The Shadow of Euclid on Architecture

Kim Williams and Sylvie Duvernoy

Years Ago features essays by historians and mathematicians that take us back in time. Whether addressing special topics or general trends, individual mathematicians or “schools” (as in schools of fish), the idea is always the same: to shed new light on the mathematics of the past. Submissions are welcome.

By craft of Euclid mason doth his cure,
To sue his mould’s rule, and his plumbline…

John Lydgate, Everything to His Semblable

There is a school of thought among scholars of the history of architecture that asserts that the birth of Gothic architecture about 1100 AD is linked to the increasing accessibility to Euclid’s Elements during the same time frame. In the words of architectural historian John Harvey,

The arrival in Western Europe of a complete version of Euclid’s Elements coincided with the adoption of the improvements introduced by Arabic astronomers in 1120. It can be no mere accident that this placing of the world of thought within a strictly scientific framework parallels the sudden rise of the new Gothic art and architecture (Harvey 1972, p. 94).

This statement essentially claims that architects’ and artists’ knowledge of Euclid’s geometry (that is, pure geometry) was being applied in their day-to-day practice of architecture and sculpture. Our aim is to examine the traces of Euclid’s geometry in early architectural theory that might have influenced practice, through the careful study of the two oldest extant books about architecture produced before and during the years in which Gothic architecture blossomed in northern Europe, namely the De Architectura Libri Decem by Vitruvius (circa 20 BC) and the Livre de Portraiture by Villard de Honnecourt (circa 1225-1250 AD). These two texts constitute the only literary sources that can show some information about the mathematical knowledge of ancient architects and how this knowledge influenced them in their search for new forms and structural challenges.

We will try to evaluate not so much the quantity and quality of mathematical notions that these books conveyed to their readers and to posterity, but rather the quantity and quality of the theoretical mathematical background that the authors appear to have learned during their studies and professional careers, and how and when they referred to it while prescribing rules for designing and building.

To begin, both authors clearly acknowledge the architect’s debt to mathematics and especially to geometry. “Geometry … is extremely helpful in architecture… arithmetic enables us to … apply the techniques of mensuration


2Other “medieval” treatments of architecture are found in the booklets by Mathes Roriczer (Büchelin von Der Finialen Gerechtigkeit, 1486; Wimperbüchelin, ca. 1488; and Geometria Deutsch, ca. 1488) and Hanns Schuttermayer (Finalenbüchelin, ca. 1489). These, however, were written at a time when Alberti had already written De re aedificatoria, and Dürer was writing Untenweisung der Messung. For this reason we decided not to consider them here.

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correctly, and difficult problems relating to modular systems [symmetriae] are resolved by the application of the laws of geometry,” writes Vitruvius in Book I, chapter I (2009, p. 5). In the preface on folio 1v of the Livre de Portraiture Villard states, “…in this book … you are able to find the technique of representation as the discipline of geometry requires and instructs [it to be done]” (Barnes 2009, p. 35).3 These statements are corroborated by descriptions in Vitruvius, and by drawings in Villard, of geometric principles meant to govern both the design of a whole building (e.g., plans and elevations) and the design of single parts (such as decorative elements). However, there are explicit references to geometry only in an abbreviated form, and in-depth discussions of purely mathematical arguments are lacking in both treatises. The possible reasons for this shortcoming are interesting in their own right, and it is worthwhile examining them to understand precisely how mathematics influenced architecture from antiquity through the Gothic period.

Pure Science and Applied Science
First, a cursory comparison between the number of ancient treatises of mathematics and those of architecture shows a disparity of number heavily in favour of the mathematical treatises. From classical antiquity, not only the books of Euclid have come down to us, but also those written by Archimedes, Aristotle, Aristarchus, Apollonius, etc. (the list is too long to cite in its entirety), whereas of those regarding architecture we have only the treatise by Vitruvius, The Ten Books on Architecture, written in about 20 BC. Similarly, in the medieval era, we have only the notebook—more a practical manual than a theoretical treatise—by Villard de Honnecourt, written between 1225 and 1250 at a time when mathematical treatises continued to proliferate: Fibonacci, Grosseteste, Sacrobosco, Bacon, Jordanus, and Campanus were all working at the time when Villard was compiling his portfolio. With the invention of the printing press, the number of architectural treatises would grow, but this takes place after the period in which we are interested.

The disparity in the number of treatises can be attributed in part to the fact that while mathematicians write, architects build, entrusting their ideas to stone rather than to paper. But the disparity reflects as well what C. P. Snow has more recently called “the two cultures” (1959), that is, a clear division between scientific and humanistic types of knowledge. We are therefore faced with a division between theoretical mathematics and applied mathematics, that is, between science and technology. Pure science is “know why”; technology is “know how.”

Is architecture a science? According to Plato, it is. He was the first, around 360 BC, in the Statesman, to introduce the division of science into two parts: a “directive science” (praktike) and a “critical science” (gnostike), a division that he exemplified with architects. According to Plato, kings and architects require “directive” knowledge, because they must give directions to others for future actions:

Now consider a master builder. No master builder is a manual worker—he directs the work of others. … He

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3It is interesting to note how, in both cases, the science of geometry is linked to the concept of representation.