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The operational concepts in the Vitruvian system of design

Leandro Manenti [i]
https://orcid.org/0000-0002-8604-8499
leandro.manenti@ufrgs.br

[i] Universidade Federal do Rio Grande do Sul – Porto Alegre – RS – Brasil

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Abstract: The study aims to contribute to understand the Vitruvian design system through the analysis of the temples described in the text leading to the three key concepts related: *proportio*, *commensus* and *commodulatio*. At first, it is proposed a conceptual discussion about the origin of the compositional elements, and further it is discussed the concept of *proportio* as an operation of sizing and scaling these elements individually. Analyzed the definition and

types of elements, it is proposed to continue the discussion on the relationship that must be built as a way of associating elements in a consistent way, leading to the notion of *symmetria*, understood as an ideal state in which the elements maintain dimensional and/or geometrical relationships between them, creating a relational harmony. From the operational point of view, it is sought to demonstrate that the Vitruvian *symmetria* is fetched from two types of relations: a modular (*commodulatio*) and a dimensional (*commensus*).

Keywords: design theory, Vitruvius, proportional systems.

Introduction

The proposed study about the treatise *De architectura* aims contribute to the clarification of the Vitruvian theoretical concepts presented in his treatise more than two thousand years ago which even today are still open to discussion, as well as verifying the operability of the architectural system proposed by the Roman author in the 1st century B.C. To reach that, a whole mapping of the concepts developed throughout the entire Latin text [1] and its various translations [2] seeks to broaden possible understanding of the text, which is then considered through examples described in the treatise as a way of verifying the consistency of the theory in design practice.

This essay aims to concentrate specifically on understanding the notions of the elements of composition [3] crucial to the Vitruvian

[1] The concept mapping conducted on the text of the *De architectura* finds a parallel with the study developed by Callebat & Fleury, 1995.

[2] The study of translations considers the following versions for three languages: French (Gros, 1990a; 1990b; 1992; 1999; 2004; 2009), Italian (Gros, 1997) and English (Rowland & Rowe, 1999).

[3] Alan Colquhoun proposes a definition for the term composition witch is widely accepted today and synthesizes the meaning taken on this interpretation. For the author, “the composition, in its modern sense, can have a fairly recent origin, but

formal system in particular and to classicism in general. It also seeks to understand the operational mechanisms for measuring and relating the parts, which are understood to be represented by the procedures of *proportio*, *commensus* and *commodulatio*. At the same time the research also allows questioning of some of the traditional understanding of architectural terms, such as Vitruvius's view of the notion of *proportio* which we believe to be different from the one established in Renaissance.

The Vitruvian Theory of Design

The formal Vitruvian system described in Book 1 is based on the idea of composition based on elements, and we can group the terms of the theory into two main groups: the principles, which determine the quintessential conditions of architectural excellence; and the procedures, which help the architect to control the project in pursuit of excellence. From this study one can understand that the three main principles of excellence can be synthesized into integrity of elements, which is related to the concept of *eurythmia*; harmony of the whole, which is related to the concept of *symmetria*; and the pertinence of the elements according to social conventions, related to the notion of *decor*.

The architect's task of composing the design needs to consider these assumptions of quality, and Vitruvius recommends guideline procedures for the architect's work. Study of the text allows identification of four main design procedures: geometrization of the proposal (*ordinatio*), which can be through adoption or adaptation of recurrent geometric schemas or even through creation of new schemas for special circumstances; the adoption of a modular system of measurement for the project, which is based on physical measurements such as the site and establishes an interval of reference (*modulus*) that will govern the measurements of the parts (*quantitas*);

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the set of ideas to which it owes its origin has roots in antiquity. It concerns the concept of arranging the parts of the architecture as elements of a syntax, and according to some a priori rules to form a whole" (Colquhoun, 2004, p. 57).

the design drawing (*dispositio*), which relates to the visible act of designing through the use of plans, elevations and perspective views;[4] and a set of other procedures that can be grouped under the notion of adjustments and which involve subtraction (*detractio*) or addition (*adiectio*) of parts, for example the curvature of the base (*scamilli impares*) or the bowing of a column (*entasis*), helping to control the perception of integrity of the elements.

This specific study is concerned with analyzing the adaptation of generic traditional elements to the particular building, which leads to the criterion of integrity, together with the construction of a relationship between them aimed at forming a coherent whole, which leads to the notion of harmony. To this end, two types of analysis are proposed: conceptual, seeking theoretical definitions of terms in the text; and also based on analysis of projects, taking the descriptions contained in the treatise as case studies.

The elements of composition

When dealing with the first of his six fundamental concepts of architecture, *ordinatio*, Vitruvius clearly considers architecture to be something based on parts, or elements (*membrus*). According to his definition,[5] these elements are adapted to each project according to the operation of *quantitas. Quantitas* is defined as the adoption of modules for measuring the elements, and these modules are based on the actual elements of the design. The definition states that if a project is designed based on elements that in isolation have a pre-established shape, the procedure of *quantitas* would then be the adaptation of this

[4] Concerning this theme Alfonso Corona Martinez defines design as the “invention of an object through another”, and clarifies that in the design process the invention of the architectural object occurs at the same time it is represented. The designer, says Martinez, "draws a non-existent object” (Corona Martinez, 2000, p. 12).

[5] “Ordering is the proportion to scale of the work’s individual components taken separately, as well as their correspondence to an overall proportional scheme of symmetry. It is achieved through quantity, which in Greek is called *posotês*. Quantity, in turn, is the establishment of modules taken from the elements of the work itself and the agreeable execution of the work as a whole on the basis of the elements’ individual parts” (Vitr. *De Arch.* I. 2. 2).

initial arrangement of elements, quantifying them or measuring them according to a common modular unit. This module is established based on the dimension of one of these elements that compose the design.

The notion of elements appears in turn through the term *membrus*, which is included in the definitions of *ordinatio*, *eurythmia*, *symmetria*, and in other parts of the text, but without precise definition, although Book III allows understanding of the *membrus* of the human body, for example, to be the palm, head, foot, forearm and chest,[6] just as the elements of architecture are forms of

[6] "The **composition** of a temple is based on **symmetry**, whose principles architects should take the greatest care to master. Symmetry derives form **proportion**, which is called *analogia* in Greek. **Proportion** is the **mutual calibration** of each **element** of the work and of the whole, from which the **proportional system** is achieved. No temple can have any **compositional system** without **symmetry** and **proportion**, unless, as it were, it has as exact system of correspondence to the likeness of a well-formed human being. For Nature **composed** the human body in such a way that the face, from the chin to the top of the forehead and the lowermost roots of the hairline should be one-tenth (of the total height of the body); the palm of the hand from the wrist to the tip of the middle finger should measure likewise; the head from the chin to the crown, one-eighth; from the top of the chest to the hairline including the base of the neck, one-sixth; from the center of the chest to the crown of the head, one-fourth. Of the height of the face itself, one-third goes from the base of the chin to the lowermost part of the nostrils, another third from the base of the nostrils to a point between the eyebrows, and from that point to the hairline, the forehead also measures one-third. The foot should be one-sixth the height, the cubit, one-fourth, the chest also one-fourth. The other **limbs**, as well, have their own **commensurate proportions**, which the famous ancient painters and sculptors employed to attain great and unending praise. Similarly, indeed, the **elements** of holy temples should have **dimensions** for each individual part **that agree** with the full magnitude of the work. So, too, for example, the center and midpoint of the human body is, naturally, the navel. For if a person is imagined lying back with outstretched arms and feet within a circle whose center is at the navel, the fingers and toes will trace the circumference of this circle as they move about. But to whatever extent a circular scheme may be present in the body, a square design may also be discerned there. For if we measure from the soles of the feet to the crown of the head, and this measurement is compared with that of the outstretched hands, one discovers that this breadth equals the height, just as in areas which have been squared off by use of the set square. And so, if Nature has **composed** the human body so that in its **proportions** the separate individual **elements** answer to the total form, then ancients seem to have reason to decide that bringing their creations to full completion likewise required a **correspondence**

the structural and decorative parts in stone that comprise the design of a temple, such as capitals, columns, architraves, friezes, tympanums, pediments and acroteria.[7]

Another important concept related to the elements, which also appears in the above definition, is that of *proportio*. Appearing in the treatise next to the term *symmetria*, it does not appear in the list of Vitruvius's six fundamental concepts, but analysis of the text confirms its crucial role in Vitruvian theory. Returning to the definition of *ordinatio*, which will be the dimensional adaption of elements taken separately and the establishment of general dimensional relations (*universeque proportionis*) with the aim of arriving at *symmetria*, we have the connection of *proportion* with a relational measurement of the parts. *Proportio* appears throughout Book III as an initial requirement for achieving *symmetria* (Vitr. *De Arch.* III. 1. 1-4), since it is concerned with establishing a relationship of co-modulation between the elements through which *symmetria* is achieved. Vitruvius introduces the famous relational description of the parts of man, for example, and concludes that just as nature made the human body with the *proportio* of its members corresponding to the whole, the ancients established that there had to be commensurability between the parts and the whole of a work of architecture.

So from this passage *proportio* is understood to be linked to the creation of relationships, and these relationships involve calculation and are therefore mathematical relationships; these mathematical relationships establish ratios that relate the dimensions of the various

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between the measure of individual **elements** and the appearance of the work as a whole. Therefore, when they handing down **proportional sequences** for every type of work, they did so especially for the sacred dwellings of the gods, as the successes and failures of those works tend to remain forever" (Vitr. *De Arch.* III. 1. 1-4).

[7] "As for drawing the volutes so that they are properly coiled with the use of a compass, and the way they are drawn, the form and the principle for these will be set down at the end of the book. Once the capitals of the columns have been completed, then they should be set, not on the level, but according to a **uniform unit** such that whatever addition was made to the stylobate repeats in the upper **elements** […]" (Vitr. *De Arch.* III. 5. 8).

elements of a project. Although the description of the dimensional relationships of the human body introduce the establishment of a module, like the palm, the foot and the cubit, Vitruvius does not use this term in the description, since it seems to lead to that idea that when these relationships between elements go beyond single relationships between two parts a modular ruling system is created, thus achieving the state of *symmetria.*

That said, a distinction can also be seen between *proportio* and *symmetria* in terms of the object they are applied to, since *proportio* would be linked to the elements in isolation, as a ratio of its dimensions, and *symmetria* would be linked to the whole, or in other words when the dimensional proportions of each element connect and form a general system. For example, the *proportio* of a Doric column is 1/6, but it will have a *symmetria* with the other elements when the 1 of the base is equal to the 1 of a metope, which in turn will have a *proportio* of 1/1. Thus the dimension of elements considered in terms of *proportio* is not restricted to absolute values but to relational values, making the Vitruvian design proposal viable, since if we understand a design as a composition of elements that have to be adjusted (*quantitas*), the use of elements with absolute dimensions would be unviable.

However, these elements have their own identity which has to be maintained even when they are adapted to form part of the whole. This integrity of content corresponds to the notion of *eurythmia,* an aesthetic criterion associated with the recognition of forms, which can be guaranteed by the use of optical adjustments in specific situations, as described in the treatise.[8]

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[8] Edson Mahfuz defends the important role of parts or elements in the design process. Although, according to the author, most people accept as true that the whole is more important than the parts, his study supports a equality between them as well as a sense of progression, that is, the composition process in architecture is developed from the parts to the whole. Also according to the author, this understanding admits that architecture consists of a combination of the archetypal and the contingent, that is, the ideal of whole adapted by the circumstances of each part (Mahfuz, 1995, p. 82).

The relations between the elements

While a work of architecture is on the one hand composed of elements that come from tradition, a cohesive whole requires the establishment of criteria for governing the relationships between them. Vitruvius therefore constructs justifications for his decisions for the design, and also for the adoption of the principles he develops, based on analogy with nature, which allegedly provides immutable rules, demonstrated in his analysis of the human body. Vitruvius uses this analogy as the basis for the criteria to be adopted, with the necessary presence of mathematical relations between the parts, referring to the pursuit of *symmetria*, or even the presence of underlying geometric schemas, such as the insertion of the human figure into a square and a circle, which relates to the concept of *ordinatio*.

Returning specifically to the analysis of the term *symmetria* in the text, the concept is described in Book I.[9] For Vitruvius the aspect of beauty (*venustas*) will be guaranteed when each type of work has a pleasing and elegant commensurability (*commensus*) of elements (*membrus*) based on a suitably calculated system of relations (*symmetriarum ratiocinationes*).

The text shows that one way of achieving *symmetria* lies in the establishment of relations of commensurability between the elements, which is contained in the etymology of the word *symmetria* itself. On the other hand, in several places the text mentions the creation of modular relations, using the term *commodulatio*, albeit

[9] "All these works should be executed so that they exhibit the principles of soundness, utility, and attractiveness. The principle of soundness will be observed if the foundations have been laid firmly, and if, whatever the building materials may be, they have been chosen with care but not with excessive frugality. The principle of utility will be observed if the design allows faultiness, unimpeded use through the disposition of the spaces and the allocations of each type of space is properly oriented, appropriate, and comfortable. That of attractiveness will be upheld when the appearance of the work is pleasing and elegant, and the proportions of its elements have properly developed principles of symmetry" (Vitr. *De Arch.* I. 3. 2).

only once, which, as shown later in the case studies, forms another way of achieving *symmetria*, different from commensurability, yet it is treated as if it were the same by many translators. The former is established through the relationship of shared measurements between one element and its neighbor, while the latter is established through the relationship of shared modules, which links all the elements based on a common interval, assisting in the actual commensurability between neighboring elements and in the general control of the whole.

For Vitruvius the action of designing includes both determination of the scale of the elements and the creation of relationships between them, thus establishing a system of *symmetria*. However, this action would become quite complex without the adoption of a regulatory pattern taken from one of the elements, which becomes a kind of minimal multiple common to all the dimensional ratios involved, and Vitruvius calls this pattern *modulus*.

Vitruvius addresses the notion of integrity when dealing with the elements, but when it comes to the relationships between them he proposes the notion of harmony. This harmony based on relations and represented by the concept of *symmetria* aims to provide the observer with a perception of order, which is achieved in two ways. Firstly through recognition of a beauty of the whole which emanates from the building through the mathematical relationships that connect the elements. Secondly through recognition of authorship, that is to say, in the perception that there has been an organizing intention of an author, who has arranged the elements according to recognizable criteria.[10]

[10] Ernst Gombrich refers to the ordered patterns created by man and says that regularity is an authorial intention signal which does not exist in nature, since the repeatable character of certain solutions is a clear sign of cultural product (Gombrich, 1979, p. 7). Helio Piñón also refers to this theme saying, repeatedly on his text, that the ordination role that the architect has on the formal structure of the project. This "ordering mind" is perceived as, according to the author, the form consists of a product of the action of a subject, inexistent in nature, which

Operability of the System

Having analyzed the Vitruvian concepts underlying the principles and procedures of a design based on an overview that sought to expand possible interpretations and build suggestions for understanding the theory, this chapter seeks to analyze the design descriptions. The descriptions in books III to VI are analyzed to compare understanding of the theory with the practice of design, thus observing the viability of the proposals.

This analysis of design procedures is based on the descriptions of the construction stages and the author's recommendations for two distinct types: temples, in which the system is clear and well defined; and houses, in which the system is more open and episodic. From these descriptions the relative and absolute dimensions can be tabulated, relating them to the theoretical concepts and making their application clearer.[11]

The clear rule in the temples

The building of temples is the most detailed of Vitruvius's typologies in his treatise, with two books devoted to it. Vitruvius sequentially addresses the construction stages of various types of temples, together with general topics concerning sacred buildings and other types of constructions, such as the genres of columns. Although his approach is organized according to stages of construction, aspects of the design can also be inferred by relating the construction stages to the theoretical concepts.

The first definition of temple design concerns the type of plan to be adopted. Based on architectural tradition, yet open to new creation, the types are well defined from a combination of plans with the spacing of columns. Variation in plan arrangement occurs through

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transforms reality according to an artistic criteria resultant of an apriorism of the subject (Piñón, 2006, p. 41-42).

[11] The complete analysis of the whole Vitruvian types of buildings was developed on the author's doctoral thesis (Manenti, 2014).

the quantity of columns on the front and rear facades and their position in relation to the cell. Vitruvius also establishes five kinds of temple, which are obtained through variation in column spacing, which also determines the size of the cells.

Having established the temple types, Vitruvius moves on to definition of the module that will govern the design and form the basis for the *symmetria*. Instead of concerning himself with detailed description of the module for all temple types, he concentrates specifically on the types that he recommends. For each one Vitruvius establishes a relationship between the dimension of the module and a fraction of the front edge of the deployed site (Vitr. *De Arch.* III. 3. 7). The rest of the design, including its heights, can be defined based on this initial dimension of the module, thus completing the geometric model for the temple and at the same time establishing the basis for the relations between the elements (Table 1).

Table 1 – Module definition and overall dimensions for designing temples on Ionic and Corinthian genres (Manenti, 2014, p. 166)

		Tetrastyle		**Hexastyle**	**Octastyle**	
		Prostyle	Amphiprostyle	Peripteral	Dipteral	Pseudodipteral
Module (M)		M = Front / 11½		M = Front / 18	M = Front / 24½	
Intercolumniation	**L**	Im = 3 M				
	Side (Is)	Is = 2¼ M				
Column	**Inferior Diameter (D)**	D = M				

	Height (H)	Pycnostyle → H = 10 M Systyle / Eustyle → H = 9½ M Diastyle → H = 8½ M Araeostyle → H = 8 M

Once Vitruvius has established the temple type and the basis for arrangement of the elements, he moves on to describe the sequence of placement and measurement of the elements, together with the different genres of columns, in order of execution. Thus in the fifth chapter of Book III Vitruvius deals sequentially with the definitions of bases, shafts, capitals, architraves, friezes, cornice, tympanum, raking cornice and *acroteria* (Table 2).

Table 2 – Definition of the *proportio* and *symmetria* for the Ionic genre (Manenti, 2014, p. 171)

IONIC GENRE			
ELEMENTS		***PROPORTIO*** **L (Length) x W (Width) x H (Height)**	***SYMMETRIA***
BASE	**ATTIC**	3 x 3 x 1	L base = W base = 1½ M H base = ½ M
	IONIC	2¾ x 2¾ x 1	L base = W base = 1⅜ M H base = ½ M
SCHAFT		1 x 1 x 9 - ½ $\left(1\frac{1}{18}\mathrm{M}\right)$	D = M H shaft = H - H base - H capital
CAPITAL		1 x 1 x ½	L = W abacus = $1\frac{1}{18}$ M H capital = ½ $\left(1\frac{1}{18}\mathrm{M}\right)$

IONIC GENRE		
ELEMENTS	***PROPORTIO*** **L (Length) x W (Width) x H (Height)**	***SYMMETRIA***
EPISTYLE	variable	TETRASTYLE → L epistyle = 11½ M HEXASTYLE → L epistyle = 18 M OCTASTYLE → L epistyle = 24½ M W epistyle = d
FRIEZE		W frieze = W epistyle H frieze = ¾ H epistyle (without images) H frieze = 1 ¼ H epistyle (with images)
DENTILS		L dentils = L epistyle + H dentils H dentils = $\frac{2}{7}$H epistyle
CORNICE		L cornice = L dentils + H fascia H fascia = $\frac{2}{7}$H epistyle H sima = 1 $\frac{1}{8}$H fascia
TYMPANUM		L tympanum = L cornice H tympanum = $\frac{1}{9}$L cornice
RAKING CORNICE		H fascia = H fascia H sima = 1 $\frac{1}{8}$H fascia
ACROTERIA		H side acroteria = H tympanum H middle acroteria = 1 $\frac{1}{8}$H tympanum

Tabulation of the descriptions reveals that the predominant relationships between the elements of the Ionic genre are modular, that is, *commodulatio* relationships. The elements from the base to

the architrave are dimensioned initially by a relation to the general module of the design, and then the other dimensions are calculated by the particular *proportio* of each element. While the elements above the architrave no longer retain a direct modular relationship, since their dimensions are governed by a numerical relationship with the immediately preceding element in order of placement, to form a relationship of commensurability, or *commensus*.

The topic of column genre continues in Book IV, with the first chapter concerned with the Corinthian. For Vitruvius, this order did not yet have well defined rules and Corinthian columns therefore follow the rules of the Ionic, differing only in terms of the capital, which is not just composed of elements that are quite different in relation to the Ionic but is also taller, thus changing the overall height relationships. The operability of the system is retained through modular relationships (*commodulatio*) (Table 3).

Table 3 – Definition of the proportio and symmetria for the Corinthian genre (MANENTI, 2014, p. 174)

CORINTHIAN GENRE			
ELEMENTS		***PROPORTIO*** **L (Length) x W (Width) x H (Height)**	***SYMMETRIA***
BASE	**ATTIC**	3 x 3 x 1	L base = W base = 1½ M H base = ½ M
	IONIC	2¾ x 2¾ x 1	L base = W base = 1⅜ M H base = ½ M
SHAFT		1 x 1 x 9 - ½ $\left(1\frac{1}{18}\mathrm{M}\right)$	D = M H schaft = Hc – H base – H capital
CAPITAL		1 x 1 x 1	L = P = 1 M

		H capital = 1 M L abacus = P abacus = $\sqrt{2}$ M H abacus = $\frac{1}{7}$ M

The sequence continues with description of the Doric, which is discouraged in advance because its system is flawed in relation to the positioning of the triglyphs and metopes (Vitr. *De Arch.* IV. 3. 1-2). With that proviso, Vitruvius returns to the initial principles, since he sees the Doric genre as requiring a new modular relationship. So although the classification of temple types does not change, the module is obtained differently, being determined only in tetrastyle and hexastyle temples (Vitr. *De Arch.* IV. 3. 3). Vitruvius in fact alters the inter-column relations, which become governed by the number of triglyphs, generating column spacings that are different from that described in the temple types (Tables 4 and 5).

Table 4 – Module definition and overall dimensions for designing temples on Doric genre (MANENTI, 2014, p. 175)

		TETRASTYLE		**HEXASTYLE**
		PROSTYLE	**AMPHIPROSTYLE**	**PERIPTERAL**
MODULE (M)		DIASTYLE → M = front / 27 SYSTYLE → M = front / 19½		DIASTYLE → M = front / 42 SYSTYLE → M = front / 29½
INTERCOLUMN-ATION	**MIDDLE (Im)**	DIASTYLE → Im = 8 M SYSTYLE → Im = 5½ M		
	SIDE (Is)	DIASTYLE → Is = 5½ M SYSTYLE → Is = 3 M		

COLUMN	**INFERIOR DIAMETER (D)**	D = 2 M
	HEIGHT (H)	Hc = 14 M

Table 5 – Definition of the *proportio* and *symmetria* for the Doric genre (MANENTI, 2014, p. 176)

DORIC GENRE			
ELEMENTS		***PROPORTIO*** **L (Length) x W (Width) x H (Height)**	***SYMMETRIA***
SHAFT		1 x 1 x 13	D = 2 M H shaft = 13 M
CAPITAL		2 x 2 x 1	L = W = 2 M H capital = 1 M H abacus = ⅓ M H echinus = ⅓ M H hypotrachelion = ⅓ M
EPISTYLE		variable	W epistyle = d H epistyle = 1M
FRIEZE	**TRIGLYPHS**	2 x 3	L triglyph = 1M H triglyph = 1½ M
	METOPES	1 x 1	L metope = 1½ M H metope = 1½ M

DORIC GENRE		
ELEMENTS	***PROPORTIO*** **L (Length) x W (Width) x H (Height)**	***SYMMETRIA***
TRIGLYPHS' CAPITAL	variable	TETRASTYLE → L = 28M HEXASTYLE → L = 43M H triglyphs' capital = $\frac{1}{6}$ M
CORNICE		TETRASTYLE → L cornice = 28 ⅓ M HEXASTYLE → L cornice = 43 ⅓ M H fascia = ½ M H fascia = 1 $\frac{1}{8}$M
TYMPANUM		L tympanum = L cornice H tympanum = $\frac{1}{9}$L cornice
RAKING CORNICE		H fascia = H fascia H cima = 1 $\frac{1}{8}$H fascia

Like the Ionic, most of the relationships in the Doric order are established through module sharing (*commodulatio*), which establishes at least one measurement of each part, which are measured as a whole according to their internal rules of *proportio.* The tympanums and raking cornice are the exceptions to this rule, retaining relationships only with the preceding adjacent elements through commensurability.

The episodic rule of houses

Concluding the architectural themes related to construction, Book VI of Vitruvius's treatise deals with private buildings, more specifically urban and rural houses (*domus* and *villas* respectively).

Generally there is clearly less concern with the establishment of overall geometric schemes, which can also be seen in the reduced use of the term *ordinatio*. On the other hand, while there is greater flexibility in relation to the architect's design, Book VI is mainly concerned with establishing sensible recommendations for designing, which seek to provide guidelines for a wide range of houses.

After Vitruvius's initial recommendations and understanding that instead of house design having one single geometric configuration it is rather an arrangement of parts that have to be planned and arranged according to the climate and *decor*, he moves on to set out geometric schemes for each of the functional parts in isolation. He also establishes relationships between them, dealing with these functional cores also as component architectural elements of the design. He firstly describes the atrium of the Roman house, which plays a similar role to the column addressed previously, through its influence on the measurements of the other internal parts (Table 6).

Table 6 – Definition of the *proportio* and *symmetria* for the *Domus* (MANENTI, 2014, p. 208)

DOMUS		
ELEMENTS	***PROPORTIO*** **L (Length) x W (Width) x H (Height)**	***SYMMETRIA***
ATRIUM	L atrium = $^{3}/_{5}$ W or $^{2}/_{3}$ W or $\sqrt{2}$ W H = W H atrium = $^{3}/_{4}$ W H covering = $^{1}/_{4}$ W	
ALAE	H alae = L alae	30 feet < W atrium ≤ 40 feet → L alae = $^{1}/_{3}$ Walae 40 feet < W atrium ≤ 50 feet → L alae = $^{1}/_{3½}$ W alae

DOMUS		
ELEMENTS	***PROPORTIO*** **L (Length) x W (Width) x H (Height)**	***SYMMETRIA***
		50 feet < W atrium ≤ 60 feet → L alae = $^1/_4$ W alae 60 feet < W atrium ≤ 80 feet → L alae = $^1/_{4½}$ W alae 80 feet < W atrium ≤ 100 feet → L alae = $^1/_5$ W alae
TABLINUM	H tablinum = $1^1/_8$ L tablinum	L atrium = 20 feet → L tablinum = $^2/_3$ L atrium 30 feet < L atrium ≤ 40 feet → L tablinum = $^1/_2$ L atrium 40 feet < L atrium ≤ 60 feet → L tablinum = $^1/_4$ L atrium
ENTRYWAYS		Small Atrium → L entryways = $^2/_3$ L tablinum Large Atrium → L entryways = $^1/_2$ L tablinum
COMPLUVIUM		$^1/_4$ L atrium < L compluvium < $^1/_3$ L atrium W compluvium → proportional to L atrium
PERISTYE	W = 1 ⅓ L	H column = P porticoes 3 D column < Intercolumniation < 4 D column If doric → rule of the triglyphs
TRICLINIA	Rectangular: W = 2 L H = (W + L) / 2 Square: W = L H = 1 ½ L	

Tabulation of the dimensions and analysis of the relationships between the elements reveals that in urban house design there is no establishment of defined geometric schemes or reference modules. But what can be seen is that the elements are connected based on numerical relationships with adjacent ones or with the atrium, which works as an initial reference for development of the process of

commensurability of measure (*commensus*).[12] Based on this initial measurement, just as in the temples, each element is measured by its specific *proportio*.

Rethinking the Vitruvian System

In conclusion, some considerations are possible: firstly that the study corroborates its hypothesis about the consistency of the Vitruvian architectural system, which is proven to be coherent, viable and flexible, although not fully clear in conceptual terms. This research concentrates on clarifying the terms of Vitruvian theory and expanding its conceptual framework through consideration of design descriptions as case studies that can be verified.

When considering a text that is so historically distant from our own times a conceptual review of all the terms, even the more established ones, is deemed necessary, since, as this study indicates, notions like *proportio* or *membrus* can acquire different connotations from those traditionally indicated in studies of Vitruvius. On the other hand, subsidiary concepts, which have not figured in architectural discussion of Vitruvius and classicism, might help to explain his theory, as suggested here in respect of *commensus* and *commodulatio. Both concepts* act on the process of measurement of the parts individually and also on the establishment of necessary relationships between them, which would be essential in the achievement of excellence.

In terms of the analysis of design descriptions, it can be seen that there is a correspondence, and therefore coherence, between these designs and the theoretical concepts. The tradition of building temples allows Vitruvius to introduce a series of clear recommendations as well as some principles for their development.

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[12] Linda Pellecchia, in her work about the Renaissance interpretation of the atria, defines these as public spaces of Roman houses responsible for transmitting the status of the family, operating together with the *tablino*, as reception sites, where customers greet the householder (Pellecchia, 1992, p. 379).

However, rather than a strict design system, this is more a way of working governed by precepts defined and accompanied by descriptions of examples, which although incomplete allow understanding of the recommended practice of the architect in relation to the act of designing.

In terms of the design of houses, the conceptual coherence of design principles and procedures can also be seen. But their application occurs episodically, based on the treatment of each room in the house separately. With no clear definition of an overall geometric scheme (*ordinatio*), the atrium is seen to be the prime space responsible for transmitting evidence of the ordering of a design.

In both cases the intervention of the architect has to be governed by maintenance of integrity of the parts. In the case of temples this would be a subtle contribution in the sense of improving what has already been established, while in the other designs there would in contrast be greater freedom for authorial involvement.

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