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Architecture is a science

Pierre Caye

Architectura est scientia... These were the terms in which Renaissance culture read and understood the definition that opens Book One of Vitruvius's *De architectura*.¹ "Architecture is a science", and furthermore, one "arising out of many other sciences, and adorned with much and varied learning; by the help of which a judgment is formed of those works which are the result of other arts".² A second definition then builds on the first: "Practice [*fabrica*] and theory [*ratiocinatio*] are its parents. Practice is the frequent and continued contemplation of the mode of executing any given work, or of the mere operation of the hands, for the conversion of the material in the best and readiest way. Theory is the result of that reasoning which demonstrates [*sollertia*] and explains that the material wrought has been so converted as to answer the end proposed [*ratione proportionis*]".

Architecture is a science for five reasons clearly expressed in these two definitions:

- 1) Architecture is a science first and foremost because it is an encyclopedic body of knowledge resting, as Vitruvius states, on "many other sciences and [...] much and varied learning". Based on his two definitions, Vitruvius sets out what amounts to a complete training course for architects, requiring them to master a wide range of theoretical and practical knowledge – mainly mathematics, both theoretical (geometry, arithmetics, music, and astronomy, known collectively as the

1 The earliest, pre-fifteenth-century manuscripts offer another, less determinant lesson: not *Architectura est scientia*, but *Architecti est scientia*, i.e. there is a body of knowledge proper to the architect. This is the lesson foregrounded by modern editions of *De architectura*.

2 *The Architecture of Marcus Vitruvius Pollio*, tr. J. Gwilt. London: Priestly and Weale, 1826, p. 3. The French translation quoted in the original version of this essay is based on the first edition by Fra Giocondo (*De architectura MP Vitruvii libri decem*, ed. Fra Giovanni Giocondo, De Tridino, Venise, 1511), which differs from that established by contemporary philologists.

quadrivium), and applied (accountancy, surveying, optics), but also covering draftsmanship, literature, medicine, and history. Vitruvius and his Renaissance commentators laid one of the major cornerstones for the encyclopedic approach to scholarship, which triumphed in the latter half of the eighteenth century with Diderot and d'Alembert's great Paris *Encyclopédie*. The aim was not, Vitruvius added, to achieve expertise in every field, but to know the basics to the extent of grasping their affinities and mutual points of overlap – the very definition of the encyclopedic approach. It may be thought to be stretching a point to justify the inclusion of Vitruvius's architect in the humanist tradition on the grounds of their encyclopedic training. Alberti's famous treatise *On the Art of Building* does, after all, restrict architectural training to mathematics and drawing.³ But reading his work, it becomes clear that he also drew on an encyclopedic range of knowledge with considerable erudition to write his own treatise. The encyclopedic approach characterizes the teaching of architecture to this day. It can even be argued that the post-1968 teaching reforms brought the old didactic tradition back into favor, with new forms of knowledge and new methods, but also with a touch more uncertainty over the rigorous nature of the dialog between the various bodies of knowledge being taught.

- 2) Vitruvian architecture, particularly in its Renaissance interpretation, is not simply an encyclopedic science, but an *architectonic* science, i.e. one which hierarchizes, orders, and arranges the bodies of knowledge in its encyclopedia to achieve a

3 “Of the arts that are useful, even vital, to the architect are painting and mathematics”. Leon Battista Alberti, *On the Art of Building*, tr. Joseph Rykwert, Neil Leach, and Robert Tavernor. Cambridge MA / London: MIT Press, 1988, p. 317.

purpose or create an oeuvre. The old scholastic epistemology differentiates between two types of knowledge, *quo* and *sub quo*. *Quo* refers to analytical forms of knowledge, which merely abstract and objectivize a given character from a complex reality: the clearest example of this type of knowledge is mathematical physics, which deals solely with the numerical aspect of bodies. *Sub quo* refers to synthetic forms of knowledge which recompose and rearrange reality in the light of their own method and purpose, such as law, particularly Roman law, considered in the Code of Justinian as knowledge of the entirety of human and divine knowledge. Another example is the medicine of Antiquity, of Hippocrates and Galen, taking a global approach to man and the body. One modern example is mathematics, which is no longer merely a tool for investigating reality, but also how it is formed and organized. Vitruvian architecture belongs to this latter category of knowledge. It orders, arranges, and organizes the entirety of artificial and technological reality of Antiquity. This means that Vitruvian architecture is far broader than what we call architecture today, in particular insofar as it does not simply identify with the building process *per se* but also, as Vitruvius's treatise makes clear, conducts major hydraulic projects and designs machines from musical instruments to weapons of war, building equipment, and even sundials. It is a global body of knowledge that sketches out a conception of reality in the service of solidity [*firmitas*], utility [*utilitas*] and embellishment [*venustas*], which then defines the entire question of technology and its purpose.

- 3) Vitruvian architecture is also a science because it follows a methodical process and because it invents the project by establishing a method for design. While the idea of the project is present in the original *De architectura*, it largely fell to

Renaissance Vitruvianism to formulate its principles and tools. The method is as rigorous as the scientific research protocols that came into being in the Renaissance: I am thinking here first and foremost of the experimental method discovered in the mid sixteenth century at the University of Padua. The understanding of architectural projects that emerges in the opening two chapters of *De architectura*, which the two first definitions are enough to flesh out, is a complex procedure, based on an analytical phase followed by a synthetic phase. In more concrete terms, to make a work "integral and unified" [*unum et integer*],⁴ it is no longer enough to bring together elements, members, and parts with more or less skill and style in a typo-morphological framework; now, the logic and shape must first be explored, even if this means modifying and transforming them, thereby transgressing the typo-morphological framework in the name of the project's unique nature. The aim is not solely to carry out the work cleanly in accordance with the planned project, but to ensure that the entire project is illuminated by an intelligent understanding of the project, corresponding to the Latin *solertia*, developed and dilated by proportionality. Hence the two phases in design: analysis and synthesis.

But why all this knowledge? Why is the Vitruvian architect called on to become encyclopedic? Why must he be an *eruditus*, a man of culture and knowledge? Alberti was to write of the perfection of the architectural project, its lineaments, its *disegno*, conceived in the mind and perfected by an inventive, scholarly intelligence, an *ingenium eruditum*.⁵ This is further grounds for evoking humanist art. The twentieth century overthrew the primacy of culture for a freer,

4 Leon Battista Alberti, *On the Art of Building, op. cit.*, p. 61.

5 "Let lineaments be the precise and correct outline, conceived in the mind, made up of lines and angles, and perfected in the learned intellect and imagination" (*Ibid.* p. 7.)

wilder art. This trend affected almost all twentieth-century art forms, except for architecture. There is such a thing as Brutalist architecture, but its "brutal" nature still remains bound by the scope of a project and the ambition to create intellectual order out of reality. As indeed indicated by the return of the encyclopedic approach to architectural training.

For the humanist architect, encyclopedic knowledge consists precisely of the reasons and tools used to modify vernacular typo-morphological shapes. Optics lets him improve the siting and design of windows to capture the light; history lends greater rigor to his drawings of ornaments such as caryatids and Corinthian capitals, while mathematics gives his drawings perfect measurements, achieving the precision that for Alberti is synonymous with perfection. Encyclopedic forms of knowledge therefore shed light on the elements and shapes produced by the building process and, as clearly laid out in the opening definition of architecture in *De architectura*, underpin the "judgment [...] formed of those works which are the result of other arts" – or, rather, the judgment by which architectural forms achieve their necessity and indeed their universality. Yet analyzing shapes to achieve precision and rigor still requires, as Le Corbusier famously put it, making a sphere, gathering together all the mental steps that form the progressive stages of the project into one simultaneous, unified, coherent whole. This is the moment of synthesis, once again managed by mathematics in the form of proportions – what Vitruvius calls *symmetria*.⁶ But this initial, numerical synthesis is not enough. If it were, architecture would merely be a matter of cold, static masses. The genius of architecture in the humanist and classical ages was to move on from quantitative to qualitative proportions, from creating relationships between

6 This does not mean symmetry in the sense of French classicism, but more broadly the system of measurements that generates a numerical relationship between all the architectural elements.

masses to creating relationships between lines – what Alberti calls *concinnitas*, Barbaro and Félibien, following Vitruvius, call *eurythmia* and Quatremère de Quincy, in a simpler, more illuminating formula, calls linear harmony, incorporating ornamentation and decor by a sort of graceful, precise, scholarly qualitative mathematics that only Alberti's *ingenium eruditum* achieves to perfection.

4) "Practice and theory are its parents", writes Vitruvius – or rather, construction and design, the building process and project. Vitruvius establishes the fundamental syntagm underpinning the entire Western system of scholarship and production: the marriage of theory and practice. Simply put, in comparison to its customary expression – for instance Aristotle's description of the medical method in *Metaphysics Z7*, in which the doctor accomplishes treatment only after coming to a diagnosis, with theory (*noesis*) preceding and dictating practice or action (*poiesis*) – Vitruvius puts practice first, starting with the building process and vernacular craft traditions, that are then explored and modified by encyclopedic knowledge. As Vitruvius writes, theory and practice are the parents of architecture. Vitruvian architecture is a form of empirio-criticism or, drawing on the line of architects from Victor Louis and Léon Vaudoyer to Jules Guadet and Auguste Perret, "pragmatic rationalism" that raises architecture to the status of an incremental form of knowledge proceeding by means of trial and error and additions. Alberti reminds his readers that the arts essentially arose from the accumulation of tiny additions by thousands of men over thousands of years.⁷ The

7

Ibid., p. 157.

place where that which is incremented aggregates, the reservoir where all of this progress accretes, is the building site itself. The building site is the treasure house of architectural production, the *thesaurus faciendi*.

The material the architect works with is not wood, or stone, or concrete, or these days steel and glass, but the building site and process themselves – in other words, formalized techniques and procedures. And that is why architecture is an architectonic body of knowledge that builds forms on top of forms, or a morphogenesis that shifts between ever more dense, elaborate forms, rather than a straightforward hylomorphic technique content merely to stamp an *a priori* form onto concrete matter like a seal on molten wax.

5) The fifth reason explaining the wholly scientific nature of Vitruvian architecture is doubtless the most obvious in terms of the modern criteria for scientificity. Vitruvian architecture is a proportional, mathematical architecture: in the Renaissance, mathematics was already the foremost criterion for scientificity, the condition for the highest scholarship, albeit by means of its own use and operativity, very different from now. Another question of philology arises in establishing the text of *De architectura*, which explains why Renaissance Vitruvian architecture aspires even more than the architecture of Antiquity to scientificity. This question concerns the term *ratiocinatio*, the critical faculty of the architect mobilizing and displacing the building site. Modern editions of Vitruvius simply state that *ratiocinatio* covers practical output, "the mode of executing any given work" *rationalis pro portione*,⁸ i.e. rationally, "in the best and

8 Vitruvius, *The architecture*, *op. cit.*, p. 3.

readiest way".⁹ Renaissance Vitruvians read this passage very differently. Fra Giocondo's influential 1511 edition had *ratione proportionis*:¹⁰ in other words, *ratio* explains, or more rather, translating *explicat* literally, "unfurls" the output according to the calculation (*ratio*) of the proportion, like a mariner unfurling and hoisting a sail. Mathematics is present at the very heart of the method of architectural investigation and design, from the opening chapter of Book 1. No need to wait for Book 3, where mathematics is used solely as a canon for measurement based on the proportions of the human body to identify the typo-morphology of buildings in general and temples in particular. Humanist philology therefore strengthens the epistemological dimension of the architecture of Antiquity. The mathematization of architecture is established as a tool not only for synthesizing, bringing together, and unifying a project, but also for analyzing the building site and process and investigating its operations even before design becomes visible. It will have escaped no-one's notice that promoting mathematics in terms of form and method heralds the birth of the engineer in the Western *episteme*. The Renaissance architect certainly foreshadowed the Enlightenment engineer, as history has long taught us. However, mathematics, though applied rigorously in both cases, does not share the same meaning or function. The architect's mathematics serves the mental process of designing a product, not the solidity of its construction. Architectural mathematics contributes to the project's morphogenesis, to the project *qua* morphogenesis, by facilitating progress from one phase to the next and translating the various steps of the design process into the same language to give

9 ⁹ Ibid., p. 3. The French version quoted in the original, by Auguste Choisy, has "à la mesure de la pénétration de la raison" (in proportion to the penetration of reason). Auguste Choisy, *Vitruve*, II, text and translation, Livres I-VI. Paris: Lahure, 1909, p. 5.

10 ¹⁰ *De architectura MP Vitruvii libri decem, op. cit.*, p.1v.

it the single voice necessary for its dynamism and for the sound completion of a building that is *unum et integer*. For the Vitruvian architect, the construction's solidity depends not so much on the resistance of its materials as on the unity of design and unification of the work, reflected in the fitness of the proportions and richness of their harmony.

It therefore becomes clear that as early as the mid fifteenth century, the renaissance of the architecture of Antiquity and the rediscovery of Vitruvius led to the emergence of all the elements of "modern science" and the scientific and technological revolution that is generally attributed to Galileo and Descartes, a century and a half later. But it appears that the intellectual modernity that architecture brings to the heart of production, fully justifying Marx's famous comparison in *Das Kapital* of bees and architects, belongs to a kind of modernity *other* than the one we hail from ourselves. The various branches of science and technology do not serve the mobilization of being or Man as master and possessor of Nature, in Descartes's famous expression. Rather, they play a part in embellishing and dignifying the world through man's spirit to achieve "the tranquil possession that [architecture] assures us of the treasures of nature".¹¹ This *other* modernity could have been the destiny of our own modernity.

Architecture is an art of difference. Just as law is based on the difference between rights and facts, philosophy is based on the difference between truths and opinions, and politics is based on the difference between institutions and chaos, architecture is based on the difference between the building site and process and the project, *fabrica* and *ratiocinatio*.

11 "If we consider what we owe Architecture and all the advantages we receive from it, we will find that the treasures of nature are only truly our own because it assures us tranquil possession of them". Jacques-François Blondel, *Cours d'architecture ou Traité de la décoration, distribution et construction des bâtiments*, I. Paris: Desaint, 1771, p. 119.

As a body of knowledge based on difference with a view to *creating* difference, architecture is a sovereign body of knowledge. As a *scientia*, it is not just the knowledge or science of construction, but rather its *critique*, tearing construction away from itself, from its burdensome weight, and suspending it in mid-air. In other words, architecture is the very knowledge that engenders differentiation between the apparatus of construction and itself, so that a prison or enclosure becomes a space as much of freedom as of protection, a space of protection via the very freedom it gives from the conditions of a social, economic, and productive life. This is what makes architecture sovereign, emancipated from the economic and social necessity it arises from. However, architectural difference has today changed its nature compared to its origins in Antiquity, whose doctrinal foundations were consolidated in the Renaissance to build the classical city.

By using the mathematics of proportions to punctuate full and empty spaces, the laws of optics to bring light into the building, geography and geology to determine the best site and orientation, and even history to explain the ornamental program demanded by architectural norms, antique, and later humanist, architecture brought in the rigorous logic of the sciences and their universal approach to reality in the traditional, empirical, vernacular world of the artisan-led building project. Vitruvian architecture applied science to technique well before the apparatus of Galileo and Descartes began designing machines. What sets classical architecture apart from traditional artisan architecture is an *epistemological* difference, clearly established by Vitruvius in the opening two chapters of his treatise, as has been shown.

Clearly, with the development of an industrial civilization, the building site and process and its constructive apparatus in turn absorbed humanist architecture's forms of rational knowledge to strengthen their grip on the act of building, to the point that the building industry now seems to be able to get along without architects. Engineers are

the new building project managers, blurring the distinction between artisan and architect; mathematics now serves less to punctuate space than to calculate the resistance of materials; sciences move from project to work site, the better to absorb architecture into the system of production and thereby reduce the difference between the site and the project, constitutive though this difference is. In the final analysis, Vitruvian architecture¹² is the victim of its own incremental logic: as it multiplied its operations, they were taken on, accumulated, conserved, and assimilated by the building site and process until they eventually came to form an autonomous constructive apparatus in their own right, able to stand in for architecture. This is what Rem Koolhaas calls Bigness. The bigger the project, the more inert it becomes and the more it resists architecture's power of criticism. This led to a twofold consequence that became apparent as early as the nineteenth century: the exhaustion of architecture's power of criticism boxed it into mere academic formalism, as reflected by the Ecole des Beaux-Arts, while at the same time, the building site developed full autonomy and succeeded in generating forms from the very matter of its own reserve, as exemplified by Viollet-le-Duc's theory of constructive rationalism.

In the twentieth century, architecture gained a new lease of life from the best of the modernist movement and once again managed to displace the constructive apparatus, though now far more powerful and hegemonic, tearing itself away from it by means of a difference that was no longer epistemological, but transcendental – in other words, by its capacity to transform the very conditions of the system of production, to dilate space and hence tear time away from its *dilatatio*, its indeterminate flight, its vain flow: in short, protecting space and time from being mobilized by technologies.

12 By “Vitruvian architecture” I mean not classicism's collection of typological forms, but rather the knowledge or “science” whose principles this article has sought to underscore.

Difference and its power to tear away are here less a question of an intellectual and technological supplement, as in the epistemological difference of Vitruvian architecture, than of the withdrawal and subtraction which, from the starting point of sentient experience, leads us to a transcendental aesthetic of space and time, or in other words the conditions of our sensibility to and orientation in the world. Architecture's wholly unique mode of production – a critical mode that operates by means of withdrawal and subtraction, not by addition, irruption, and disruption – expresses the non-productive conditions of the reproduction of human capacities, without which all systems of production are doomed to entropy. This is what makes architecture an ark, a protective envelope. Architecture is therefore a transcendental technique that seeks to transform not matter itself, but the spatio-temporal conditions in which matter presents itself to us to be transformed. This is how it establishes difference in the most fundamental conditions of modern life. And this is how what was once a science has now become a fully-fledged art form in its own right.

Translated from the French by Susan Pickford

Abstract

Vitruvian architecture cannot be reduced to a collection of easily recognized forms or a rigorously encoded ornamental repertoire. Vitruvian architecture is first and foremost a method of building on, or rather *over*, the world. To be more precise, it is a "science", as proudly stated in Renaissance architectural theory – an encyclopedic science that mobilizes all forms of knowledge to assert its mastery over the empirical, artisan-led building process; it is an *architectonic* science whose method of conception and design

assays a broad range of products and works, far beyond what we would now label "architecture". This epistemological situation explains Vitruvian architecture's symbolic dominance of the practical realm in the humanist and classical ages. Yet the humanist architect's scientific prerogatives have now passed into the hands of engineers and building consultants, following an entirely different understanding of forms of knowledge and their relationship to the construction of the world. Contemporary architecture nonetheless remains a privileged form of knowledge, still more sovereign than the science of the Ancients, a transcendental body of knowledge, the understanding of time and space on which the entirety of human praxis is built.

Biography

Pierre Caye is a former student at the Ecole Normale Supérieure and research director at the French National Centre for Scientific Research, and now heads the Jean Pépin Research Center. He is the founding member of an international research unit on artistic knowledge and art treatises from the Renaissance to the Enlightenment. His works include *Le Savoir de Palladio: architecture, métaphysique et politique dans la Venise du Cinquecento* (Klincksieck, 1995), *Empire et Décor: le vitruvianisme et la question de la technique à l'âge humaniste et classique* (Vrin, 1999), and co-translations of two works by Leon Battista Alberti, *De re ædificatoria* with Françoise Choay (Seuil, 2004) and *I Libri della famiglia* with Nella Bianchi Bensimon (Les Belles Lettres, 2019). He has also written an essay on the philosophical and legal principles of sustainable development, *Critique de la destruction créatrice. Production et humanisme* (Les Belles-Lettres, 2015). His most recent publications are *Comme un nouvel Atlas. D'un état meilleur que la puissance* (Les Belles-Lettres, 2017) and three collective works on art theory: *Daniele Barbaro, Vénitien, patricien, humaniste* (Brepols, 2017) with Frédérique Lemerle, Laura

Moretti and Vasco Zara, *Quand l'art se dit et se pense* (Garnier, 2018) with Florence Malhomme, and *La pensée-Breton. Ecriture, art et magie* (L'oeil d'or, 2021).