

From Quantitative to Qualitative Architecture in the Sixteenth and Seventeenth Centuries: A New Musical Perspective

Presented at Nexus 2010: Relationships Between Architecture and Mathematics, Porto, 13-15 June 2010.

Abstract. In Rudolf Wittkower's influential view, Renaissance musical theory, based on Pythagorean and Platonic proportions, is a paradigm of harmony, order, and spatial organisation in architecture from Alberti to Palladio. However, sources from *Hyperotomachia Poliphili* (1499) and other sixteenth-century French treatises, through René Ouvrard's *Architecture Harmonique* (1679) seem to show another, undiscovered story. The keys to interpretation include a different philological reading of Vitruvian theory of proportion, as Fra' Giocondo's French lessons show. This is a starting point for a particular sixteenth-century passage between two different conceptions of architecture – from anthropomorphic to rhetoric, from volumetric to linear, and from quantitative to qualitative – which will find a definitive arrangement in the seventeenth century.

1 Introduction

The relationship between music and architecture can be considered from different disciplinary perspectives, for example from those of acoustics, aesthetics, or history. Here I would like to engage with a simpler and yet more controversial approach: the analogical and the proportional. Let me first make it clear that I am not an historian of architecture, but of music. Furthermore, my discussion is somewhat at variance from that presented in the standard text, Rudolf Wittkower's *Architectural Principles in the Age of Humanism* [Wittkower 1949]. Yet I am not the first to raise criticisms of the work of this Warburg-trained historian since its publication in 1949. A debate about Wittkower's analysis of Palladio's villas began in the late sixties, carried out for example in the pages of the *Bollettino del Centro Internazionale di Studi di Architettura Andrea Palladio*, represented vigorously on one side by Eugenio Battisti [Battisti 1968, 1973] and on the other by Decio Gioseffi, who devoted his corrosive verbal skills to a decisive refutation [Gioseffi 1972, 1978, 1980a-b, 1989]. This debate has been extended by Deborah Howard, Malcom Longair, Branko Mitrovic, Elwin Robison, Lionel March [Howard & Longair 1982; Mitrovic 1990, 1998, 1999, 2001, 2004; Robison 1998-99; March 1998, 2010]. I have had the occasion elsewhere to focus on the positions of each of these historians, and have already attempted to offer a methodological overview and an alternative analytical approach [Zara 2007]. A broad revision of Wittkower's basic general conceptual framework has already been suggested by Henry Millon and Alina Payne [Millon 1972; Payne 1994]. More recently the musicologist Luisa Zanoncelli has raised doubts about the extent of the musical knowledge of one of Wittkower's protagonists, Alberti [Zanoncelli 1999, 2007], doubts that had already been raised,

although with different nuances, by historians like Paul von Naredi-Rainer, George Hersey, Pierre Caye, Danilo Samsa, and Angela Pintore [Naredi-Rainer 1977, 1982, 1985, 1994; Hersey 1976; Caye and Choay 2004; Samsa 2003; Pintore 2004]. Nevertheless, as the recent systematic synthesis offered by Peter Vergo demonstrates, Wittkower's book is still the mandatory starting point [Vergo 2005]. Let me then summarize Wittkower's thesis.

The point of departure is the *Descrizione* or *Memoriale per condur la fabbrica de la Chiesa ... Sancti Francisci a Vinea Venetiarum*, written by the Franciscan friar Francesco Zorzi, and completed on 1 April 1535. The story is well known: the doge Andrea Gritti, unhappy with the drawings made by Jacopo Sansovino, official architect of the *Serenissima*, hired Zorzi, who suggested that the proportions of the church should be modified according to the principles of the Pythagorean-Platonic doctrine of sonic numbers. This doctrine, based on the Pythagorean concept of the *tetraktys* and on a philosophic *substratum* provided by the dialogues of Plato, maintains that simple relationships between small numbers mirror the harmony between macrocosm and microcosm. The most basic of these relationships are as follows: 1:2, the *diapason* (in musical terms, the interval of the octave); 2:3, the *diapente* (the interval of the fifth); and 3:4, the *diatesson* (the fourth). These are not new ideas. Zorzi had already provided an exposition of these doctrines in his *De harmonia mundi totius*, published ten years before; this *summa* of Neoplatonism and Christian Cabala was widely distributed in Latin and in translation, but immediately came under some suspicion of heresy. The *Memoriale*, with its combination of Vitruvian anthropomorphism, Solomonic mysticism and exegesis of the Old and New Testaments, would represent the practical expression of Zorzi's ideas [Vasoli 1998; Campanini 2007]. The document was reviewed by several experts (Titian, Sebastiano Serlio, Fortunio Spira and Sansovino himself, among others), and the construction eventually proceeded through different avenues [Foscari and Tafuri 1983]. For Wittkower, the analogical relationship between the two disciplines is not exhausted by a simple transposition of musical intervals to the spatial dimensions of the building:

The ratios of musical intervals are regarded as binding, and not the building up of consonant intervals into musical harmonies. Nothing shows better than this that Renaissance artists did not mean to translate music into architecture, but took the consonant intervals of the musical scale as the audible proofs for the beauty of the ratios of the small whole numbers 1:2:3:4 [Wittkower 1962: 102].

The contribution that music brings to architecture is to draw it into the *quadrivium*, thus guaranteeing that it could be considered as a *scientia* rather than simply an *ars mechanica*. The Zorzi memorandum is generally considered the first document in which musical ideas are introduced in a very explicit way as point of reference for architectural design. It also functions as a synthesis of a way of thinking that started with Alberti's famous and now hackneyed *dictum*: 'indeed the very same numbers, through which a most delightful harmony is created when borne into the ears, bring it about that the eyes and the mind are filled with a marvellous pleasure' (*hi quidem numeri, per quos fiat cum illa concinnitas auribus gratissima reddatur, iidem ipsi numeri perficiunt, ut oculi animusque voluptate mirifica compleantur*), and which would continue, in Palladio's *Quattro Libri*, to flourish throughout the sixteenth century. For Wittkower, the seventeenth century was thus a period of decadence. It is true that here and there—in

England, Italy and France—strong links with this tradition remained. But according to Wittkower, in France the tradition became ‘doctrinal and didactic’:

There was an important French classicist current, the representatives of which kept alive the Platonic conception of numbers in a doctrinal and didactic sense. François Blondel was perhaps the first architect who gave this academic turn to the old Italian ideas on proportion. Almost a whole book of his ‘Cours d’architecture’, 1675-83, deals with musical proportions in architecture. His approach to the problem is historic and apologetic, for, in contrast to his Renaissance predecessors, he has to prove a case of which many of his contemporaries were ignorant [Wittkower 1962: 126].

According to Wittkower, architects of the seventeenth century began to break the laws of harmonic proportion in architecture; those of the eighteenth century forgot them entirely.

Here I shall present a picture that leads in a different direction. I do not believe that the seventeenth and eighteenth centuries were quite as decadent as Wittkower claimed. On the contrary, I suggest that this period saw the beginnings of systematic thought about the relationships between the disciplines of architecture and music, and a broad dissemination of the results.

2.1 The Architecture Harmonique of René Ouvrard

The first source I shall consider is the *Architecture Harmonique, ou l’Application de la Doctrine des Proportions de la Musique à l’Architecture*, published at Paris in 1679 [Ouvrard 1679]. This is the first book that addresses this topic exclusively, and the first written by a musician and music theorist [Vendrix 1989; Pauwels 2000]. Unfortunately Wittkower – as he freely confessed – was unable to consult this work, for of the two copies extant after World War II, the one in Paris was inaccessible in the *caveaux* of the Bibliothèque Nationale de France (now: Imp. Rés. V. 1886); the second copy (Lyon, Bibliothèque Municipale, Rés. 367374) was presumably too far away to be consulted easily. Wittkower was thus constrained to rely on secondary literature, from which he adopted some incorrect conclusions, especially from the third volume of Angelo Comolli’s *Bibliografia storico-critica dell’architettura civile e arti subalterne* (Rome, 1791). For example, he states that the treatise posited the creation of a hypothetical sixth order of architecture, the harmonic order, something that would have important consequences [Wittkower 1962: 126]. Although Françoise Fichet’s anthology on French classicism gives a few extracts from Ouvrard, it is not without mistakes of evaluation [Fichet 1979: 175-182]. So, despite Ouvrard’s importance, a partial and fundamentally incorrect vision of his work continues to the present day. However, because of its primacy and originality, this treatise has the potential to offer an incomparable historical view of the status of the proportional analogy between the disciplines of architecture and music.

It must be admitted that the author, René Ouvrard, was not a heavyweight in the world of musical literature. His name is hardly found in the historiography of music. But he was not a newcomer either, having been *maître de musique* for sixteen years in the most prestigious musical institution in France, the Sainte Chapelle du Palais de Paris [Brenet 1910; Cohen 1974, 1975; Vendrix 1988]. Ouvrard, who wrote on theology, combinatory mathematics, mnemonic algebra, acoustics, physics, and the theory and

history of music, was thus a typical seventeenth-century polymath in the mould of a Marin Mersenne or an Athanasius Kircher. The *Architecture Harmonique* was conceived as a part of his *magnum opus*, *La Musique Rétablie depuis son origine*, an encyclopedic account of the entire science and practice of music and of its literature, but this treatise was never finished, and remained in manuscript [Zara 2008a]. At least three elements of the *Architecture Harmonique*, a work of only thirty pages, deserve to be mentioned: firstly, the object of the treatise, namely the correspondence between music and architecture; secondly, the more general context; thirdly, the received tradition, and a conceptual shift in architecture, as mentioned above.

1. Ouvrard updates the Pythagorean *tetraktys* by reference to the *senario* introduced by Gioseffo Zarlino in his *Istitutioni Harmoniche* (1558). Zarlino had explained that not all the consonances used in modern music are encompassed by the first four numbers of the *tetraktys* (1:2:3:4), but that they extend as far as the first six integers. Beside the consonant intervals, Zarlino acknowledged that the following ratios produce imperfect consonances: 4:5 (major third), 5:6 (minor third), 3:5 (major sixth), and 5:8 (minor sixth) [Zarlino 1558; Mambella 2008]. So far there is nothing extraordinary here: Ouvrard's operation reflects the real need to revise theory in the light of practice. By his time, these latter intervals were widely accepted in theoretical reflection and were ubiquitous in the practice of musical composition. But the epistemological consequences are very much to the point. For to widen the set of acceptable consonances to the first six numbers means that relationships not previously considered consonant suddenly become so. Thus there are more musical numbers than initially expected. In an appendix to his work (*Addition à l'Architecture Harmonique*) Ouvrard repeats sections of Vitruvius' *De Architectura libri decem*, the architectural canon *par excellence*, drawing attention to the musical relationships mentioned in the text. Ouvrard's intention here is to demonstrate that 'toute les proportions qu'il [Vitruvius] a prescrites, sont toutes Harmoniques, quoy qu'il ne leur ait pas donné ce nom, ou que peut-estre il n'en sceut pas la qualité' ('that all the proportions prescribed by Vitruvius are harmonic, even if he did not describe them as such, or if he did not know that they were such'). [Ouvrard 1679: 16]

2. Ouvrard was the first theorist to define the fundamental proportional relationship not as those existing between *diapason*, *diapente* and *diatesseron*, but instead those between *re*, *fa* and *la* (what we would call a d-minor triad). This relation can readily be transposed downward to *ut*, *mi*, *sol* (what we would call a C-major triad), since the sounds that make up the major triad – the terminology is revealing – are more *plaisants* than those that make up the minor triad:

Ce bastiment a donc des harmonies, 2, 3, 4, 6, 8, 10, 12, 16, 24, 32, qui feroient en Musique ces accords, Ut, Sol, Ut2, Sol3, Ut3, Sol3, Ut4, Sol4, Ut5: Ou plutôt, comme les plus grandes longueurs des tuyaux ou des cordes font les sons les plus bas, en retranchant le nombre 32, on aura dans cet ordre ces proportions, 24, 16, 12, 10, 8, 6, 4, 3, 2, qui feront en Musique ces sons, Ré, La, Ré2, Fa2, La2, Ré3, La3, Ré4, La4 [...] Ce qui fera ces harmonies, Ut, Sol, Ut2, Sol2, Ut3, Mi3, Sol3. Cette harmonie est plus agreable que la precedente à cause de la Tierce Majeure qui est à celle-cy, Ut, Mi, Sol; au lieu de la Mineure qui est en celle-là, Ré, Fa, La [Ouvrard 1679: 10].

Therefore Ouvrard transforms a universal and metaphysical unit of measure – the ancient Greek terminology referred to proportional relationships – by transposing it to a

contingent level and thus transforming it into an immanent sonic reality. Now the fundamental elements are not relationships but real, audible sounds.

3. Ouvrard goes one step further and transforms individual buildings – his model is Solomon’s temple – into huge megaphone resonators whose foundations vibrate and whose hollow beams, when blown by the wind, resound as a tangible, physical proof of the validity of the correct application of the natural laws of proportion:

Et comme ces proportions étoient d'accord avec celles du Temple, & du Sanctuaire, & que Salomon étoit trop sçavant en Musique pour n'avoir pas mis les Trompettes des Prestres, & les divers Instruments des Levites sur le même ton du Bastiment, de l'Autel, & du Bassin; non seulement on entendoit une harmonie parfaite par cette résonnance, mais tout l'Edifice étoit ébranlé & faisoit un bourdonnement & frémissement agreable, tel que celui qu'on entend dans les voûtes des degrez, lors qu'on sçait prendre leur ton. Nous voyons un exemple sensible de ce pouvoir de résonnance sur les pierres mêmes, dans un pilier en arcade de l'Eglise de Tours, qui tremble à veuë d'œil, & se remuë, dans l'espace de plus de demy-pied, au son d'une certaine cloche, & demeure immobile au son de toutes les autres, quoy que plus proches de luy, & plus grosses que celle qui le fait trembler [Ouvrard 1679: 13].

In this way Ouvrard explains the phenomenon of sympathy, to which he would return in his unfinished work *La Musique Rétablie* [Zara 2008a]. This example is modelled on the practice, described by Vitruvius in the fifth book of *De Architectura*, of placing vases strategically around a theatre according to Pythagorean proportions to improve their acoustics [Mourjopulous 2003; Godman 2008]. Significantly, this example testifies to Ouvrard’s need to anchor the validity of his laws of proportion in empirical reality. Critics of Ouvrard have often dwelt on this example, associating it to the phonurgic machinery of Ouvrard’s learned contemporary, the Jesuit Athanasius Kircher [Gozza 2007 (2009)], though they have misunderstood its origins and considered it simply as an example of baroque extravagance, an inferior counterpart to the ascendant rationalism of a Descartes [Picon 1989; Hersey 2000]. However, it was a reading of Ouvrard’s description, alongside treatises like the *Génération Sonore* of Jean-Philippe Rameau, that allowed the mid-eighteenth century architect and theorist Charles-Estienne Briseaux (*Traité du Beau essentiel*, 1752) to constitute the linear correspondence between spatial dimensions and musical intervals. Briseaux’s *Division de la Corde sonore* illustrates this point perfectly, in its insistence on a literal translation of the axiom $1:2 = \text{diapason} = \text{Octave} = \text{Do-do}$. Briseaux is thus the first after Ouvrard to make an explicit correspondence between musical proportions and intervals between real sounds. Theorists before Ouvrard spoke of the *diapason*, and never of particular pitches such as *ut-mi-sol*; after Ouvrard, theorists began to speak of definite pitches. This shift may be observed first in Briseaux. [Briseux 1752: 44; Testa 2003]. This does not intend to offer a ‘doctrinal and didactic’ vision, as Wittkower would have it, of the early Renaissance tradition as represented by Alberti. I do not believe that the Florentine wanted to achieve such a mimesis: he, as Palladio and his followers, based his work on a metaphysical foundation that could legitimate his knowledge and his activities. Even Ouvrard and Briseux looked for theoretical proofs, and in wanting them to be empirical (that is, demonstrable), they organized their thoughts in a systematic way, and with great subtlety; Briseux, for example bases his own demonstrations on Newton’s thesis. Their speculation thus becomes objective doctrine, not one based merely on a subjective,

‘doctrinal’ interpretation. The aberrant ‘melodic’ interpretations of the architecture of Alberti and Palladio extended later on to every building and every era, as if a series of notes actually issued from the architect’s compass, are due to a misunderstanding brought about by removing Ouvrard’s work from its context [Bonhôte 1971; Kappraff and McLain 2005]. Once this has happened, the interpretation begins to look dogmatic, since it fails to take into consideration the specific cultural context of production. For this reason I am reluctant to accept analogical interpretations like that offered by George Hersey, who maintained that Ouvrard’s work was natural and mimetic. For example, Hersey treated François Blondel’s interpretation of Ouvrard’s ideas (see below) as normative, applying for example the musical correspondence of the Attic base to Piranesi’s candelabrum, designed in 1770, a century after Ouvrard; in Hersey’s analysis, this design produces an unresolved dissonant chord (*do-fa-si*). Hersey also applied Blondel’s analysis to Bernini’s *baldacchino* – designed in 1624-33, fifty years before Blondel – which he claimed to generate a melody in the key of f-minor and in duple meter [Hersey 2000: 22-51]. Explanations of this kind play fast and loose with history, contingent facts, and specific cultural elements [Zara 2005; 2007; 2007 (2009)].

2.2 *The Seventeenth-century French context*

Did the *Architecture Harmonique* find any contemporary resonances that might permit modern historians to counter Wittkower’s well-established picture? At a first glance, the answer seems to be negative. In October 1690, the *Académie d’Architecture* dedicated three sessions to a reading of the treatise, but the conclusion is uncertain:

L’on a achevé de lire le traité de l’Architecture Harmonique par M. Ouvrard qu’on avoit commencé dans les assemblés précédentes, et, après avoir examiné les exemples qu’il tire de Vitruve avec l’application qu’il en a fait aux nombres harmoniques, on a trouvé qu’à la vérité les distributions s’accordent bien avec ces nombres, mais qu’il y a plusieurs bastiments antiques, de ceux que l’on a estimé, dont la distribution ne s’accorde pas précisément avec cette proportion harmonique [Lemonnier 1912: 203-204].

In July 1692 Christiaan Huygens wrote to Leibniz about this ‘petit traité extravagant’ [Vendrix 1992]. Ouvrard himself failed to mention this treatise in his testament (dated July 21, 1694), unlike his other works. His friend and correspondent, the *abbé* Claude Nicaise, in a *Mémoire concernant Maître René Ouvrard*, written during the same year, likewise failed to mention this work [Zara 2008a]. In 1725, Sebastien de Brossard knew little of the work apart from its title, and the fact that he had lost his own copy of it: ‘cette dissertation estoit fort curieuse mais il y a plus de 35 ans que je l’ay perdue et je n’en fait ici mention qu’affin d’insinuer la nécessité de la faire chercher’ [Zara 2007 (2009)]. Not even Briseux had first-hand knowledge of the *Architecture Harmonique*, and he fails to mention Ouvrard in his *Traité du Beau essentiel*. By contrast, eighteenth-century Italian scholars of architectural theory always cite Ouvrard, but for them the *Architecture Harmonique* represented a kind of Holy Grail: the treatise was conspicuous for its absence, and acquired a kind of *aura image*. (In this regard, the case of Wittkower is also emblematic.)

Much more reductively, the context of this work has always been read through the lens of the *querelle* on the nature of architectural proportions carried out between the *médecin-savant* Claude Perrault, translator of Vitruvius and creator of the famous *Colonnade* at the Louvre, and François Blondel, first director of the *Académie d’Architecture* [Herrmann 1973]. For Perrault, such proportions are arbitrary, the result

of custom (*accoutumance*) [Scalvini and Villari 1991; Lemerle 2006]. For Blondel, by contrast, they arise from natural laws [Brault 2006; Gerbino 2010]. But this interpretation also requires greater nuance. Elsewhere I have tried to demonstrate how the subject and exposition of the *Architecture Harmonique* reveal a context that exceeded the boundaries of the specific debate over the analogy of musical and architectural proportions, revealing a complex level of speculation that precedes and provides a foundation for the *Querelle des Anciens et des Modernes* [Zara 2006], and perceptibly changes the peculiar point of view on the analogy [Zara 2007 (2009); Zara 2010]. Let me then summarize the principal arguments:

1. Claude Perrault dedicated the first pages of his *Ordonnance des Cinq Espèces des Colonnes* to a formal refutation of Ouvrard's treatise. Ouvrard wrote:

ce qu'il y a de différence, c'est que les proportions de la Musique consistent tellement dans un point indivisible, que sur le Monochorde l'épaisseur d'un cheveu qui manqueroit à la justesse du son harmonieux se fait sentir; au lieu que la veüe n'est pas si subtile pour apercevoir les petits défauts des proportions [Ouvrard 1679: 9].

Perrault replied:

la connoissance que nous avons par le moyen de l'oreille de ce qui résulte de la proportions de deux cordes dans laquelle l'harmonie consiste, est tout à fait différente de la connoissance que nous avons, par le moyen de l'oeil, de ce qui résulte de la proportions des parties [Perrault 1683: iv].

This disagreement was carried on before the background of the debate over the natural foundations of music and those of architecture on the other. In his provocative translation of Vitruvius' treatise, Perrault wrote:

Les proportions des membres d'Architecture n'ont point une beauté qui ait un fondement tellement positif, qu'il soit de la condition des choses naturelles, et pareil à celui de la beauté des accords de la Musique, qui plaisent à cause d'une proportion certaine et immuable, qui ne dépend de la fantaisie [Perrault 1673: 102].

While the detractors of natural law argue that the musical analogy is to be rejected, Perrault's statement witnesses to the fact that this analogy was widely diffused and perceived even as a commonplace.

2. In an attempt to counter the influence of Perrault, François Blondel used Ouvrard's thesis in his *Cours d'Architecture*, a collection of the weekly lessons given to real architects, thus giving it an academic authority and consequently an audience that it could never reach on its own. Blondel also amplified and transformed Ouvrard's ideas, for example by translating the Attic base measures into musical terms [Blondel 1683: 756-760]. This act would have major consequences, unknown to its author; for the musical transposition of the Attic base would take on its own independent life. It was cited and developed in the eighteenth century by Nicolas le Camus de Mézières, the father of *architecture parlante*, in *Le génie de l'architecture* published in 1780 [Le Camus de Mézières 1780: 32] and also by Antonio Vittone and Berardo Galiani. In the nineteenth century it was cited by Baldassarre Orsini and Jean-Michel de Bioul, becoming a regular *topos* in the architectural literature, despite the fact that Ouvrard never mentioned the dimensions of the orders or the bases, or their musical correspondences [Zara 2007

(2009)]. As a result, readers from the eighteenth century to today (as we have noted in the case of Hersey) have generally read Ouvrard by way of Blondel's interpretations [Costantini 2002; Martin 2006]. But the two positions remain quite distinct: Ouvrard tried to demonstrate an analogy, Blondel a mimesis. In any case, Blondel's appropriation again testifies that musical analogy is a familiar element in the construction of the discourse of architectural theory.

3. In the following chapter of his *Cours d'Architecture* [Blondel 1683: 756-760], Blondel attempted to bolster his attempt to provide a workable contrast with Perrault's arguments by introducing the arguments of an architect who was only recently rediscovered by historians: François Bernin de Saint-Hilarion [Scalvini and Villari 1994]. Although his treatise *Des Proportions d'Architecture* was never published and his name was forgotten quite quickly after his death, Bernin was very well known during his life, and he was in contact with Félibien, Le Vau, Mansart, Ouvrard, and all the major architects of his time. Bernin attempted to demonstrate the geometrical nature of architectural proportions. His treatise is not concerned with musical proportions, but, again, this *topos* must be rejected first in order to establish the basis for another. The first line of the manuscript states clearly:

S'il est vray que les Proportions Harmoniques sont capables d'accorder les Sons, et que leur Accord produise des effets agréables aux Oreilles comme nous l'expérimentons, il paroist vraisemblable que les Proportions Géométriques doivent aussi avoir la force d'accorder les dimensions, et que c'est principalement de cet Accord que les yeux sont touchez si agréablement à la vuë des beaux Ouvrages de la Nature ou de l'Art [Bernin de Saint-Hilarion: fol. 2r].

And again, specifying in his fifth chapter (*Quelle sorte de Proportion convient à l'Architecture*) he writes:

Puisque les proportions Geometriques ne conviennent point à la Musique: aussi les musicales ne conviennent point à l'Architecture, les unes etant l'Objet des yeux par les diverses dimensions, et les autres etant l'Objet de l'Ouyë par les differens sons; ce qui semble n'avoir rien du tout de commun, tout de mesmes que ce qui touche le Goust ou l'Odorat ne touche pas pour cela la Vuë ou l'Ouyë [Bernin de Saint-Hilarion: fol. 4v].

4. Three decades before these speculations, Abraham Bosse, teacher of perspective at the *Académie de Peinture*, made drawings in pen-and-ink to accompany the lute compositions of Denis Gaultier, collected in the *Rhétorique des Dieux*. In these drawings, the architectural elements, or more precisely the architectural orders, correspond to the mode of the musical compositions: the Dorian mode corresponds to the Doric order, the Ionian mode to the Ionic order, and so on. The preface to the manuscript is explicit:

Et comme chacun de ces modes est propre à exciter certaines passions, et qu'ils sont propres a certaines chants, l'on a représenté dans chacun les actions que le mode fait naistre, les Instruments tant anciens que modernes q' luy sont plus convenable, et mesme l'on a observé d'y faire l'Architecture conforme à ces modes [Buch 1989; Pauwels 2000].

Bosse's mentor, Nicolas Poussin, showed the same attitude, as testified by the famous letter *On the modes*, addressed to his patron Chantelou and dated November 24th 1647

[Jouanny 1911: 370-375; Blunt 1989]. Here Poussin teaches his reader to understand the *ethos* of a pictorial subject through the ancient theory of the musical modes exposed by the ubiquitous Zarlino [Lockspeiser 1967; Pomme de Mirimonde 1972; Mérot 1994; Barker 2000; Stumpfhaus 2005]. A parallel case may perhaps be found in the correspondences between the architectural orders and musical modes outlined in the different choices that Poussin made for the two series of the *Sept Sacrements* [Zara 2008b]. The reference to musical analogy is not confined to Poussin's correspondence. André Felibien, a diplomat who enjoyed an enviable academic career (*conseiller honoraire dell'Académie de Peinture, secrétaire de l'Académie d'Architecture, historiographe des Bâtiments du Roi*) and who in 1676 published the first French architectural dictionary (*Des Principes de l'Architecture, de la Sculpture et de la Peinture*) relates that Poussin's paintings contain an *ethos* that suggests the musical modes: *dorien, lydien, ionien*, and an improbable *lesbien*. Henri Testelin, his successor, did not forget his predecessor's teaching nor, unfortunately, his habitual inaccuracy; according to Testelin, the relevant modes were *phrygien* and *corinthien* (*sic!*) [Allard 1982; Montagu 1992].

5. In his *Parallèle de l'Architecture Antique avec la Moderne*, which Ouvrard read as a kind of moral inspiration, Roland Fréart de Chambray – translator of Palladio and Leonardo, and benefactor of Poussin, to whom he dedicates his *Idée de la Perfection de la Peinture* (1662) – identified the Solomonic order as 'the flower of Architecture and the order by the orders' [Fréart de Chambray 1650: 71]. He did fail to mention the fact that Juan Bautista Villalpando, in his widely received *In Ezechielem Explanationes* [Villalpando 1595-1604] had designed this order, to the most minute details of the metopes and triglyphs, in explicit reliance on the Pythagorean *tetraktys* [Ramirez 1991; Sanchez de Enciso 2008]. Because of the deep musical relationship affirmed in Villalpando's work, Claude Perrault mocked the author, accusing him of mystagogy with his ridiculous 'mystère des proportions' [Hermann 1967].

6. Returning to the *Architecture Harmonique*, we note that these two elements – the order and the musical analogy on a rhetorical and not a solely proportional plan – are present both in the genesis of the work and in its legacy. As we have noted, the treatise arose in reaction to the provocations of Perrault (see above), and as a result of the contest announced by Colbert in 1673 (the year of the opening of the *Académie d'Architecture*) for the creation of a sixth architectural order, the French order, which was to encompass in itself the character of the nation, and which was for this reason to be placed at the top floor of the *cour carrée* of the Louvre as summit and synthesis of all the other orders. At stake was the establishment of a rhetorical paradigm capable of giving life to a precise and peculiar character: the French national order. But Ouvrard was not interested in creating a new order, and merely recalled the musical rules, 'puisque sans la Doctrine des Proportions Harmoniques tous les Ordres d'Architecture ne sont que des amas confus de pierres sans ordre & sans regle' [Ouvrard 1679: 2]. For Ouvrard, a music theorist and pedagogue, proportion means character, as illustrated by the lore of the modes from Pythagoras and Plato and beyond. Perrault recognized the importance of this notion, as is clear from the programmatic 'Préface' of his *Ordonnance des Cinq Espèces des Colonnes*: 'il me reste de dire les raisons que j'ai de changer aussi quelque chose dans les Caractères qui distinguent les Ordres; ce qui est une license encore plus grande que celle de toucher aux proportions' [Perrault 1683: xxij-xxiv]. But unlike Ouvrard, Perrault considered proportion and character as two distinct notions. According to contemporary *Dictionnaire françois* of Pierre Richelet, Perrault considered 'caractère' to mean 'la

marque qui distingue une personne, ou une chose d'une autre' [Richelet 1680: 110]. It is a morphological sign, a distinguishing attribute which remains however fundamentally exterior the object, an addition. One century later Le Camus des Mézières criticised Perrault's idea exactly because of this distinction:

Il paroît qu'on ne peut varier que dans les ornemens & les hauteurs Rien de plus ingénieux que celui que Perrault a destiné à l'Ordre François; les masses sont à peu près les mêmes que celles de l'Ordre Corinthien. Mais les attributs en changent le caractère [...]. L'idée est ingénieuse, mais l'ensemble n'est enfin qu'un chapiteau composite, rien de nouveau dans les proportions, conséquemment point de sensations qui caractérisent un nouvel Ordre [Le Camus de Mézières 1780: 38-39].

This does not mean that Le Camus de Mézières acted in the same way as Ouvrard. It is important to emphasise that sixteenth-century architectural treatises tend to concentrate on the architectural orders, because in the diameter of the orders resides the principle of the rule [Szambien 1986]. This is true for Ouvrard (and this is the reason why he dismissed the creation of a new order in favour of a demonstration of the order of the law), but not for Le Camus de Mézières, who dedicated just a few pages to a discussion of the orders. Like the anthropomorphic paradigm, the notion of order from the universal became subjective during the seventeenth century [Rykwert 1998; Zara 2007 (2009)]. In the new and properly aesthetic value, the musical reference remains, but dismisses its *numerical* basis and now assumes a *rhetorical* model. 'Music means a range, not an essence' [Serravezza 2004: 125], a sentiment illustrated by Le Camus de Mézières:

Ne pourroit-on pas cependant employer dans cet Ordre des proportions mixtes ou participants des deux différens Ordres, comme on emploie les demi-tons? C'est une question à resoudre, & sans doute assez délicate [Le Camus de Mézières 1780: 38].

Nobody could find a solution. And for the very first time, a dissonance, the semitone, became a positive touchstone. But the presence of these elements, these actors, these words, suggests that such ideas had been circulating for some time. Moreover, the French context makes it clear that the link between music and architecture was now to be established not simply on the basis of numbers or proportions, but more properly on the basis of rhetoric.

3 The rhetorical model and the Hypnerotomachia Poliphili

In the fifteenth century a number of factors gathered independently around the analogy between music and architecture, and served to strengthen the rhetorical model of music and architecture. Although these are more or less independent, they combined to contribute to a redefinition of architecture. The most characteristic factors are as follows: the analogy made by Francesco Colonna in the *Hypnerotomachia Poliphili* (1499) between the 'compositional process' exercised by architects and composers; a misguided emendation to the text of Vitruvius made in 1511 by Frà Giocondo (1433-1515), which made Vitruvius' work seem more deeply dependent on the principle of proportion than is really the case; Colonna's substitution of Vitruvius' terms *ratiocinatio* and *fabrica* with Gaffurio's terms *lineamento* and *prattica*; and finally, the gradual adoption, over the course of the sixteenth century, of the metaphor of an architectural feature, the 'scale' (that is, a ladder or staircase), in the language of music. All these features show

independently that the model of rhetoric increasingly complemented the mathematical model of music and architecture current before the sixteenth century.

As we have already noted, the *mystère des proportions* had ancient origins: references can be found, perhaps with different *foci*, in Alberti, Zorzi, Barbaro and Palladio. Philibert Delorme, the first architect in France to write about architecture, announcing a book dealing entirely with the divine proportions – one that was however never to be published – repeats the *exempla* of Zorzi's Venetian *memorandum* about the Venetian church, even giving them in the same order:

Nous parlerons des saintes et divines proportions données de Dieux aux saints pères du vieil testament: comme à son Patriarche Noé, pour fabriquer l'Arche contre le cataclysme et déluge; à Moïse, pour le Tabernacle de l'autel, des tables, des courtines, du parvis et autres; à Salomon, pour le Temple qu'il édifia en Jérusalem ... [Delorme 1576: fol. 4r].

It is unknown if Delorme had seen the manuscript by the Venetian friar, whether directly in Venice during his stay there (a period that coincided with the construction of the Minorite Church), or indirectly through his teacher Serlio, one of those who had been commissioned by the doge to examine Zorzi's *memorandum*, and who would spend his last years working in France [Blunt 1958; Pérouse de Montclos 2001]. Nevertheless, it is clear that Delorme's description of the 'divines' contained some musical resonance. As Pérouse de Montclos states, the connexion may be indirect, for Zorzi's *memorandum* was based on the ideas expressed more fully in *De harmonia mundi totius* (see above).

But there is another book that preceded that of Zorzi and, as Carlo Dionisotti suggested, may have inspired it in several respects [Dionisotti 1968]: Francesco Colonna's *Hypnerotomachia Poliphili*, printed and published by Aldo Manuzio in Venice in 1499. This book was born in the same Venetian friary in which Francesco Zorzi lived, and was well known even into the seventeenth century; Félibien describes it as 'a book that all people know today' [Blunt 1958], and Blondel possessed the original version as well as a French translation made in the sixteenth century by Jean Martin, who also translated the works of Serlio, Vitruvius and Alberti [Gerbino 2002]. The architectural value of this 'strife of love in a dream' was immediately recognized by Colonna's contemporaries. In fact one can find there, years before Zorzi's speculations, not a simple comparison between architect and musician, but an assimilation of the method of design employed by the former to that used by the latter [Onians 1988: 207-215]:

Perche in alcuna parte havendo facto moto del fine debito allarchitectare, che e la præstante inventione, di acquistare modulatamente dil aedificio il solido corpo. Poscia licentemente quello invento, Lo Architecto perminute divisione el reduce, Ne piu ne meno quale il Musico havendo invento la intonatione & il mesurato tempo in una maxima quello da poi proportionando in minute Chromatiche concinnamente sopra il solido lui el riporta. Per tale similitudine dapo la inventione la principale regula peculiare al Architecto e la quadratura. Et questa distribuentila in parvissime, La harmonia se gli offerisce dil aedificio & commodulatione, Et al suo principale gli convenienti correlarii [Colonna 1499: fol. c iiiii].

(This is why I have spoken in several places about the proper goal of architecture, which is its supreme invention: the harmonious establishment of the solid body of a building. After the architect has done this, he reduces it by minute divisions, just as the musician sets the scale and the largest unit of rhythm before subdividing them proportionately into chromaticisms and small notes. By analogy with this, the first rule that the architect must observe after the conception of the building is the square, which is subdivided to the smallest degree to give the building its harmony and consistency and to make the parts correlate with the whole [Colonna 1999: 47].)

Colonna's use of the word *concinnamente* shows that he was a careful reader of Alberti. (We do not need to resort to the excessive conclusions of Liane Lefavre, who identified Colonna with Alberti despite all the philological, historical and lexicographical evidence to the contrary) [Schmidt 1978; Borsi 1995; Lefavre 1997]. However, there is a fundamental difference in their respective approaches. Alberti had worked in an ontological and metaphorical model in which proportions (embodied for example in the Pythagorean *tetraktys*) reflect the harmony of cosmos; for him, this harmony should also stand as the basis for architecture. By contrast, Colonna's point of departure was a practical one, defined by the initial blueprint (the *preliminare quadratura*). The passage cited above is fundamental, for it reveals two important points: firstly, the evolution of architectural practice from the medieval model, which was based on the practical experience of the building site, to the renaissance model, which was based on a projectual design (the *cosa mentale*); and secondly, a conviction that the architect, when designing his project, must act in a way analogous to the composer. It is in Colonna's text that we first find this comparison made so clearly. The architect is no longer compared to the practical musician – the *cantor* of the medieval tradition – but rather to the learned theorist, the *musicus*, who manipulates both dimensions of *scientia musica* – the vertical axis (the *intonatione* of the intervals determined by the monochord) and the horizontal axis (the *mensurato tempo*, the relationships of prolation between the different temporal values) – and records what he had conceived mentally through notation. For Colonna, this is equivalent to the architect's preliminary *quadratura* [Zara 2010]. In my opinion, this change in approach reveals a switch to a linear concept of architecture, one which is not only anthropomorphic but more precisely rhetorical, linear and not volumetric, qualitative rather than quantitative.

In her study of the architectural representation contained in the *Hypnerotomachia Poliphili* and of the conceptual mechanisms that hold Colonna's descriptions, Roswitha Stewering points out the following:

Contrary to the anthropomorphic conception of architecture, in which human proportions are considered the basis for the aesthetic norm, in the 'Hypnerotomachia' architectural theory seeks to incorporate human qualities: reason is manifested in harmonious proportions [Stewering 2000: 10].

This integration of human qualities into mathematical measure makes it possible to achieve an assimilation of the musical theory of affects and the anthropomorphic theory of the architectonic orders in a rhetorical key. Take for example the following passage: 'The place and situation seemed very difficult [*laborioso*]. Logistica accordingly, noticing this, immediately began to sing in the Dorian mode [*cum Dorio modo & tono di*

cantare].’ Here Colonna assigns a musical logic to the architectural one defined by Alberti for the Doric order, which he describes as ‘rather suitable for work’ (*ad laborem aptius*) [Colonna 1499: f. i]. A similar process happens to Venus, whose song is in the Lydian mode and whose the temple is built on Corinthian columns, the mode and order particular to the goddess of love [Onians 1988: 211-212]. This attitude reveals a change from a linear to a volumetric concept of harmony in architecture, a change from a quantitative mathematics based on *symmetria* and a qualitative mathematics based on *eurhythmia*. This shift is expressed by a textual amendment suggested in 1511 by Frà Giocondo to a contested passage near the beginning of the first book of Vitruvius’ *De architectura*: *Ratiocinatio autem est quae res fabricatas sollertiae ac rationis pro portione demonstrare atque explicare potest*. Frà Giocondo amended *sollertiae ac rationis pro portione* to *solertia ac ratione proportionis* [Vitruvius 1511: f. A1r-v]. This amendment – accepted by most sixteenth century editors, such as Georg Messerschmidt (1543), Guillaume Philandrier (1552) and Daniele Barbaro (1567) – gives the misleading impression that Vitruvius considered proportion as a guiding principle of his work right from the beginning of the first book, rather than being restricted to his discussion (in the third book) of the analogy between the proportions of architecture and those of the human body. While fifteenth-century commentators on Vitruvius seem to agree with the master’s definition of architectural *ratiocinatio* – with construction (*fabrica*) as one of the two elements of architectural knowledge – Frà Giocondo’s amendment gives quite a different impression of Vitruvius’ project. This change of attitude is attested in the passage from Colonna, who clearly thinks of proportion as the basis of the *preliminare quadratura*. As Pierre Caye comments:

Frà Giocondo, and Philandrier after him, does not read *proportione rationis*, but *proportionis ratione*, that is, ‘according to the principle of proportion’. [If one reads the text with Giocondo’s emendation,] the theory of proportions, that is the use of mathematics, that till then in Vitruvius occurred only in the third book (in the formal context of the description of the body and the description of figures), appears right from the first book as the primary operator of the architectural method of the conception of the project [Caye 2007 (my trans.)].

While Vitruvius works in terms of volume, the new focus on proportion, while already hinted at in Alberti, becomes fully evident in Colonna (thanks to the musical analogy), and comes to fuller expression in Giocondo’s misguided emendation of Vitruvius, which would be widely accepted by subsequent sixteenth-century editors. Colonna does not use Alberti’s terms *utilitas* and *pulchritudo*, but substitutes for them the terms *lineamento* and *prattica* respectively, which are taken not from Vitruvius’ distinction between *ratiocinatio* and *fabrica*, but are borrowed (in Italian translation) from the contemporary music theorist Franchino Gaffurio (*Theoricum opus musicae disciplinae* and *Practica musicae*) [Onians 1988: 208]. For Colonna, the architect no longer uses the mechanical mediaeval process of design *ad quadratum* or *ad triangulum*; rather, by analogy with music, the architect obtains a law or a measure to which every part of the project is related (*Io Architetto perminute divisioni el reduce*). Palladio’s letter to Giovan di Pepolli suggests that he may have been aware of the relation between the anthropomorphic paradigm and musical proportion under the sign of *eurhythmia*:

L’architettura non è altro che una proporzione dei membri in un corpo, cussi ben l’uno con gli altri e gli altri con l’uno simetriati e corrispondenti, che armonicamente rendino maestà e decoro [...] dee il corpo con membri

e questi con quello aver insieme armonica proporzione, e che da quello nasce poi quel bello che da gli antichi greci Heurithmia [sic] vien detto: che altro non vuol dire che cussi ben composto corpo che più non si desidera [Portoghesi 2008: 177].

The final testimony to the rise of a rhetorical approach to music in the sixteenth century is the gradual application of an architectural feature – the staircase (*scala*) – to a basic musical phenomenon. Over the course of the sixteenth century, the term ‘scale’ gradually ousted the Greek term *systema*. The metaphor of the ‘musical staircase’ first appears in Andreas Ornithoparchus’ *Musice Actiue Micrologus* (1517). In the second edition of his *Commento a Vitruvio* (1567), Barbaro felt it necessary to define this term. Zarlino manoeuvres it with caution, preferring the old term *sistema*. The presence of the word – and the metaphor – in the title of Ottavio Scaletta’s treatise *Scala di musica necessaria per principianti* (1585) signals its definitive adoption [Giani 2000].

4 Conclusions

The new relationship between music and architecture, brought to maturity in the seventeenth century, illustrates a fundamental shift in the conceptualisation of architecture, a change that goes beyond analogical agreement and that touches directly on the foundation and the nature of architectural thought and its definition. This knowledge had been sketched in a speculative and literary way in the fifteenth century, was developed to some extent in a rhetorical conception of the harmonic parallels between music and architecture during the sixteenth century, and was at last completely encoded in the seventeenth. The narrative presented here thus poses a serious challenge to Wittkower’s assertion that the analogy between architecture and music, laid down in the Italian Renaissance, broke down during the seventeenth century, degenerating particularly in France into a kind of formalism.

Many questions arise from this interpretation, which deserve more attention than can be offered here. First of all, in my opinion, is the spiritual legacy presented by the biblical description of Solomon’s temple as an ideal archetype for Christian churches. The presence of this heritage is particularly evident in Villalpando and Ouvrard, in each case with some kind of musical connexion. The very universality of the Solomonic model led Perrault to ridicule his predecessors and offer a more austere and ‘purified’ version. Also deserving of more attention is the central figure of Sebastiano Serlio, who examined Zorzi’s *memorandum* and later taught Delorme; Serlio is rightly described by Yves Pauwels from a rhetorical perspective as *Praeceptor Galliae* [Pauwels 2002]. Serlio’s riddle-speculations on order and decoration, as well his hidden theological ideas, still divide historians [Tafari 1985; Carpo 1993; Frommel 1998]; and as yet there has been no study of his musical knowledge. And we must take account, even in discussions of music, of the role of images in the transmission of theoretical knowledge [Collins Judd 2000]. A case in point is the possible relationship between Francesco di Giorgio Martino’s design for the church of Santa Costanza, the design of the temple of Venus in Colonna’s *Hypnerotomachia*, and Delorme’s design for a church based perfectly on divine (or musical?) proportions. What is the relationship between these three designs? How did the design pass from one hand to another? Delorme perhaps knew the *Hypnerotomachia*, but had he seen Martino’s design? What did these men know of their respective predecessors? The problem of the circulation of architectural images is one that is only beginning slowly to be studied in depth [Carpo 1998; 2001].

This historical revision is intended to pose a number of questions that might lead to a better understanding of the nature of the parallels between music and architecture. Such a reconsideration must take into account the fact that the analogical relationship that links the two disciplines consists not simply of the application of musical proportions to the spatial dimensions of a building, but also reflects fundamental epistemological shifts, such as the move from a consideration of abstract intervals to intervals between real sounds; or particular developments in the interpretation of canonical texts. Analogy is much more rich, nuanced, complex and fascinating.

Acknowledgments

First of all I wish to thank Marco Martin and Maria Semi, who from distant lands and with infinite kindness, translated the initial version of this essay. But, above all, my thanks and gratitude go to Grantley McDonald, who not only turned English from a second language into that of a native speaker, but also helped me, through questions and acute criticism, clarify several passages of the present work. If my line of argument is clear, it is thanks to him.

References

- Allard, Joseph C. 1982. Mechanism, Music, and Painting in 17th Century France. *The Journal of Aesthetics and Art Criticism* 40, 3: 269-279.
- BARKER, Naomi Joy. 2000. 'Diverse Passions': Mode, Interval and Affect in Poussin's Paintings. *Music in Art* 25, 1-2: 5-24.
- BATTISTI, Eugenio. 1968. Le tendenze all'unità verso la metà del Cinquecento. *Bollettino del Centro Internazionale di Studi di Architettura Andrea Palladio* 10: 127-146.
- . 1973. Un tentativo di analisi strutturale del Palladio tramite le teorie musicali del Cinquecento e l'impiego di figure retoriche. *Bollettino del Centro Internazionale di Studi di Architettura Andrea Palladio* 15: 211-232.
- BERNIN DE SAINT-HILARION, François. 1680. *Des Proportions d'Architecture*. Munich, Bayerische Staatsbibliothek, Cod. Icon 193.
- BLONDEL, François. 1675-1683. *Cours d'Architecture enseigné dans l'Académie Royale d'Architecture*. Paris: P. Abouin and F. Clouzier.
- BLUNT, Anthony. 1937. The Hyperotomachia Poliphili in the 17th Century France. *Journal of the Warburg Institute* 1, 2: 117-127.
- . 1958. *Philibert De l'Orme*. London: Zwemmer.
- BONHÔTE, Jean-Marc. 1971. Resonance musicale d'une ville de Palladio. *Musica Disciplina* 25: 171-178.
- BORSI, Stefano. 1995. *Polifilo architetto. Cultura architettonia e teoria artistica nell' 'Hypnerotomachia Poliphili' di Francesco Colonna, 1499*. Rome: Officina.
- BRAULT, Yoann. 2006. La défense des proportions dans le 'Cours d'Architecture' de François Blondel. Pp. 30-38 in *Claude Nicolas Ledoux et le livre d'architecture – Étienne Louis Boullée l'utopie et la poésie de l'art*, Daniel Rabreau and Dominique Massounie eds. Paris: Monum.
- BRENET, Michel [Bobillier, Marie]. 1910. *Les Musiciens de la Sainte-Chapelle du Palais*. Paris: Picard.
- BRISEUX, Charles-Etienne. 1752. *Traité du beau essentiel dans les arts, Appliqué particulièrement à l'Architecture, et démontré Physiquement et par l'Expérience; Avec Un traité des Proportions Harmoniques, et l'on fait voir que c'est de ces seules Proportions que les Édifices généralement approuvés, empruntent leur Beauté réelle et invariable*. Paris: Chez l'Auteur et Chereau.
- BUCH, David J. 1989. The Coordination of Text, Illustration, and Music in a Seventeenth-Century Lute Manuscript: 'La Rhétorique des Dieux'. *Imago Musicae* 6: 39-81.
- CAMPANINI, Saverio. 2007. Francesco Zorzi: armonia del mondo e filosofia simbolica. Pp. 239-260 in *Il pensiero simbolico nella prima età moderna*, Annarita Angelini and Pierre Caye, eds. Florence: Olschki.
- CAYE, Pierre and CHOAY Françoise. 2004. *Leon Battista Alberti: L'Art d'Édifier*. Paris: Seuil.
- CAYE, Pierre. 2007. L'édition du 'De architectura' de Vitruve et la constitution du savoir architecturale à la Renaissance, comunicazione letta al Colloquio Internazionale L' 'Archivium'

- et le travail de la pensée. Humanisme philologique, humanisme philosophique, Paris, 22-23 May 2007.
- CARPO, Mario. 1993. *La maschera e il modello. Teoria architettonica ed evangelismo nell' 'Extraordinario Libro' di Sebastiano Serlio*. Milan: Jaca Book.
- . 1998. *L'architettura dell'età della stampa. Oralità, scrittura, libro stampato e riproduzione meccanica dell'immagine nella storia delle teorie architettoniche*. Milano: Jaca Book (Eng. trans. *Architecture in the Age of Printing. Orality, Writing, Typography, and Printed Images in the History of Architectural Theory*, Sarah Benson, trans. Cambridge, MA: The MIT Press, 2001).
- . 2001. How Do You Imitate a Building That You Have Never Seen? Printed Images, Ancient Models, and Handmade Drawings in the Renaissance Architectural Theory. *Zeitschrift für Kunstgeschichte* **64**, 2: 223-233.
- COHEN, Albert. 1974. René Ouvrard (1624-1694) and the beginnings of French Baroque Theory. *Report of the Eleventh ISM Congress – Copenhagen 1972*. Copenhagen: Wilhelm Hansen, vol. I, pp. 336-342.
- . 1975. The Ouvrard-Nicaise correspondence (1663-93). *Music & Letters* **56**, 3-4: 356-363.
- COLONNA, Francesco. 1499. *Hypnerotomachia Poliphili*. Venice: In aedibus Aldi Manutii.
- . 1999. *Hypnerotomachia Poliphili. The Strife of Love in a Dream*. Joscelyn Godwin, trans. London: Thames & Hudson.
- COLLINS JUDD, Cristle. 2000. *Reading Renaissance Music Theory. Hearing with the Eyes*. Cambridge: Cambridge University Press.
- COSTANTINI, Michela. 2002. La trasformazione storica dell'applicazione dei rapporti musicali all'architettura attraverso la lettura armonica della base attica. *Le culture della tecnica*, nuova serie **14**: 75-102.
- DELORME, Philibert [Philibert de l'Orme]. 1567. *Premier tome de l'architecture de Philibert De l'Orme conseiller et aumônier ordinaire du Roi, et abbé de S. Serge les Angiers*. Paris: Federic Morel.
- DIONISOTTI, Carlo. 1968. *Gli umanisti e il volgare fra Quattro e Cinquecento*. Florence: Le Monnier.
- FICHET, Françoise. 1979. *La théorie architecturale à l'âge classique. Essai d'anthologie critique*. Liège: Mardaga.
- FOSCARI, Antonio and TAFURI, Manfredo. 1983. *L'armonia e i conflitti: la chiesa di San Francesco della Vigna nelle Venezia del 500*. Torino: Einaudi.
- FRÉART DE CHAMBRAY, Roland. 1650. *Parallèle de l'Architecture Antique et Moderne, avec un Recueil des Six Principaux Auteurs qui ont écrit des Cinq Ordres, savoir: Palladio et Scamozzi, Serlio et Vignola, D. Barbaro et Cataneo, L. B. Alberti et Viola, Bullant et De l'Orme, comparés entre eux. Par R. Fréart, sieur de Chambray*. Paris: E. Martin. (Modern ed.: *Parallèle de l'architecture antique avec la moderne suivi de Idée de la perfection de la peinture*, Frédérique Lemerle-Pauwels and Milovan Stanic, eds. Paris: Ecole Nationale Supérieure des Beaux-Arts, 2005.)
- FROMMEL, Sabine. 1998. *Sebastiano Serlio architetto*. Milan: Electa.
- GERBINO, Anthony. 2002. The Library of François Blondel 1618-1686. *Architectural History* **45**: 289-324.
- . 2010. *François Blondel: Architecture, Erudition, and the Scientific Revolution*. London & New York: Routledge.
- GIANI, Maurizio. 2000. Scala musica. Vicende di una metafora. Pp. 31-48 in *Le parole della musica. III. Studi di lessicologia musicale*, Fiamma Nicolodi and Paolo Trovato, eds. Florence: Olschki.
- GIOSEFFI, Decio. 1972. Il disegno come fase progettuale dell'attività palladiana. *Bollettino del Centro Internazionale di Studi di Architettura Andrea Palladio* **14**: 45-62.
- . 1978. Dal progetto al trattato: incontro e scontro con la realtà. *Bollettino del Centro Internazionale di Studi di Architettura Andrea Palladio* **20**: 27-45.

- . 1980a. I disegni dei ‘Quattro Libri’ come modelli: modellistica architettonica e teoria dei modelli. *Bollettino del Centro Internazionale di Studi di Architettura Andrea Palladio* 22: 147-64.
- . 1980b. Convegno palladiano: precisazioni dovute. *Bollettino del Centro Internazionale di Studi di Architettura Andrea Palladio* 22, 2: 193-203.
- . 1989. Palladio oggi: dal Wittkower al postmoderno. *Annali di architettura* 1: 105-121.
- GODMAN, Rob. 2008. The Enigma of Vitruvian Resonating Vases and the Relevance of the Concept for Today. *International Computer Music Conference Proceedings*, Queen’s University, Belfast. Available at: <http://quod.lib.umich.edu/cgi/t/text/pagevieweridx?c=icmc;idno=bbp2372.2008.065;cc=icmc;view=image> (last accessed 3 January 2011).
- GOZZA, Paolo. 2007 (2009). I suoni taumaturghi. Un’estetica musicale barocca dello spossamento. *Musica e Storia* 15, 2: 417-441.
- HERRMANN, Wolfgang. 1967. Unknown designs for the ‘Temple of Jerusalem’ by Claude Perrault. Pp. 143-158 in *Essays in the History of Architecture presented to Rudolf Wittkower*, Douglas Fraser, Howard Hibbard and Milton J. Lewine, eds. London: Phaidon.
- . 1973. *The theory of Claude Perrault*. London: Zwemmer.
- HERSEY, George L. 1976. *Pythagorean Palaces. Magic and Architecture in the Italian Renaissance*. Ithaca: Cornell University Press.
- . 2000. *Architecture and Geometry in the Age of the Baroque*. Chicago: University of Chicago Press.
- HOWARD, Deborah and Malcolm LONGAIR. 1982. Harmonic Proportion and Palladio’s ‘Quattro Libri’. *Journal of the Society of Architectural Historians* 41, 2: 116-143
- JOUANNY, Charles. 1911. *Correspondance de Nicolas Poussin*. Paris: Jean Schemit.
- KAPRAFF, Jay and Ernest G. MCCLAIN. 2005. The System of Proportions of the Parthenon: A Work of Musically Inspired Architecture. *Music in Art* 30, 1-2: 5-16.
- LE CAMUS DE MÉZIÈRES, Nicolas. 1780. *Le génie de l’architecture; ou, L’analogie de cet art avec nos sensations*. Paris: B. Morin. (Eng. trans. *The Genius of Architecture; or, The Analogy of That Art with Our Sensations*, Robin Middleton, ed. Chicago: University of Chicago Press, 1992.)
- LEFAIVRE, Liane. 1997. *Leon Battista Alberti’s Hypnerotomachia Poliphili. Re-Cognizing the Architectural Body in the Early Italian Renaissance*. Cambridge, MA: MIT Press.
- LEMERLE, Frédérique. 2006. Claude Perrault théoricien: l’ ‘Ordonnance des Cinq Espèces de Colonnes’ (1683). Pp. 18-29 in *Claude Nicolas Ledoux et le livre d’architecture – Étienne Louis Boullée l’utopie et la poésie de l’art*, Daniel Rabreau and Dominique Massounie eds. Paris: Monum.
- LEMONNIER, Henry. 1912. *Procès-Verbaux de l’Académie Royale d’Architecture 1671-1793*. 10 vols (1911-1929). Paris, Jean Schemit.
- LOCKSPEISER, Edward. 1967. Poussin et les modes. *Revue de Musicologie* 53: 61-64.
- MAMBELLA, Guido. 2008. Corpo sonoro, geometria e temperamenti. Zarlino e la crisi del fondamento numerico della musica. Pp. 185-233 in *Music and Mathematics in Late Medieval and Early Modern Europe*, Philippe Vendrix ed. Turnhout: Brepol.
- MARCH, Lionel. 1998. *Architectonics of Humanism: Essays on Number in Architecture*. London: Wiley-Academy.
- . 2008. Palladio, Pythagoreanism and Renaissance Mathematics. *Nexus Network Journal* 10, 2: 227-244.
- MARTIN, Marie-Pauline. 2006. L’analogie des proportions architecturales et musicales: évolution d’une stratégie. Pp. 40-47 in *Claude Nicolas Ledoux et le livre d’architecture – Étienne Louis Boullée l’utopie et la poésie de l’art*, Daniel Rabreau and Dominique Massounie eds. Paris: Monum.
- MÉROT, Alain. 1994. Les modes, ou les paradoxes du peintre. Pp. 80-86 in *Nicolas Poussin 1594-1665*, exhibition catalogue, Pierre Rosenberg and Louis-Antoine Prat eds. Paris: RMN.
- MILLON, Henry A. 1972. Rudolf Wittkower, ‘Architectural Principles in the Age of Humanism’: Its Influence on the Development and Interpretation of Modern Architecture. *Journal of the Society of Architectural Historians* 31, 2: 83-91

- MITROVIC, Branko. 1990. Palladio's Theory of Proportions and the Second Book of the 'Quattro Libri dell'Architettura'. *Journal of the Society of Architectural Historians* **49**, 3: 279-292.
- . 1998. Paduan Aristotelianism and Daniele Barbaro's Commentary on Vitruvius 'De Architectura'. *Sixteenth Century Journal* **29**, 3: 667-688.
- . 1999. Palladio's Theory of the Classical Order and the First Book of 'I Quattro Libri dell'Architettura'. *Architectural History* **42**, 2: 110-140.
- . 2001. A Palladian Palinode: Reassessing Wittkower's 'Architectural Principles in the Age of Humanism'. *Architettura* **31**, 2: 113-131.
- . 2004. *Learning from Palladio*. New York: Norton.
- MOURJOPOULOS, Vassilantopoulos. 2003. A study of Ancient Greek and Roman Theater. *Acta Acoustica* **89**: 123-136.
- NAREDI-RAINER, Paul von. 1977. Musikalische Proportionen, Zahlenästhetik und Zahlensymbolik im architektonischen Werk L. B. Albertis. *Jahrbuch des Kunsthistorischen Institutes der Universität Graz* **12**: 81-213.
- . 1982. *Architektur und Harmonie. Zahl, Maß und Proportion in der abendländischen Baukunst*. Köln: DuMont.
- . 1985. Musiktheorie und Architektur. Pp. 149-174 in *Geschichte der Musiktheorie. I. Ideen zu einer Geschichte der Musiktheorie*, Frieder Zaminer ed. Darmstadt: Wissenschaftliche Buchgesellschaft.
- . 1994. La bellezza numerabile: l'estetica architettonica di Leon Battista Alberti. Pp. 292-299 in *Leon Battista Alberti*, Joseph Rykwert and Anne Engel eds. Milan: Olivetti-Electa.
- ONIAN, John. 1988. *Bearers of Meaning. The Classical Orders in Antiquity, the Middle Ages and the Renaissance*. Princeton: Princeton University Press.
- OUVRARD, René. 1679. *Architecture Harmonique, ou l'Application de la Doctrine des Proportions de la Musique à l'Architecture*. Paris: J. B. de la Caille.
- PAYNE, Alina A. 1994. Rudolf Wittkower and Architectural Principles in the Age of Modernism. *Journal of the Society of Architectural Historians* **53**: 322-342.
- PAUWELS, Yves. 2000. 'Harmonia est discordia concors': le modèle musical dans l'architecture des temps modernes. Pp. 313-325 in *L'Harmonie*, Charles Charraud ed. Orléans: Meaux.
- . 2002. *L'architecture au temps de la Pléiade*. Paris: Monfort.
- PÉROUSE DE MONTECLOS, Jean-Marie. 2000. *Philibert de l'Orme. Architecte du Roi (1514-1570)*. Paris: Mengès.
- PICON, Antoine. 1989. *Claude Perrault ou la curiosité d'un classique*. Paris: Picard.
- PINTORE, Angela. 2004. Musical Symbolism in the Works of Leon Battista Alberti. From 'De re aedificatoria' to the Ruccelai Sepulchre. *Nexus Network Journal* **6**, 2: 49-70.
- POMME DE MIRIMONDE, Albert. 1972. Poussin et la musique. *Gazette des Beaux-Arts* **79**: 129-150.
- PORTOGHESI, Paolo. 2008. *La mano di Palladio*. Torino: Allemandi.
- RAMÍREZ, Juan Antonio, ed. 1991. *Dios Arquitecto. J. B. Villalpando y el Templo de Salómon*. Madrid: Siruela.
- RYKWERT, Joseph. 1996. *The Dancing Column: On Order of Architecture*. Cambridge, MA: MIT Press.
- ROBISON, Elwin C. 1998-99. Structural Implications in Palladio's Use of Harmonic Proportions. *Annali di architettura* **10-11**: 175-182.
- SAMSA, Danilo. 2003. L'Alberti di Wittkower. *Albertiana* **6**: 51-94.
- SANCHEZ DE ENCISO, Sabina. 2008. Música y arquitectura en el 'De postrema Ezechielis prophetae visione' de J.B. Villalpando. *Cuadernos de Música Iberoamericana* **15**: 7-40.
- SERRAVEZZA, Antonio and Paolo GOZZA. 2004. *Estetica 'e' musica. L'origine di un incontro*. Bologna: CLUEB.
- SCALVINI, Maria Luisa and Sergio VILLARI. 1991. *Claude Perrault: L'ordine dell'architettura*. Palermo: Aesthetica Preprint.
- . 1994. *Il manoscritto sulle proporzioni di François Bernin de Saint-Hilarion*. Palermo: Aesthetica Preprint.

- SCHMIDT, Dorothea. 1978. *Untersuchungen zu den Architekturekphrasen in der Hypnerotomachia Poliphili. Die Beschreibung des Venus-Tempels*. Frankfurt am Main: R. G. Fischer.
- STEWERING, Roswitha. 2000. Architectural Representations in the 'Hypnerotomachia Poliphili' (Aldus Manutius, 1499). *Journal of the Society of Architectural Historians* **59**: 16-25.
- STUMPFHAUS, Bernhard. 2005. *Modus – Affekt – Allegorie bei Nicolas Poussin*. Reimer: Dietrich.
- SZAMBIEN, Werner. 1986. *Symétrie Goût Caractère. Théorie et terminologie de l'architecture à l'âge classique 1550-1800*. Paris: Picard.
- TAFURI, Manfredo. 1985. *Venezia e il Rinascimento. Religione, scienza, architettura*. Torino: Einaudi.
- TESTA, Fausto. 2003. Il 'Traité du Beau Essentiel' di C.-E. Briseux e il tema delle proporzioni armoniche nella teoria architettonica del secolo dei Lumi. *Oltrecorrente* **7**, 1: 143-154.
- VASOLI, Cesare. 1998. Il tema musicale e architettonico della 'Harmonia Mundi' da Francesco Giorgio veneto all'Accademia degli Uranici e a Gioseffo Zarlino. *Musica e Storia* **6**, 1: 193-210.
- VENDRIX, Philippe. 1988. René Ouvrard et l'évolution de l'art musical. *Revue belge de musicologie* **42**: 193-197.
- . 1989. Proportions harmoniques et proportions architecturales dans la théorie française des XVII^e et XVIII^e siècles. *International Review of the Aesthetics and Sociology of Music* **20**, 1: 3-10.
- . 1992. L'augustinisme musical en France au XVII^e siècle. *Revue de Musicologie* **78**: 237-255.
- VERGO, Peter. 2005. *That Divine Order. Music and the Visual Arts from Antiquity to the Eighteenth Century*. London: Phaidon.
- VILLALPANDO, Juan Bautista and Jeronimo DEL PRADO. 1595-1604. *Ezechielem Explanaciones et Apparatus Urbis ac Templi Hierosolymitani*, Rome: A. Zanetti.
- VITRUVIUS. 1511. *M. Vitruvius per Iocundum solito castigatior factus cum figuris et tabula ut iam legi et intelligi possit*. Venice: Giovanni Tacuino de Tridino.
- . 1543. *M. Vitruvii viri svæ professionis peritissimi, de architectura libri decem, ad Augustum Cæsarem accuratiss. conscripti: & nunc primum in Germania qua potuit diligentia excusi, atque hinc inde schematibus non iniucundis exornati*. Strasbourg: Knobloch-Machæropiceus [Messerschmidt].
- . 1552. *M. Vitruvii Pollionis de architectura libri decem ad Cæsarem Augustum, omnibus omnium editionibus longè emendatiores, collatis veteribus exemplis*, Guillaume Philandrier, ed. Lyon: Jean de Tournes.
- . 1567. *M. Vitruvii Pollionis de architectura libri decem, cum commentariis Danielis Barbari, electi Patriarchæ Aquileiensis*. Venice: Franciscus Franciscium Sensensis & Ioannes Crugher Germanus.
- WITTKOWER, Rudolf. 1949. *Architectural Principles in the Age of Humanism*. London: Warburg Institute. (Citations in this present paper taken from the 3rd ed., London: Academy Editions, 1962.)
- ZANONCELLI, Luisa. 1999. Reciproche influenze dell'idea di 'divina proporzione'. Pp. 199-212 in *Leon Battista Alberti. Architettura e cultura*, Claudio Gallico ed. Florence: Olschki.
- . 2007. La musica e le sue fonti nel pensiero di Leon Battista Alberti. Pp. 85-116 in *Leon Battista Alberti teorico delle arti e gli impegni civili del 'De re aedificatoria'*, Arturo Calzona, Francesco Paolo Fiore, Alberto Tenenti and Cesare Vasoli eds., 2 vols. Florence: Olschki.
- ZARA, Vasco. 2005. Musica e Architettura tra Medio Evo e Età moderna. *Storia critica di un'idea. Acta Musicologica* **77**, 1: 1-26
- . 2006. Antichi e Moderni tra Musica e Architettura. All'origine della 'Querelle des Anciens et des Modernes'. *Intesezioni* **26**, 2: 191-210.
- . 2007. Da Palladio a Wittkower. Questioni di metodo, di indagine e di disciplina nello studio dei rapporti tra musica e architettura. Pp. 153-190 in *Prospettive di iconografia musicale*, Nicoletta Guidobaldi ed. Milan: Mimesis.
- . 2008a. Una storia della musica all'ombra di Port-Royal: la 'Musique Rétablie' di René Ouvrard. *Studi Musicali* **37**, 1: 59-100

- . 2008b. Modes musicaux et ordres d'architecture: migration d'un modèle sémantique dans l'œuvre de Nicolas Poussin. *Musique – Images – Instruments. Revue française d'organologie et d'iconographie musicale* **10**: 62-79
- . 2007 (2009). Suono e carattere della base attica. Itinerari semantici d'un metafora musicale nel linguaggio architettonico francese del Settecento. *Musica e Storia* **15**, 2: 443-474
- . 2010. Dall' 'Hypnerotomachia Poliphili' al Tempio di Salomone. Modelli architettonico-musicali nell' 'Architettura Harmonique' di René Ouyard, 1679. Pp. 131-156 in *La réception de modèles 'cinquecenteschi' dans la théorie et les arts français du XVII^e siècle*, Sabine Frommel and Flaminia Bardati, eds. Geneva: Droz.
- ZARLINO, Gioseffo. 1558. *Le istituzioni harmoniche*. Venetia: Francesco de' Franceschi.

About the author

Vasco Zara is Maître de conférences in ancient music at the Université de Bourgogne of Dijon, researcher at the Unité Mixte de Recherche 5594 « ARTeHIS » of the Université de Bourgogne, and associated member of the Centre d'Études Supérieures de la Renaissance (Tours). He obtained his Ph.D. from the University of Bologna and from the Centre d'Études Supérieures de la Renaissance (Tours), with a dissertation on the works and theory of René Ouyard, maître de musique at the Sainte-Chapelle in Paris during the second half of the Sixteenth-Century (and whose correspondence and *Architettura Harmonique, ou l'Application de la Doctrine des Proportions de la Musique à l'Architecture*, will be published shortly). He is one of the directors, together with Philippe Vendrix (CESR, Tours) and Ennio Stipcevic of Zagreb's Academy of Sciences, of the research program Renaissance Music in Croatia (<http://ricercar.cesr.univ-tours.fr/3-programmes/EMN/Croatie>). An affirmed scholar in the studies that deal with the relationship between music and architecture during the Medieval and the Renaissance periods, he is the bibliographical referee for the Study Group on Musical Iconography about these topics. His actual research focuses on the relations between polyphony, geometry and theology in the fourteenth and fifteenth centuries.