

RESEARCH ARTICLE

# Canons of Proportion and the Laws of Nature: Observations on a Permanent and Unresolved Conflict

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The mind of the artist always seems to oscillate between two poles: on one side, reality as represented by nature in all its aspects, and on the other, the dream of absolute perfection. This is the fundamental problem of the eternal conflict between the laws of nature and the canon of aesthetic proportions, which presents itself in different, though often related, guises. This article identifies, through explorations of thinkers from Vitruvius, to Galileo, to Le Corbusier, the problematic knots of a phenomenon that the champions of ideal proportions have always had to face and often to hide, even from themselves, when confronted with the evidence of facts.

## Introduction

[Some artists] replace nature [...] with another nature [...] the forms of which are simple actions of the soul [...] In this way they construct perfect worlds that are sometimes so distant from our own as to be inconceivable [...] But all that relates to the reality of nature bears [...] much greater consequences than those that the world of thought can imagine. (Valéry 1947: 145)<sup>1</sup>

It is with these words that Socrates, in Paul Valéry's *Eupalinos*, defines the two poles between which the mind of the artist always seems to oscillate: on one side, reality as represented by nature in all its aspects, and on the other, the dream of absolute perfection. This is the fundamental problem of the eternal conflict between the laws of nature and the canon of aesthetic proportions, which presents itself in different, though often related, guises. Here I will try to identify, using simple and schematic ideas worthy of deeper discussion, the problematic knots of a phenomenon that the champions of ideal proportions have always had to face and often had to hide, even from themselves, when confronted with the evidence of facts.

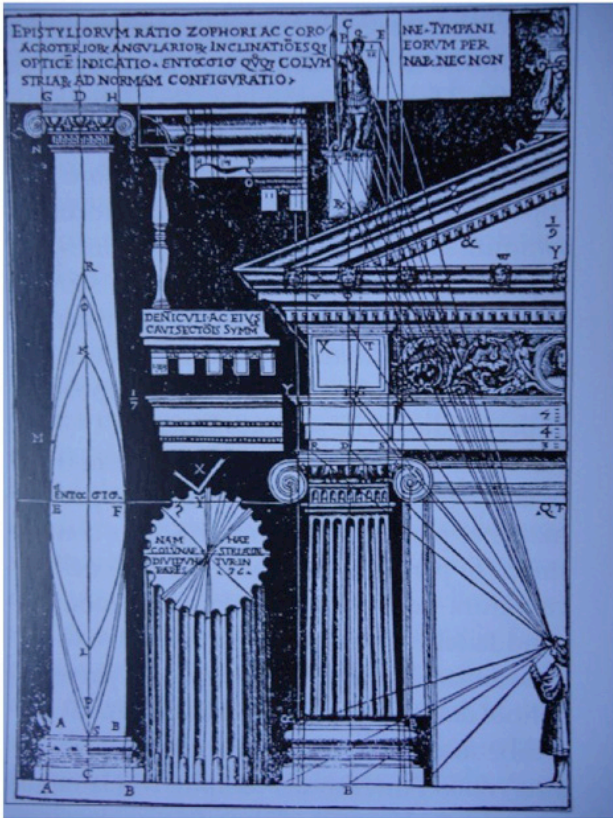
In the history of architectural theory, one of the most striking conflicts is between the canons of numerical proportion and those of the natural laws of visual perception. Deriving his ideas from Greek sources, Vitruvius describes a proportional canon based on the image of the ideal male body in the unrealistic representation of a frontal view. What Vitruvius is regarding is an immobile man, without volume or inner vitality; he is a simple ideogram characterized merely by the potential of his measurements to form geometric and proportional

relationships. Yet such a model, once translated into architecture, has to face the visual evaluation of an actual viewer, whose position – whatever it may be – can never coincide with that conventional vanishing point at infinite distance from which Vitruvius regards the man and from which the appearance of the building must be designed. Thus a relationship (either static or dynamic) is inevitably established between the subject and the object of vision – a relationship that generates a conflict with the immutability of a predetermined canon of proportion.

Vitruvius, fully aware of the problem, suggests a series of corrections to the very canon that he himself had proposed, with the intention of re-establishing the visual appearance of the ideal initial proportions (**Fig. 1**).

Nonetheless, the theory of 'optical corrections' thus proposed by him contains limitations that undermine its usefulness. For example, rather than becoming an organic and universal theory based on incontestable scientific principles, Vitruvius' corrections consider empirically only a few elements of the architectural orders.<sup>2</sup> Furthermore, such elements are to be observed from a single, and not properly defined, eye-level point of view, and this point excludes the infinite other possible points from which the building might be observed. According to Vitruvius, the architect should in principle compensate for apparent foreshortening due to perspective (as in the case of columns) by sufficiently increasing height dimensions: 'Since the eye errs', he claims, 'one must compensate with the help of reason' (Vitruvius 1997, 1: 250).<sup>3</sup> Since Vitruvius cannot provide a universal theory valid for the infinite number of potential visual situations that one might encounter, in addition to common sense he calls upon the architect's ingenuity and acumen (Vitruvius 1997, 1: 282),<sup>4</sup> thereby introducing into the design process a criterion of uncontrollable subjective creativity that openly conflicts with the absolute objectivity and universality of canonical proportions.

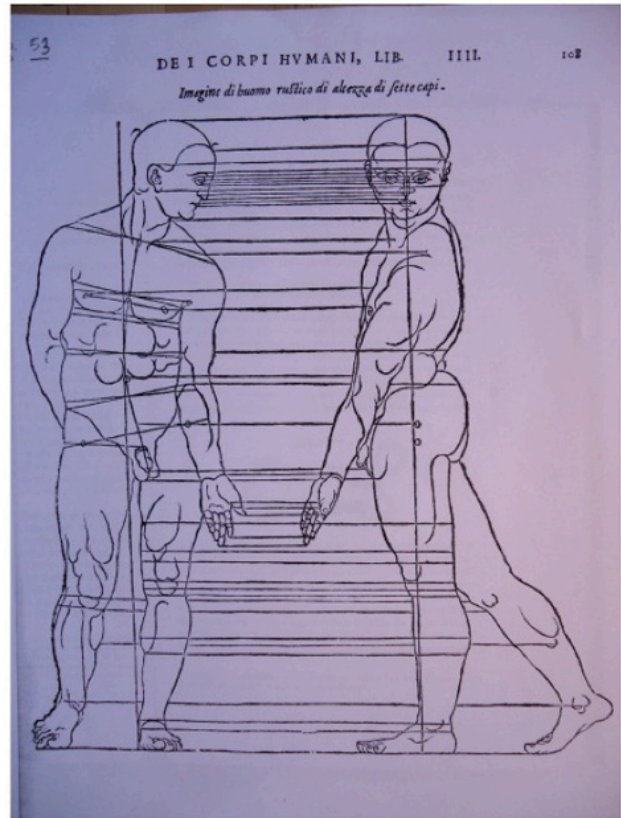
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**Figure 1:** A study of the optical distortions described by Vitruvius in the interpretation by Cesare Cesariano in his Vitruvius edition. Reprinted from: *Vitruvio. De Architectura translato [...] commentato et affigurato da Cesare Cesariano*. Como, 1521, p. lx.

We are dealing here with the obstacle encountered by most Renaissance interpretations of *De architectura*, specifically those influenced by Platonic thought, which regards proportion as the general rule of the cosmos.<sup>5</sup> At the very moment in which visual perception alters each principle of proportion, Neo-Platonists, following their master, tend to dismiss the problem, even if raised by the authority of Vitruvius. For the Neo-Platonists, in fact, the distortion of appearances can be regarded solely as the consequence of the corruption of reality produced by the senses.

It is no accident that the matter of optical corrections is practically ignored in a large part of the classical architectural literature, starting with Leon Battista Alberti's *De re aedificatoria* (Curti 2003).<sup>6</sup> This can be regarded as a case of veritable self-censorship. Daniele Barbaro, however, cannot censor himself on the topic of optical corrections because he is commenting on Vitruvius, who devotes much attention to the subject in his treatise. Thus Barbaro cannot refrain from expressing his critical judgment. It is highly significant that Barbaro, the most learned commentator on Vitruvius, recalling Plato, considers perspective distortion not a simple and natural mode of visual perception, but rather an actual 'affliction' – an 'ailment' – through which true proportion is 'cheated and betrayed'; he claims then that it has to be 'treated' with the thaumaturgic powers of Reason and of Art, which, being universal, are not 'subordinate to the human senses' (Barbaro 1567: 133).



**Figure 2:** A study by Dürer of the proportions of the human body. Reprinted from: *Di Alberto Dürero [...] della simmetria dei corpi humani Libri Quattro*. Venice, 1591, p. 108.

Problems associated with the visual translation of proportional relationships are found not only with architects but with all artists devoted to the representation of man. The human body, regarded by all the followers of Vitruvius and many others as the repository *par excellence* of proportional perfection, should for consistency manifest its proportions even when reproduced in diverse dynamic situations.<sup>7</sup> This is the problem addressed by Leonardo da Vinci in his *Treatise on Painting*, where he expands upon motifs that provoke changes in man's measures when they are determined either by the movement of limbs or the physical deformity caused by age (Leonardo da Vinci 1890, III: 13–172). This is the same problem, though in somewhat different form, that Albrecht Dürer confronts in the *Four Books on Human Proportion* (Fig. 2), where he examines the human body in dynamic states of disequilibrium, thus acknowledging variables seen from a biological point of view (Dürer 1528: Book IV). Still, both artists have to give up their efforts to establish canons of 'visual proportion', since such canons cannot easily be described with unique numerical terms or simple geometrical diagrams if they are to describe the various dynamic states of the human body.

This difficulty would later be explicitly acknowledged and accepted by Vincenzo Danti, a sculptor and admirer of Michelangelo, who claims that in painting and sculpture 'no rule has ever been formulated [...] above all for the human figure', that may have 'fixed proportions, since

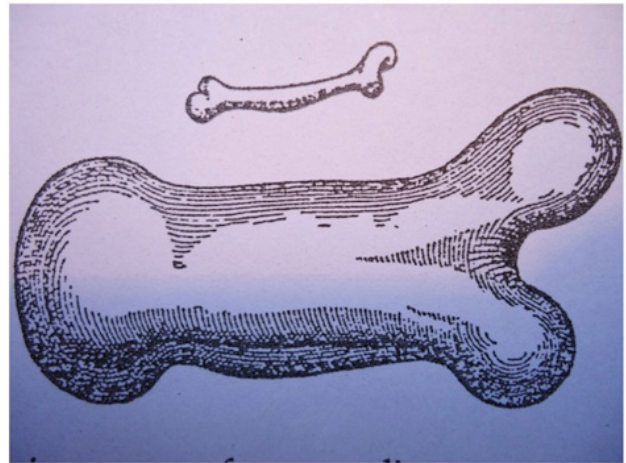
all its members vary in length and size while in motion' (Danti 1960: 237).<sup>8</sup> Gian Paolo Lomazzo similarly maintains that solely 'the eye combined with the human intellect, guided by the art of perspective, must be the rule and the judge of painting and sculpture' (Lomazzo 1974: 217). In the late *Cinquecento*, then, the natural behavior of visual perception begins to triumph in the debate over the abstract canons of proportion; Michelangelo had already deemed the whole question pointless when he claimed that the artist should trust only the sense of proportion that he has 'in his eyes' – that is, the entirely sensorial experience that he has developed and that has emerged within him – as a sort of second nature.<sup>9</sup>

The most significant and representative case of the conflict between nature and canons, based on scientific rather than abstract considerations, is the one that arises in the relationship between proportions, building materials, and the dimensions of a building, a problem that Galileo Galilei studied, laying the groundwork for a true and proper science of construction. The act of building in a statically correct way, properly taking into account the physical characteristics of the materials used, is self-consciously at the heart of the *Discorsi*, Galileo's scientific *magnum opus*, published at Leiden in 1638 (Galilei 1990).

One of the axioms common to all canons of proportion is their alleged invariability in any situation, independent of the physical dimensions of the building to which they are applied, the materials used in its construction, or the movement of the observer. Hints of a critical attitude toward this axiom, however, already appear in Vitruvius, in his discussions of war machines and related models necessary for their construction. Vitruvius maintains that some machines 'built on a large scale from small models turn out to be efficacious; some [...] instead, independent of their models, become autonomous forms, and last, some that seem identical to their models break as soon as they are made larger' (Vitruvius 1997, 2: 1358).<sup>10</sup>

In an epoch when the design process was primarily through the production of reduced-scale models, which follows the medieval tradition and which Alberti confirms, the problem noted by Vitruvius clearly played a crucial role from both a theoretical and practical point of view.<sup>11</sup> Even if the 'smaller machine' (the model) could be considered perfect in its proportions, it could not be demonstrated that these same proportions guaranteed a proper static working of the 'larger machine' (i.e. the building), constructed on a different scale and with different materials than those used in the design model. Thus no plausible explanation could be given for the collapse of many buildings.

Awareness of this problem is revealed by two sixteenth-century authors with completely different educations and practical interests. One is Luca Pacioli, a staunch champion of the golden section. Indeed, despite it being merely a mathematical proportion previously formalized by Euclid, Pacioli turns the golden section into a totalizing virtue, a savior of nature and of man's destiny, thus extending its capabilities beyond all reasonable limits (Pacioli 1509). The other is Bonaiuto Lorini, a military engineer foreign to the world of esoteric speculation



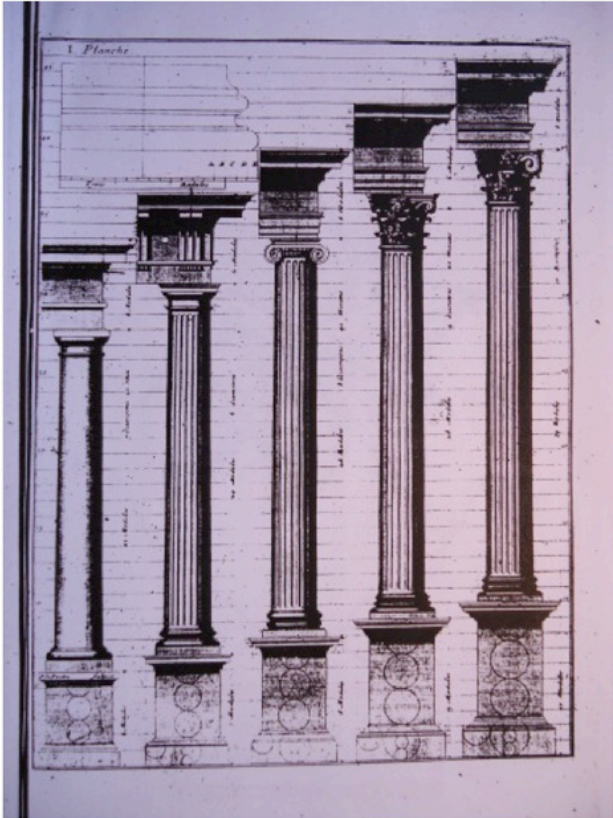
**Figure 3:** Variations in the proportions of a man's bone in relation to his build. Reprinted from: Galileo Galilei, *Discorsi e dimostrazioni matematiche intorno a due nuove scienze*. Turin, 1990, p. 141.

(Lorini 1597). Both, however, write clearly of the danger of buildings collapsing even after having been studied in models constructed with what had been deemed a perfect canon of proportions.<sup>12</sup>

Structural failures were generally attributed to generic problems such as imperfect materials, and were thus blamed totally on unforeseen and accidental causes rather than the way the building had been designed. The presence of this widespread belief is confirmed by Galileo himself in the opening of his *Discorsi*, where he expressly and repeatedly criticizes the empirical and false theory behind the idea of supposedly imperfect materials (Galilei 1990: 12–13). This attitude is most likely due to the surviving presence of the influence of Neo-Platonic ideology, which, as seen in Barbaro's writings on perspective, attributed to the shortcomings of the sensory world the cause of every known anomalous phenomenon in nature.

Galileo first describes the solution to the question of the invariability of proportions by analyzing the physical properties of materials subjected to forces of varying intensity and from various directions. Dismissing all alleged cases of the 'imperfection of material' as misleading, Galileo demonstrates that a machine built from the same materials and with the same proportions as its model is less resistant than the model, because the larger it is the weaker it is, inherently. Galileo arrives at this conclusion by considering, among other cases, a very particular 'machine', the human body – ironically the very one that had long been regarded as the supreme expression of absolute and invariable proportional relationships. Well known is the drawing of the bone from a human limb that Galileo uses as an example of his theory, pointing out that 'he who wishes to retain in a huge giant the same proportions as those of the limbs of a man of average height, must either find material for his bones that is that much more durable and resistant, or admit that his strength will be proportionally much weaker than that of men of average height' (Galilei 1990: 141) (**Fig. 3**).

After Galileo, the final blow to the concept of absolute and invariable proportions might have been dealt

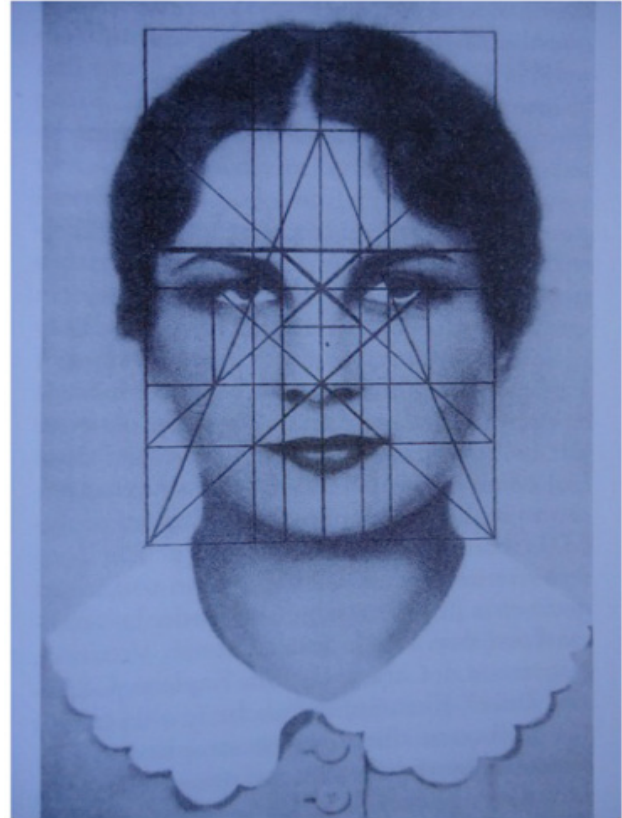


**Figure 4:** The proportions of the five orders of architecture according to Claude Perrault. Reprinted from: Claude Perrault, *Ordonnance des cinq espèces de colonnes*. Paris, 1683, p. 34.

by Claude Perrault, this time through the comparison between canons of proportion and the natural laws that condition the workings of the human psyche (**Fig. 4**).

His comparison did not have that devastating effect for a variety of reasons. Nevertheless, Perrault dealt a severe blow to classical theories, which were still dominant in the various academies of architecture in Europe, especially in the Académie Royale d'Architecture, then directed by François Blondel, placing them very much in doubt. According to Perrault, via a sort of progressive collective mental adaptation (called *accoutumance*) only certain proportions of the orders had prevailed in architectural tradition and had become established as those uniquely valid from an aesthetic point of view. This adaptation process, owing to particular historical and local conditions, guaranteed, as if through a process of natural selection, the survival of only certain types of proportions. These were the ones to be found in certain structures characterized by a strong 'positive' quality (such as structures bearing high canonical value), or those seemingly built in compliance with the most careful observations of the natural law of *firmitas*. According to Perrault, proportion thus loses all absolute and metaphysical value, and its importance diminishes to become a mere temporary and transient mental concept, since it is often conditioned by the natural laws of adaptation to the prevailing conditions of the surroundings.<sup>13</sup>

With Perrault the life cycle of the idea of absolute and innate proportions might have come to an end. The laws



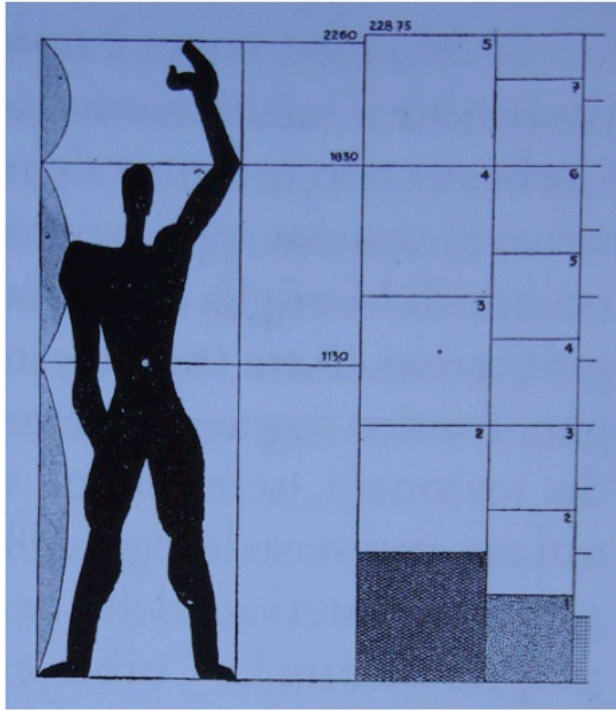
**Figure 5:** 'Harmonic analysis' of a female face. Reprinted from: Matila C. Ghyka, *Le nombre d'or*. Paris, 1931, vol. 1, pl. 19.

of nature appeared finally to prevail over those of the canons of proportion and thus over the very idea of beauty in the classical sense. Things turned out otherwise, however, for the conflict was destined to be revived.

In the mid-nineteenth century, the idea of proportion came back in its esoteric and Pythagorean sense – now linked to the golden section – and representing again an all-encompassing vision of nature and human production. With a sort of obsessive tenacity, authors including Adolf Zeising (1854), David Hay (1856), John Pennethorne (1878), and later Henry Provensal (1904), Mathieu Lauweriks (1909), Jay Hambidge (1924) and Matila Ghyka (1931) maintain that the momentous golden section may be identified anywhere – in shells as well as in human faces (**Fig. 5**), in Gothic as well as in Greco-Roman and Renaissance buildings, regardless of their natural or artificial origins, or their modifications for various causes – and exists as an underlying organizational principle.

Le Corbusier claimed that in the Modulor, which he generated through the golden section, he had found a 'measurement unit that harmonized with the human scale, universally applicable both to architecture and mechanics' (**Fig. 6**); in short, an *other* idea to rescue humanity from the mental and physical horrors of World War II (Le Corbusier 1950).

Once again the conflict between idea and nature was reintroduced, even if now interpreted only on a symbolic level. Indeed, while Le Corbusier was immersed in complicated mathematical calculations during his invention



**Figure 6:** An image from Le Corbusier's *Modulor 2*. Reprinted from: Le Corbusier, *Modulor 2*. Boulogne-sur-Seine, 1955, p. 59.

of the Modulor, the industrial world, subject to the most ruthless of nature's laws, that of *homo homini lupus*, was busy manufacturing horrible weapons of extermination rather than producing harmony for mankind with useful objects. The sense of this open conflict between theory and experience, between utopia and reality (which Le Corbusier, because of his intellectualized infatuation, perhaps deluded himself into believing could be eliminated), is expressed lucidly by Berthold Brecht, a poet deeply engaged in social action, in an illuminating epigram where he claims, 'While the architects, bent over their drawing tables, toil over a wrong calculation, the cities of the enemy remain unharmed' (Brecht 1962: 145).

## Notes

- <sup>1</sup> *Eupalinos ou l'architecte* (1921) by Paul Valéry is a living testimony to an almost dreamlike way of understanding architecture as a kind of synthesis of science, spiritualism and esotericism, which are often confused in their roles. This text had considerable influence in French intellectual circles during the twenties and thirties of the twentieth century, very likely with respect to proportion and the golden section in particular.
- <sup>2</sup> Vitruvius' theory on the causes of visual distortions is incoherent. Besides attributing distortions to purely perspectival causes, he occasionally attributes them to physical and psychological ones. Vitruvius affirms that architecture is a science (*scientia*) but regarding optical corrections does not offer the reader a proper scientific theory that is universally applicable to an infinite variety of visual situations. The scientific laws of perspective will in fact be formulated only in the late Renaissance. The attitude of Vitruvius on this subject is in

sharp contrast with the formidable scientific achievements reached during the Hellenistic period, even in the discipline of mathematics; Euclid's *Elements* being the most notable example. Perhaps Vitruvius, while deducing his theory from Hellenistic sources, is not capable, as often happens, of understanding its exact meaning, limiting himself to indications of a partial and empirical nature. On this issue, see Curti (2003). In particular, Vitruvius takes into consideration, albeit one by one, certain elements of the architectural order (above all columns and architraves) and the stylobate, but never the temple in its volumetric and structural entirety.

- <sup>3</sup> 'Ergo, quod oculus fallit, ratiocinatione est exaequandum' (Vitruvius, *De architectura* 3.3.11). All translations are by the author.
- <sup>4</sup> '[T]unc erit ut ingenio et acumine de symmetriis detractioes aut adiectiones fiant' (Vitruvius, *De architectura* 6.3.11).
- <sup>5</sup> As is known, it is primarily in the *Timaeus* that Plato explains the Cosmos as a product of precise aggregative laws governing the primary elements (earth, fire, and air), and often stemming from highly precise laws of proportion.
- <sup>6</sup> Alberti, in the ninth book of *De re aedificatoria* hints at the theme of optical corrections, but then, despite his promise of elaboration, does not discuss the topic further in the text. The passage in question reads: 'some difference is to be made between the proportions of a large building and those of a small one, which arises from the different interval that there is from the beholder's eye, which must in this case be considered as the center, to the extreme height which it surveys' (Alberti, *De re aedificatoria* 9.3).
- <sup>7</sup> In addition to the followers of Vitruvius, other artists, painters and sculptors naturally regarded the human body as the ideal model of beautiful proportions. Furthermore, many artists, painters and sculptors were inclined to consider the human body, which was considered a divine creation, as a repository of perfection, from the point of view of its external features (for example, Filarete). The rediscovery during the Renaissance of Roman statuary derived from the Hellenistic period had perhaps helped to cultivate this belief. In addition, Polycleitus and his *Canon* concerning the perfect proportions of the human body, and the work of Phidias, were cited by many Roman authors (Cicero, Pliny, Quintilian, etc.) whose writings began to be recognized during the Renaissance. On the relationship between anthropomorphic proportions and their representations in moving bodies, see Curti (2006: 109–116).
- <sup>8</sup> According to Danti (1960: 237), in painting and in sculpture 'no rule has ever been established [...] above all for the human figure, which seems beset by so many compositional difficulties', for the moment in which its proportions become destabilized, since all principal limbs vary in scale and length when in motion.
- <sup>9</sup> According to Vasari (1906, 7 (*Vita di Michelagnolo Buonarroti*): 270), Michelangelo maintained that an

architect, in order to ensure 'a certain concordance of grace in everything' ('una certa concordanza di grazia nel tutto'), should 'have compasses in his eyes and not in his hand, because the hands work and the eye judges' ('avere le seste negli occhi e non in mano, perché le mani operano e l'occhio giudica').

<sup>10</sup> '[S]unt alia quae exemplaribus non magnis similiter magna facta habent effectus, alia autem exemplaria non possunt habere sed per se constituuntur, nonnulla vero sunt quae in exemplaribus videntur veri similia, cum autem crescere coeperunt dilabuntur' (Vitruvius, *De architectura* 10.16.5).

<sup>11</sup> Leon Battista Alberti claimed that it was necessary to design with the help of models also in order to be able to assess in one glance the complex proportions of the building being built (Alberti, *De re aedificatoria*, II.i.21).

<sup>12</sup> Pacioli (1509) asks himself, 'che diremo de li moderni edifizii [...] ordinati et disposti con varii e diversi modelli i quali all'occhio par che alquanto rendino vaghezza per lor esser piccoli, e poi nelle fabbriche non regano al peso [...] [e spesso] [...] ruinano?' (Cf. Bruschi 1978: 77.) Lorini (1597, V I) notes that 'Nell'effettuare l'opera in forma reale non si venga a restare ingannati [...] come spesso accade a quelli che confidano solo nella facilità che mostrano i modelli piccoli senza saper i necessari suoi fondamenti'.

<sup>13</sup> On the concept of *accoutumance* in Claude Perrault, which is developed above all in *Ordonnance des cinq espèces de colonnes selon la méthode des anciens* (Paris 1683), cf. Herrmann (1973) and Curti (2006: 150–165).

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**How to cite this article:** Curti, M 2014 Canons of Proportion and the Laws of Nature: Observations on a Permanent and Unresolved Conflict. *Architectural Histories*, 2(1):19, pp. 1-7, DOI: <http://dx.doi.org/10.5334/ah.bn>

**Published:** 20 June 2014

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