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The Origins of Graph Paper as an Influence on Architectural Design

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EVERYONE acquainted with Thomas Jefferson's architectural drawings knows that many of them are on squared paper, yet no one who has so far written about them seems to have remarked upon the importance and novelty of this technique. Fiske Kimball, in *Thomas Jefferson, Architect*, points out that 'neither coördinate paper nor lead pencil was used in drawings made by Jefferson before his residence in France'¹ (namely, before August 1784) and remarks that the use of pencil was probably due, in part, 'to his own adoption of coördinate paper, which allowed him to employ a freer medium in spite of his deficiencies of technique'.² But no one seems to have discussed the implications of this practice which, though of little importance at the time he adopted it, was to have a profound influence on architectural theory in the early nineteenth century. Was it invented by Jefferson himself, or did architects, engineers, and scientists already commonly use squared paper at this time?

As regards Jefferson's use of squared paper, there is one aspect of this technique which should be considered before anything else, even though it is of minor importance. This is the fact that all the varieties of squared paper he used were graduated in decimal divisions. Jefferson's enthusiasm for the decimal system is well known from his famous *Notes on the Establishment of a Money Unit and of a Coinage for the United States*, written in April 1784. The idea was not of course new, for the *Encyclopédie*, under the heading 'Décimale', had urged its adoption for currency, weights, and measures thirty years before and had stated that 'il seroit très à souhaiter que toutes les divisions, par exemple de la livre, du sou, de la toise, du jour, de l'heure, &c., fussent de 10 en 10'. What is more to the point is that several years earlier Jefferson had dimensioned at least one of his architectural specifications in decimals of a foot. The specifications for a 'decorative outchamber', dated 1779 and illustrated by F. D. Nichols in *Thomas Jefferson's Architectural Drawings* (plates 5 and

6) show this clearly; and we know that he long persisted in the curious practice of dividing inches into tenths instead of eighths or sixteenths. Thus on 8 October 1823, when writing to the United States Consul in Leghorn with respect to the Corinthian capitals for the Virginia University Rotunda (a building designed, as is well known, on squared paper), he stated that they were to be 'of marble for columns whose diminished diameters are 2 feet 8 4/10 inches English measure'.³ This, incidentally, did not prevent him from stating, later in the same letter, that the diameters of the wooden capitals for the interior were to be '15 11/16 Inches English'.

Since Jefferson's first known use of squared paper for designing buildings was after his arrival in Paris, it may be assumed that his earliest drawings on squared paper were the sketches for the Virginia Capitol prepared for Clérisseau's draftsmen (fig. 1).⁴ His reasons for taking advantage of decimal squared paper when adapting the details and proportions of the Maison Carrée to the divergent requirements of a much larger building seem fairly obvious. Moreover, the source of his technique for finding proportions by means of a squared grid can easily be guessed, since it was recommended and exemplified by Philibert de l'Orme in Book VIII of his *Architecture* (1567), the best known as well as one of the earliest architectural textbooks to be published in France. But where did he obtain the squared paper, or get the idea of using it for architectural drawing? For it was not just ordinary paper ruled by hand, but paper specially engraved. Was this type of paper already readily obtainable from Paris stationers at this time, and if so, what was its original intended use?

3. W. B. O'Neal, *Jefferson's Buildings at the University of Virginia: The Rotunda* (Charlottesville, 1960), p. 28.

4. Though some of the sketches for the modifications to the Hôtel de Langeac were also drawn on squared paper in 1785, there seems good reason for giving primacy to the Capitol drawings in view of the letters exchanged between James Buchanan and Thomas Jefferson on 20 March 1785, 13 August 1785, and 26 January 1786. Printed in Julian P. Boyd (ed.), *The Papers of Thomas Jefferson* VIII and IX.

1. Fiske Kimball, *Thomas Jefferson, Architect* (Boston, 1916), p. 142.

2. Kimball, *Jefferson*, p. 105.

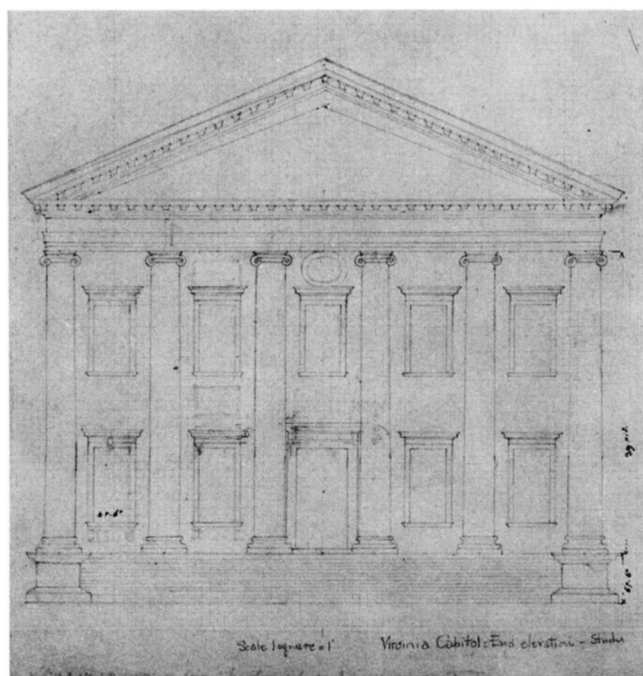


Fig. 1. Front elevation of the Capitol, Richmond, Va., by Jefferson. Jefferson's earliest drawing on squared paper (courtesy Massachusetts Historical Society).

No clue is offered by the squared paper used for the Virginia Capitol (paper classified by Kimball as 'BB'), since it has no watermark, and there is no inscription on the engraving. But the next batch of squared paper purchased by Jefferson, classified by Kimball as 'CQ', is much more informative. We know from his account book that it was paid for on 17 October 1788,⁵ and we know both from this entry and the inscription engraved on the paper that it was bought from a well-established stationer in Paris called Crépy, who had his shop in the rue St. Jacques, at the sign of St. Peter.⁶ The engraving also tells us that the type of squared paper was called 'du 10 en 10'—a term which one might naturally be inclined to associate with the *Encyclopédie's* article on the decimal system just quoted (fig. 2).

The necessary clue as to the accepted use of squared paper by Jefferson's contemporaries is certainly to be found in the *Encyclopédie*, and also in this term 'du 10 en 10'; but the original purpose of squared paper had in fact nothing to do with the decimal system at all. The paper

5. Information supplied by Mr. John Cook Wyllie, librarian of the Alderman Library, University of Virginia. I should like to express here my gratitude to Mr. Wyllie for so kindly and generously responding to my inquiries.

6. According to J. Grand-Carteret, *Papeterie et Papetiers de l'Ancien Temps*, p. 214, 'S. Pierre' was the shop sign of J. Crépy le père, who was primarily a publisher of engravings. Since Crépy le père was active from 1680 to 1730, it is possible that the plates from which paper 'CQ' was printed were quite old.

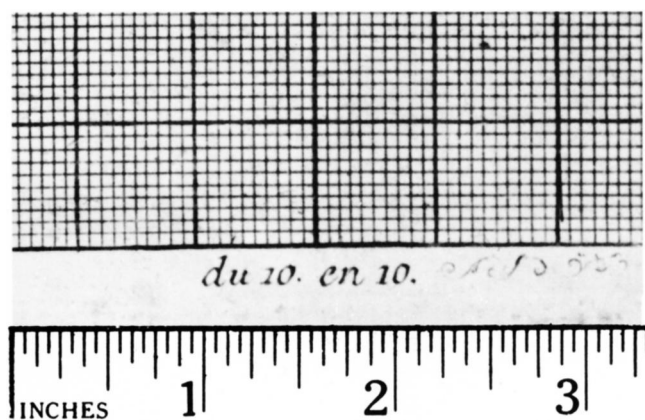


Fig. 2. A section of the Crépy paper at full scale (courtesy Alderman Library, University of Virginia).

was used in the mid-eighteenth century, not by engineers, scientists, or architects (as the *Encyclopédie's* article on 'Papier Reglé' makes clear),⁷ but by silk weavers, as patterns and codes for their looms. First a design was carefully drawn and colored, and this was then copied onto a piece of squared paper in such a way that the relevant squares would indicate to the weaver the warps which were to be taken or left.

The *Encyclopédie* mentions only two kinds of squared paper; one arranged with each square of the main grid containing a hundred squares ('du 10 en 10')—for making silk ribbons; the other arranged with each square of the main grid containing eighty rectangles ('du 8 en 10')—for making silk gauze. But in fact there were a great number of grids used by the silk weavers of Lyon,⁸ as is shown by the contents of three volumes of 'papier de mise en cadre' preserved in the Musée Historique des Tissus of that city (fig. 3).⁹ The oldest datable example, which has a drawing on it signed 'J. Revel, 1733', is 'du 8 en 11' (namely, each square contains eighty-eight rectangles),

7. *Encyclopédie* XI (1765), 862. Since the editors of the *Encyclopédie* were primarily interested in scientific matters, it seems inconceivable that no mention would have been made of the use of squared paper by mathematicians and engineers at this date, if it had been a common practice at the time.

8. Where the industry had been established since the late fifteenth century. Indeed, it would be tempting to suggest that the idea of using a squared grid as a basis for a design was borrowed directly from the silk weavers by Philibert de l'Orme (who lived and worked in Lyon during most of his early life) were it not that the technique seems to have been familiar to all mediaeval masons, as is clear from some of Cesariano's illustrations in the 1521 edition of Vitruvius. It was doubtless this technique they referred to as 'ad quadratum'.

9. I should like to express my thanks to the director of the Musée Historique des Tissus, M. Robert de Micheaux, and to M. Guicherd for their generous assistance. My colleague Professor Stuart Wilson has kindly drawn my attention to the fact that the Library of Congress also possesses some original eighteenth-century designs for brocades drawn on squared paper, in its Chadbourne Collection.

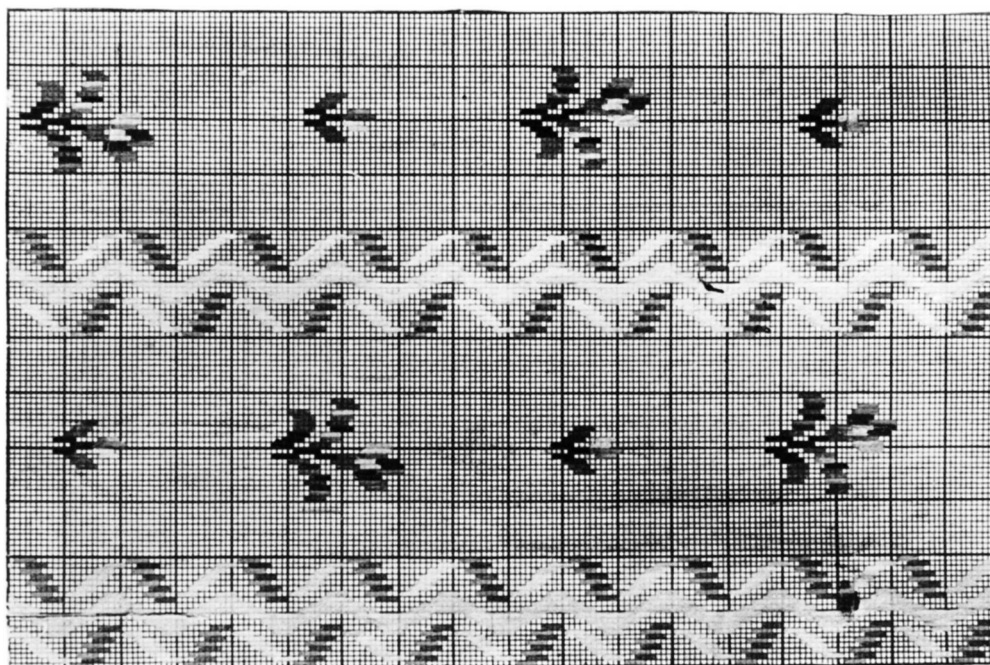


Fig. 3. Design for a silk border, drawn in color on paper of the type known as 'du 10 en 10' (courtesy Musée Historique des Tissus, Lyons).

but there were many other grids, such as 'du 9 en 10', issued by various local stationers, such as Seraucourt, Dagoty, Huilliot, and Veret. Among these eighteenth-century drawings on squared paper preserved in the museum, it is noteworthy, from the point of view of the topic under consideration, that 'du 10 en 10' is comparatively scarce.

In all these examples of silk weavers' squared paper, the dimensions of the grids varied considerably, and the lines were spaced without very much regard for accuracy. Moreover, these lines were not particularly finely drawn. Exact measurement was unnecessary, since the drawn patterns were neither the same size as, nor mathematically scaled to, the patterns which appeared on the finished silk. The normal measurement for a square, as given by the *Encyclopédie*, was 'de cinq ou six lignes, plus ou moins' (namely, five or six twelfths of a French inch, more or less), which would correspond to from three eighths to half an English inch, as compared with the dimensions (slightly less than five eighths of an English inch) of the squares of the Crépy paper 'cq' used by Jefferson. Whether or not the engraved graduations on paper 'cq' are in fact in fractions of an English inch, as claimed by Kimball and Nichols, or in fractions of a French inch seems immaterial; but all the evidence would seem to suggest that everything about this squared paper is French.

Three weeks after making this purchase of Crépy paper (which I suspect was his second purchase of silk weavers' paper, although since none of the numerous account-book entries for paper can be identified as relating to drawing paper before 1788, it is impossible to attain certainty on

this point),¹⁰ Jefferson bought more squared paper. But this time he had it specially engraved and printed—despite the fact that he had not used up the supply of Crépy paper (which may have been a stopgap, since blank sheets of it still remained in 1826).¹¹ The person he paid for this new squared paper on 9 November 1788 was named Corneillon, and since he is not listed by Grand-Carteret as a stationer, we may assume that he was an engraver. This is the paper 'BD' on which the drawings for Virginia University Rotunda were inscribed. It is graduated, like the earliest surviving examples of Jefferson's squared paper (namely, 'BB', on which the Virginia Capitol was drawn), in English inches and tenths of an inch, but in this instance the squares are numbered—a refinement which would have been of no value to silk weavers, but was of considerable use to Jefferson (fig. 4). It may well constitute, together with paper 'BB', the first recorded use of graph paper specifically made for architectural, engineering, or mathematical drawing.

The use of graph paper was to be of incalculable importance in the subsequent history of architecture, since it constituted the origin of what is now termed the 'modular' system of design, and formed the basis of Durand's system which, from 1795 onwards, was taught to engineering students at the newly founded Ecole Polytechnique. Students of nineteenth-century architecture are well aware that the plans in Durand's published textbook are all

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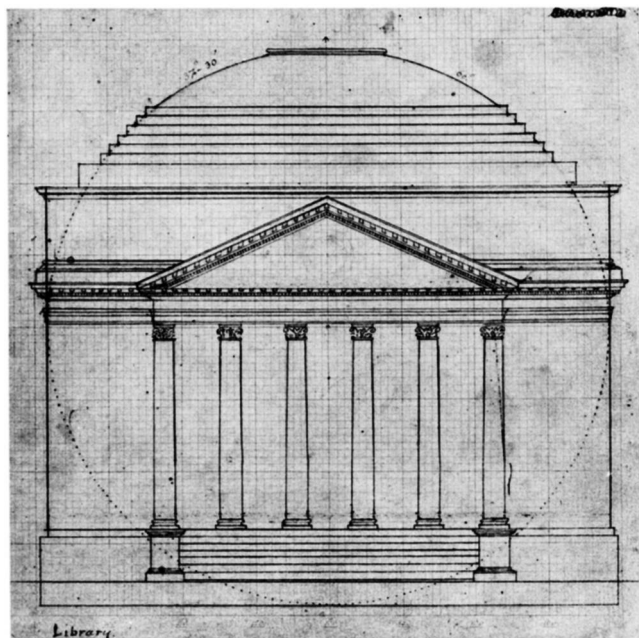


Fig. 4. Front elevation of the Rotunda, University of Virginia, by Jefferson (courtesy Alderman Library, University of Virginia).

based and inscribed upon carefully drawn grids (fig. 5). Similarly, the wide influence of Durand's method on the next generation of architects, such as von Klenze, is made abundantly clear in the second chapter of Henry-Russell Hitchcock's *Architecture, Nineteenth and Twentieth Centuries*. But its dependence on the use of squared paper is not, I think, generally known, though this can be proved by reference to a lithographed lecture course of 1819 preserved in the library of the Ecole Polytechnique.¹² The course was given by Captain J. F. Soleirol at the military academy at Metz, and was entitled 'Cours de Construction à l'usage des Elèves de l'Ecole Royale de l'Artillerie et du Génie'. On page 188, paragraph 568, the following statement occurs: 'Le papier rayé à carreaux, dont on se sert à l'Ecole Polytechnique dans le cours d'architecture, est très-propre à faciliter les moyens de grouper et croquer la disposition des masses d'un projet de bâtiment. On considère chaque carreau comme formant un entre-axe ou un de ses multiples.'

Thomas Jefferson did not, like Durand and his disciples, use the lines on his squared paper as axes for columns; nor did he, at first, even place his designs symmetrically in accordance with the grid. On the contrary, he seems to have used the squares simply as an easy method of measuring distances in feet. But there seems to be no

12. Catalogue No. H³a 59.

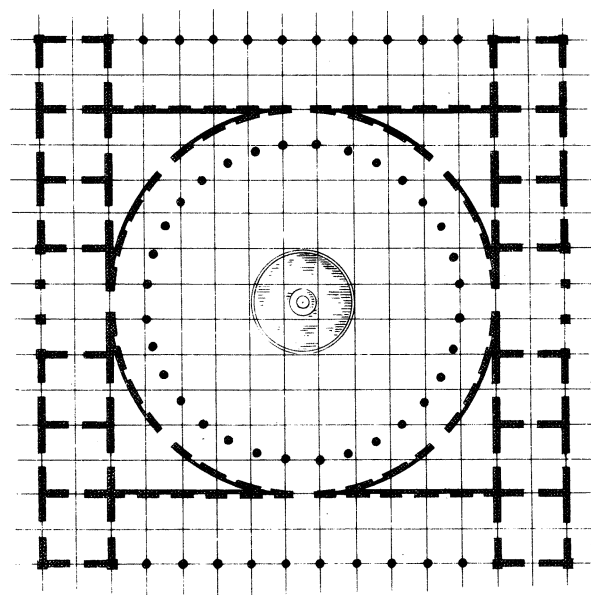


Fig. 5. Specimen plan based on square grids (from Durand, *Précis des leçons d'architecture données à l'Ecole Polytechnique*).

evidence of anyone before him using squared paper for architectural drawings, and it would be interesting to know whether the idea had occurred independently to any of his contemporaries. Did Durand, for example, who only completed his architectural studies at the Academy School two years before Jefferson arrived in Paris, think of it himself, or did he learn of the method from one of the young French architects who made the drawings for the Virginia Capitol under Clérissieu's supervision?

Alternatively, did both Jefferson and Durand get the idea from the same source? In this latter respect, it is worth noting that Durand, though usually described as a pupil of Boullée, was in fact officially the pupil of Perronet,¹³ the first director of the School of Civil Engineering (Ecole des Ponts et Chaussées), and the first to introduce modern mathematics into structural design. Perhaps it was Perronet who first saw the advantages of using silk weavers' squared paper for architectural calculations and drawings. Perhaps Jefferson consulted him when he received George Washington's letter, written on 25 February 1785,¹⁴ asking him to find a French engineer to supervise road construction in the Western Territory. The possibilities are as numerous as they are fascinating, and if this essay focuses scholarly attention on them, it will at least have made some contribution towards bringing the true facts about this curious practice to light.

13. *Procès-Verbaux de l'Académie Royale d'Architecture* ix, 26.

14. Boyd (ed.), *Jefferson* viii, 3-6.