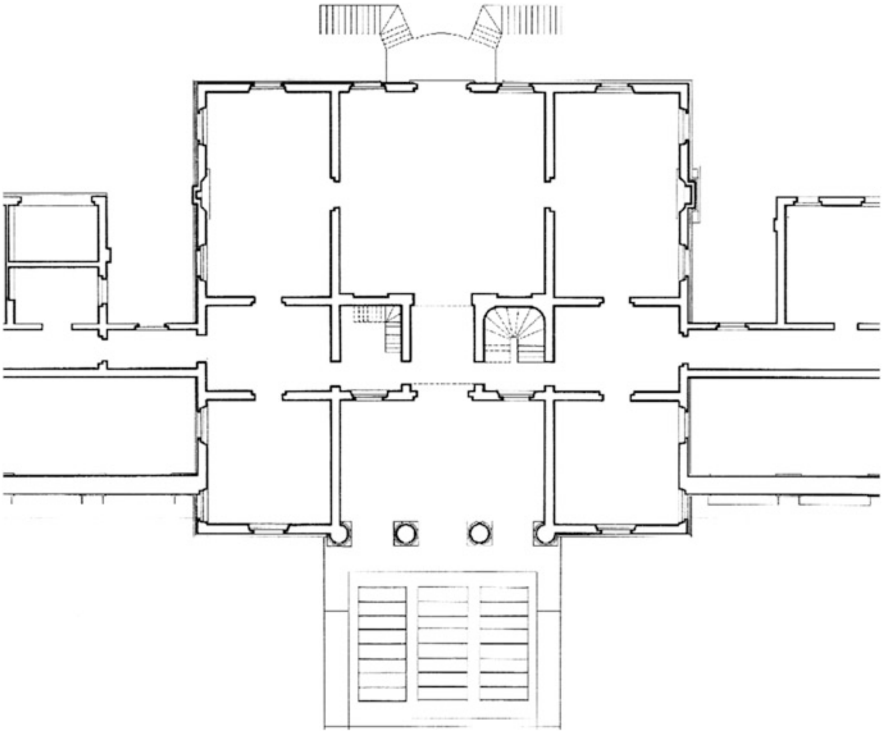

Fig 55.7 First-floor plan of Palladio's Villa Emo, Fanzolo. Survey drawing by Mario Zocconi and Andrzej Pereswet-Soltan (1977: Pl. III). Reproduced by permission

basis for the geometric analysis that follows. The discrepancy between the built plan and Palladio's published version is subtle, but sufficient to allow for a different proportional system (Favero 1972: 31–32). In the built version, the golden ratio prevails throughout the elevation and plan, appearing repeatedly in the building's measures, from the overall proportions of the central block to the placement of individual doors and fireplaces.

The plan of the central block is not perfectly square, but proportioned to a circle inscribed by two smaller squares (Fig. 55.9). Room dimensions on the first floor are in golden mean ratio. The system of dividing a golden rectangle into a square and reciprocal golden rectangle is evident (Fig. 55.10). The central passage is in golden proportion (Fig. 55.11). The placement of doors and fireplaces derives from a regular pentagon whose base is drawn on the front edge of the portico (Fig. 55.12). Approximate golden mean spirals flow through the scheme (Fig. 55.13).

Fig 55.8 Façade elevation of Palladio's Villa Emo, Fanzolo. Survey drawing by Mario Zocconi and Andrzej Pereswet-Soltan (1977: Pl. VI). Reproduced by permission

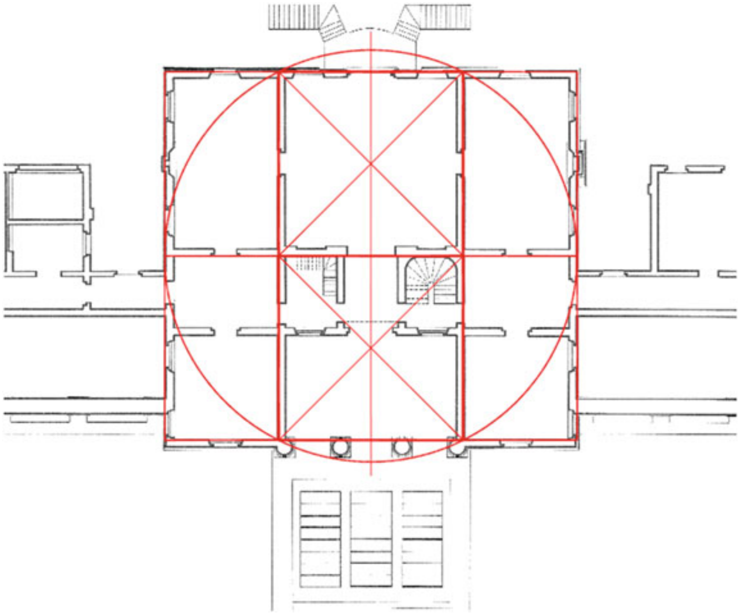

Fig 55.9 The plan of the central block is not perfectly square, but proportioned to a circle inscribed by two smaller squares. Overlay: author

On the front façade of Villa Emo, double squares delineate the flanking walls. The diagonals of the double squares locate the endpoints of the hip of the roof, in golden mean proportion (Fig. 55.14). Proportions derived from other geometric shapes are present. A rectangle proportioned to the half-side and altitude of an equilateral triangle, in ratio 1:√3, defines the height and width of the upper two

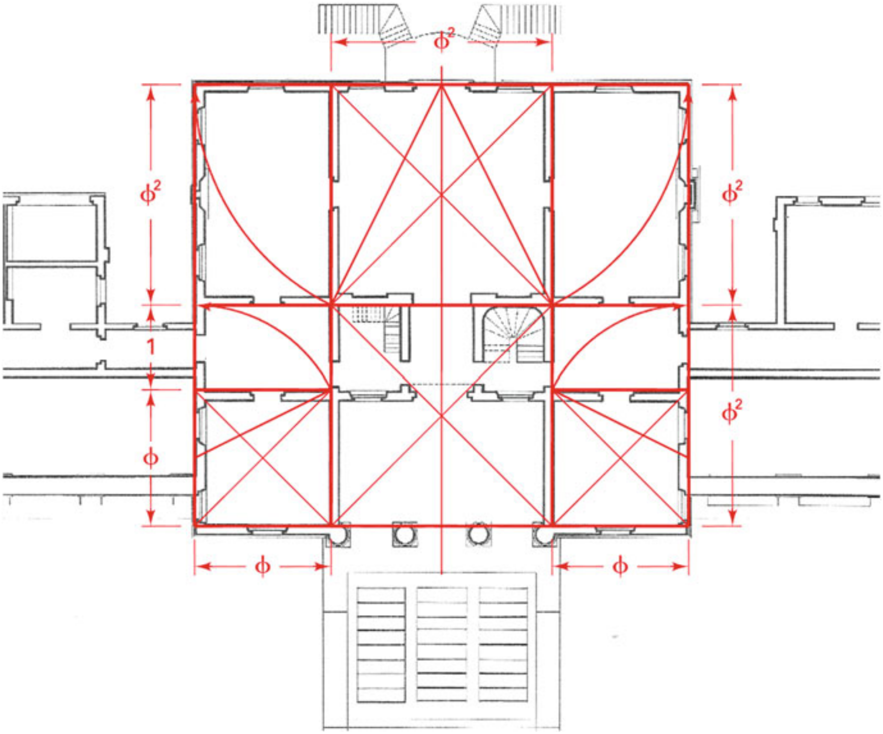

Fig 55.10 Room dimensions are in golden mean ratio. The system of dividing a golden rectangle into a square and reciprocal is evident. Overlay: author

stories (Fig. 55.15). But golden mean proportions dominate the façade overall (Fig. 55.16).

Total Harmony

Palladio's design reflects an integrated system of proportion in which a simple geometric theme binds plan and elevation, interior and exterior, and whole and part to achieve dynamic unity in three dimensions. Harmony is preserved at Villa Emo not merely in the style and proportions of the architect's classical building, but in numerous aspects of villa life. The villa sustained a nurturing agricultural relationship with the land for more than four and a half centuries.

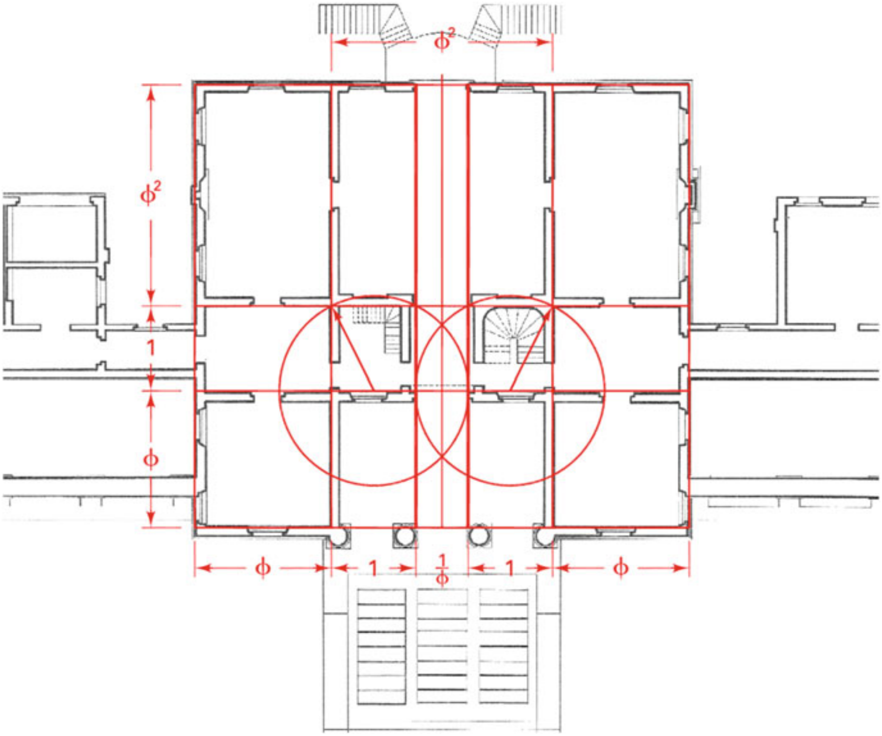

Fig 55.11 The central passage is in golden proportion. Overlay: author

In *I Quattro libri*, Palladio recommends that houses and temples be built "with such proportions that together all the parts convey to the eyes of onlookers a sweet harmony..." (Palladio 1997: 213). Villa Emo achieves beauty and integrity not merely in the mathematical design of spatial elements, but in the blending of mathematical proportions with organic methods of land-use planning and siting. Ultimately, Palladio's vision of harmony evokes the heavens as a pattern for architecture. As celestial revolutions produce the seasons, each in its proper place and all in agreement, architecture should orchestrate the elements of building, landscape, and the human community so that beauty will arise from "the relationship of the whole to the parts, and of the parts among themselves and to the whole" (Palladio 1997: 7, 213). To this Villa Emo aspires in each particular.

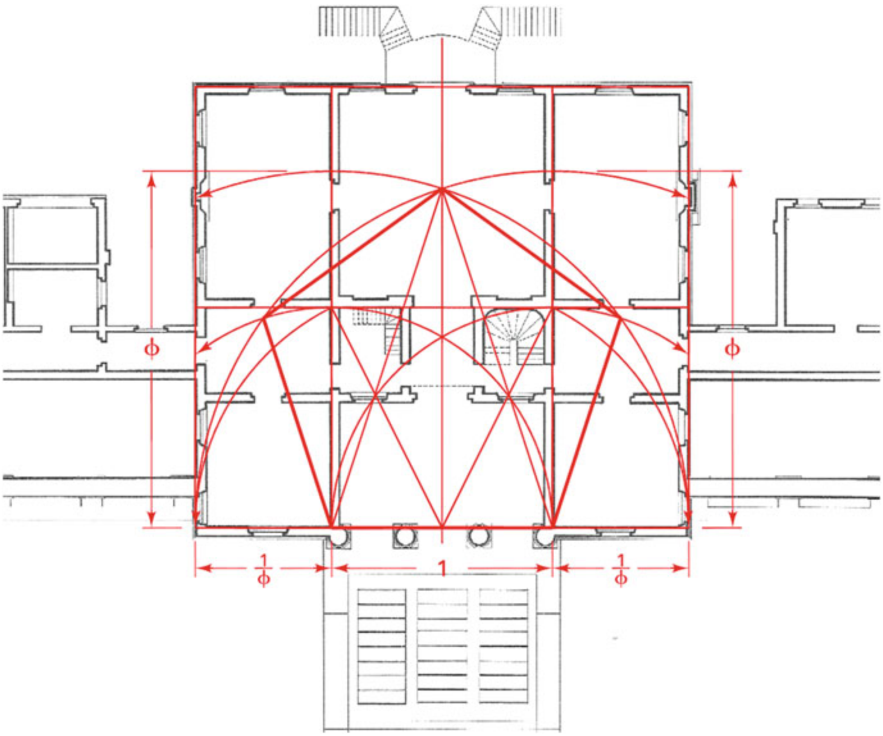

Fig 55.12 The placement of doors and fireplaces derives from a regular pentagon whose base is drawn on the front edge of the portico. Overlay: author

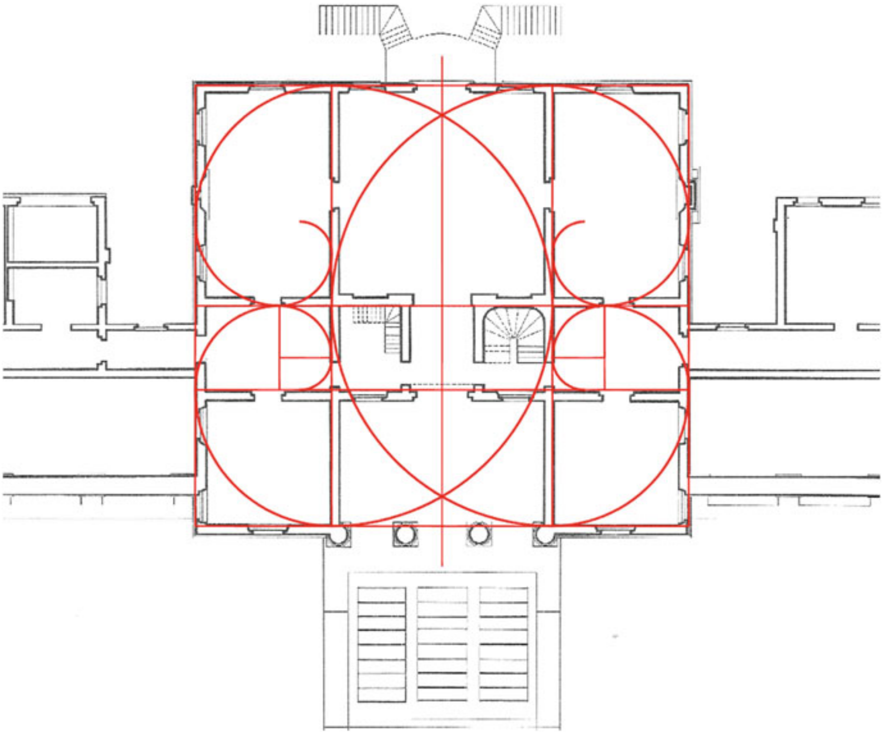

Fig 55.13 Approximate golden mean spirals flow through the scheme. Overlay: author

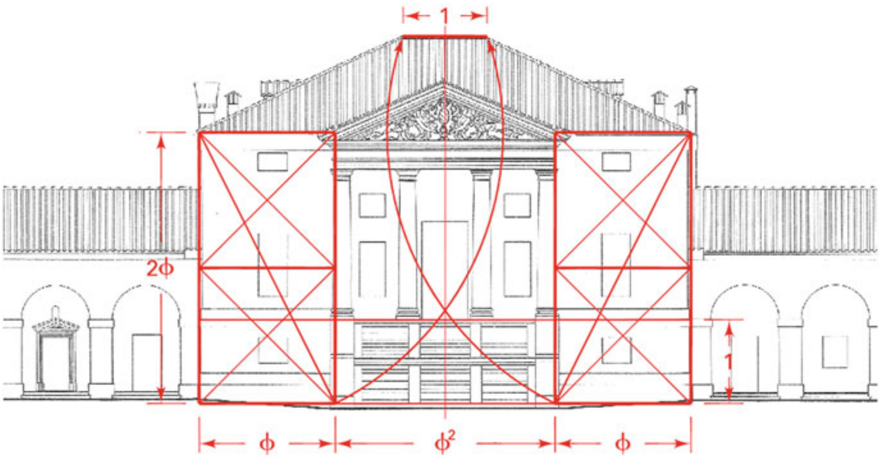

Fig. 55.14 Double squares delineate the flanking walls. Their diagonals locate the endpoints of the hip of the roof, in golden proportion. Overlay: author

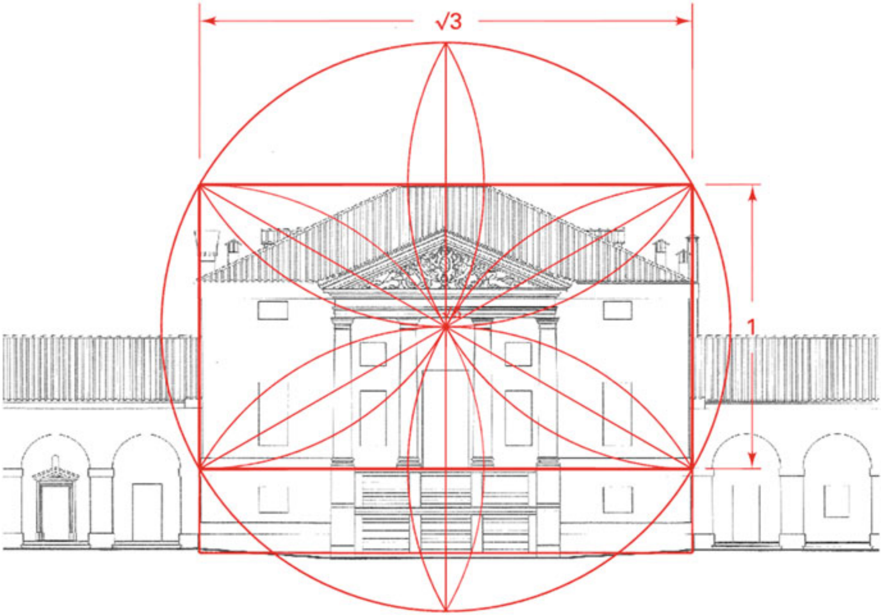

Fig. 55.15 A rectangle proportioned to the half-side and altitude of an equilateral triangle locates the upper two stories. Overlay: author

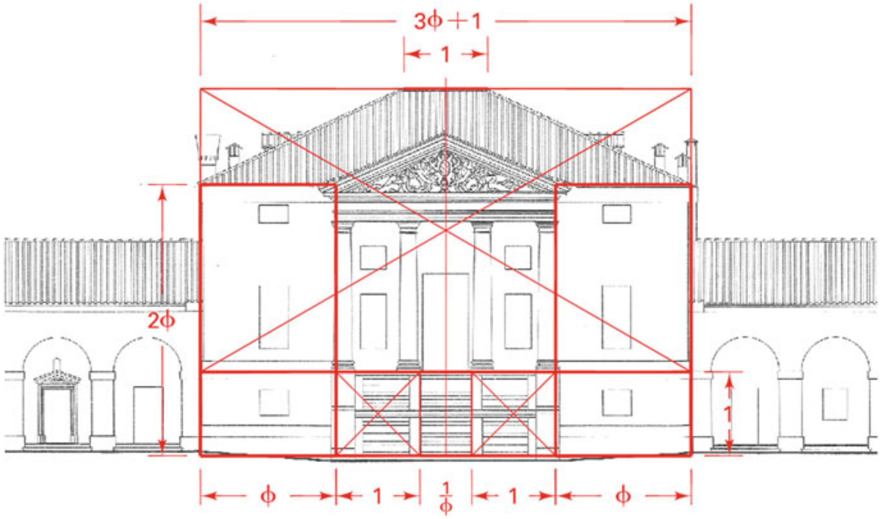

Fig. 55.16 Golden mean proportions dominate the façade. Overlay: author

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Biography Rachel Fletcher is a geometer and teacher of geometry and proportion to design practitioners. With degrees from Hofstra University, SUNY Albany and Humboldt State University, she is the author of *Infinite Measure: Learning to Design in Geometric Harmony with Art, Architecture, and Nature* (GFT Publishing, 2013). She was the creator/curator of the museum exhibits "Infinite Measure," "Design by Nature" and "Harmony by Design: The Golden Mean." She is founding director of the Housatonic River Walk in Great Barrington, Massachusetts, and founding co-director of the Upper Housatonic Valley African American Heritage Trail. She has been a faculty member of the New York School of Interior Design since 1996 and a contributing editor to the *Nexus Network Journal* since 2005. She resides in Great Barrington, Massachusetts, and her website is http://www.rachelfletcher.org.

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