Descriptive Geometry in England — a Historical Sketch

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Abstract

History of Descriptive Geometry in France and its utilisation in the French educational system since the 18th century has already been well documented in the work of Taton (1951), and more recently Sakarovitch (1989, 1995). The history of the technique in England, however, makes a captivating story, particularly as it relates not only to the technique itself, or how the treatises relating to it were translated into English, but because it was also closely related to the establishment of the architectural and engineering professions in Britain.

The technique of Descriptive Geometry was invented by Gaspard Monge[1] in or around 1764, when Monge, as part of his everyday work duties at the at l'École Royale du Génie de Mézières,[2] was given the task of determining the plan of defilement in a design of fortification. His invention was deemed so ingenious, and so useful in military engineering, that it was proclaimed a military secret. The scenarios of what 'might have been if'[3] would be interesting to consider here, for the technique was not published until the end of the century, and until Monge himself became involved in setting up the institutions of the new Republic during the Revolution.[4]

The new educational institutions of the Republic defined the ways in which mathematics, engineering and architecture and their communications were to be conducted. Descriptive Geometry was one such revolutionary subject, as Sakarovitch (1995) pointed out:

> A scholastic discipline which was born in a school, by a school and for a school (but maybe one should say in the École Polytechnique, by the École Polytechnique, and for the École Polytechnique), descriptive geometry allows the passage from one process of training by apprenticeship in little groups which was characteristic of the schools of the Ancien Regime, to an education in amphitheatres, with lectures, and practical exercises, which are no longer addressed to 20 students, but

[1]Gaspard Monge, (1746–1818), born in Beaune, died in Paris, France. Monge is most famous for his invention of Descriptive Geometry and for his work on the application of analysis to geometry. See Taton (1951), Sakarovitch (1989, 1995 and 1997).

[2]The Royal School of Engineering at Mézičres was founded in 1748 and was closed in 1794 when it transferred to the School of Engineering at Metz.

[3]Some 'ifs' might be: what if Monge did not become so prominent in the New Republic, setting up the institutions such as École Polytechnique and École Normale Supérieure which provided the setting for the teaching of Descriptive Geometry; what would have happened if Monge died during the Terror; or what would have happened if indeed no one looked seriously at the technique as it was invented by, at the time, a lowly clerk in the drafting office of a famous engineering school.

[4]Monge was one of the first teachers at École Normale Supérieure and one of the founders of the École Polytechnique.

to 400 students. Descriptive geometry also stems from revolutionary methods. A means to teach space in an accelerated way in relation to the former way of teaching stereotomy, an abstract language, minimal, rapid in the order of stenography, descriptive geometry permits a response to the urgent situation as for the education of an elite, which was the case of France at the moment of the creation of the École Polytechnique.[5]

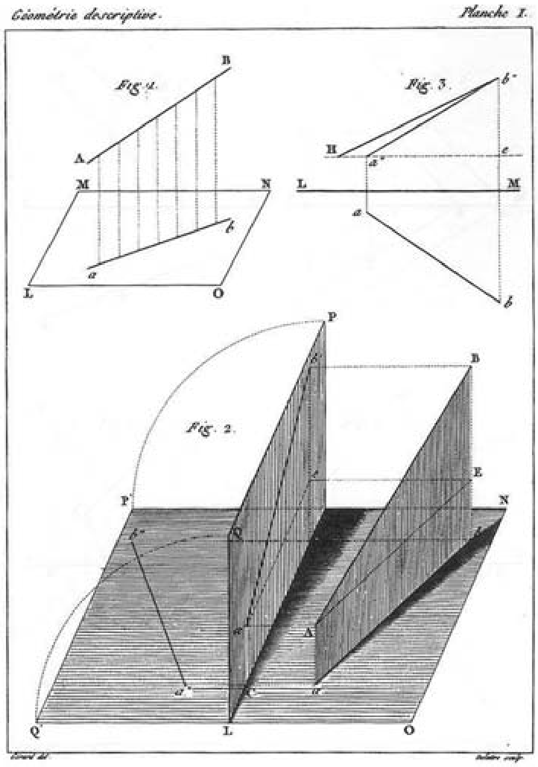

Figure 1 – Plate one from Géométrie Descriptive, Paris An VII (1799)

The further historical development of Géométrie Descriptive in France has been well documented in the work of Taton (1951), Sakarovitch (1989, 1995, 1997), and Guinness (1990). However, little has been known so far of the fate Descriptive Geometry met upon its translation into English. The scarcity of information and references to it in the contemporary practices in English mathematics education leaves room for contemplation that led to this publication.

In fact, the first treatise on descriptive geometry in English language was first published by a former pupil of Monge, Claude Crozet, who found a place teaching the subject at the newly founded military academy at West Point, US.[6]

Unknown to the British public for some decades, this book was in England preceded by a series of treatises on the orthographic projection published by, mainly, an architectural writer, who described himself as an 'architect and a mathematician', Peter Nicholson[7]. Notably,

[5]Sakarovitch (1995), p. 211.

[6]Claude Crozet (1790–1864) wrote *A Treatise on Descriptive Geometry* in 1821 for the use of cadets at the Military Academy at West Point US. Crozet was born in Villefranche, France and was educated at École Polytechnique. He emigrated to the United States in 1816 and on the recommendation of Lafayette and Albert Gallatin, was appointed on 1st of October 1816, the assistant professor of engineering at West Point Academy and on 6th of March 1817 professor and head of the department.

[7]Peter Nicholson (1765–1844) was born in Prestonkirk, East Lothian on 20th July 1765, a son of a stonemason. His mathematical writings are mainly to be found in three papers and two books: 1817 – *An Introduction to the Method of increments*; 1818 – *Essay on the Combinatorial Analysis*; 1820 – *Essay on Involution and Evolution*. His books on mathematics were: 1823 – *A popular Course of Pure and Mixed Mathematics* and in 1824 – *A Practical System of Algebra*. The list of his architectural opus is lengthier and not of concern for this paper.

technique very similar to that of descriptive geometry appeared almost fully explained in Nicholson's *Treatise on stone-cutting* in 1823.[8] Nicholson's *Treatise on Projection*, published in 1840 set out his technique in detail. This became accepted and known as the 'British system of orthographic projection'[9] and was republished many times during the 19th century in the works of Binns and Bradley, although without the reference to its inventor.[10]

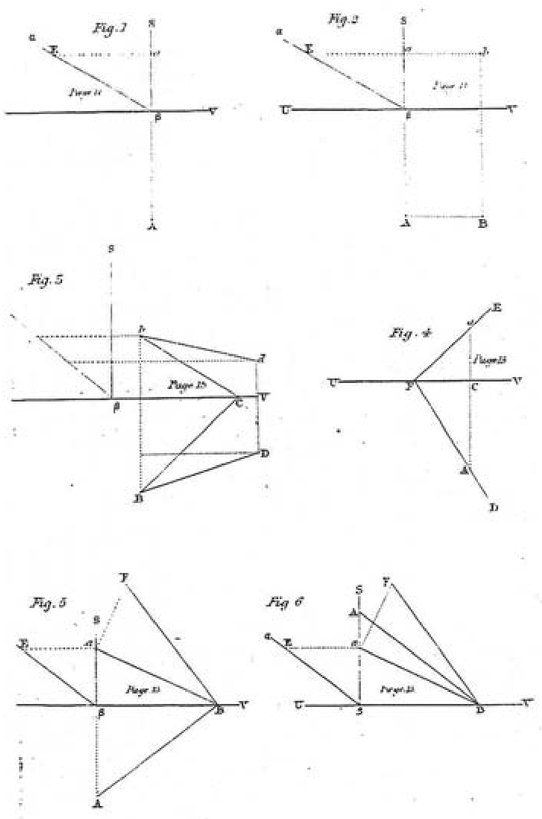

Figure 2 – Plate 1 from Nicholson's *Treatise*, London : 1840

Géométrie Descriptive 'proper' was translated into Spanish in 1803, and into English in 1809, presumably for military purposes, as there are no publications to be found in English libraries to suggest that the work was made public. No complete work on the subject appeared in English until 1841, when Rev. T. G. Hall of King's College, London, published *The Elements of Descriptive Geometry, chiefly designed for students in Engineering*, which mentioned Thomas Bradley as the first one to give lectures on Descriptive Geometry, at the Engineering Department of King's College in London.

This treatise was succeeded by a few treatises all of which were published for the English military academies[11], and all of which were the straightforward translations of the original technique. According to the records in the British Library, it would seem that the last of these treatises was one published by Heather of the Woolwich Military Academy in 1851[12]. However, treatises continued to be published in England until the end of the 19th century with 'Descriptive Geometry' in their titles, but very little of the original technique can be found in them; these treatises were mainly based on the system invented and described by Peter Nicholson.

[8] See Nicholson, (1822) p. 45.
[9] See Grattan-Guinness, I. and Andersen, K. (1994).
[10] See bibliography.
[11] They were published for the Military Academy schools at Woolwich and at Portsmouth.
[12] See Heather (1851).

In order to understand the reasons for this state of affairs, let us turn to the developments related to the mathematics education, and in particular the education geared for the architectural and the engineering professions which would have been the primary users of any such technique.

The translation of descriptive geometry into English was contemporary with the changing nature of educational politics in England. English were, at the time, discussing and taking steps to improve the provision of education for the poor and the working class, not least because the need for an educated and trained working force became obviously needed by the rise of the modern concepts of the building professions — the engineering and the architectural.

At the same time, with the adoption of the concept of profession, the craftsman and the professional became differentiated to such an extent that a need for a clear and easily transmissible system of communication between the two became an urgent issue. The first and foremost problem was that of inventing a new principle of graphical communication. Such a 'language' needed to satisfy two most important prerequisites: it had to be easily transmissible, and it had to be standardised, to allow usage across the territory for which it was valid.[13]

Up to and during the greater part of the 18th century, the geometrical techniques employed by craftsmen and designers were empirical recipes,[14] they offered no underlying principle of unity by which the similar processes of defining and executing the methods of stone-cutting could be transferred from one case to another. These techniques often resembled a catechism rather than an exact method. Furthermore, geometrical methods, both graphical and constructive,[15] were in the 17th and 18th centuries expounded in treatises on the art of stone-cutting; they were mainly based on what authors found from the sources still surviving within the operative masons' craft, and were deeply coloured by the mythology pertaining to the secrets of the mediaeval masons.[16] But the need for a clearly defined communication technique amidst the separation of the professional and craftsmen made the search for it an urgent issue, discussed and entertained on various levels of the engineering (both civil and military) and the architectural professions.

Between 1795 and the time the engineering and architectural schools at the English Universities were established, this search led to the creation of a variety of systems of communication. Unlike the situation in France, the search was never, however, dependent entirely on the knowledge and use of descriptive geometry.[17]

Descriptive Geometry was also deemed to be an abstract and foreign subject, not suitable for teaching at the English institutions. This may be accepted as partly truthful assessment of the educationalists at the time, as Descriptive Geometry was, in France, taught in a setting completely unrecognisable to that of the educational institutions of Britain at the time.[18]

[13]Monge described this as one of the primary aims of Descriptive Geometry; it was to 'serve as a language of communication' and one which would help the French nation rise 'above the dependence' on any foreign invention of graphical communication. See Monge (1799), p. 1–2.

[14]Booker (1963), p. 24.

[15]Graphical would be those techniques and methods whose primary aim was to represent objects (architectural or otherwise) as they would appear once completed; the constructive are those technique which are used in order to derive certain properties of an object — for example finding the exact length of a diagonal of a cube would deem to be a constructive manipulation and part of a constructive method/technique.

[16]In English language in particular, the work of Moxon: *Mechanick Exercises; or the Doctrine of Handy Works*, published in London 1677, 1693, and 1700, was one such publication, as were the numerous works of Batty Langley who published extensively for the building craftsmen during the period between 1720 and 1760.

[17]For example, French had few other techniques of graphical communication invented in the first two decades of the 19th century, of which Cousinery's published in 1828 and 1841 was the most interesting one (in terms of the conception of space and projection). They could not, however, compete with the comprehensiveness of Descriptive Geometry.

[18]See quoted passage from Sakarovitch (1995) at the beginning of this paper.

The new institutions where the working men and the building professionals would be educated in such communication technique were of the two levels: Mechanics' Institutes catered for the working classes, while the newly founded schools of architecture and engineering started offering courses to the aspiring architects and engineers. Both types of institutions sought the teachers and considered possibilities in terms of their programmes of education that would be conducive to their respective goals.

The first Mechanics' Institute was founded in Edinburgh in 1821, largely resting its *raison d'etré* upon the philosophy of George Birbeck,[19] who provided a course of lectures in the period between 1799–1804 for the working men. Another institute was then founded in Glasgow in 1823, and yet another in London in the same year.

England had, at the time, an already established philosophy of education which was by some perceived as an anti-establishment and radical practical philosophy. At the same time as the Mechanics' Institutes were being founded across the country, moves were being made to establish the schools for professionals, mining and civil engineers, and architects, based on the modern principles of profession and industry.

The University College London was founded in 1828 on the two of the new brave principles of education — strict religious undenominationalism and the teaching of subjects applicable to modern life. In the same year, the King's College London was founded, aiming to provide 'modern' syllabus for the professionals — the mining, the engineering, and the architectural schools opened there few years later.

One man who was instrumental in both setting down the framework of the educational programme for the Mechanics Institutes, and being involved in founding of the University College London was Lord Brougham. Brougham,[20] was a Scottish philosopher and politician who, in the same year when the first Mechanics' Institutes were founded in Glasgow and London, wrote his famous pamphlet *The Practical Observations upon the Education of the People, Addressed to the Working Classes and their Employees.* He also advised the nation on the suitability of the subjects to be studied at the Mechanics' Institutes. They should include practical subjects, although mathematics, such as 'doctrines of Algebra, Geometry, and Mechanics' should be taught, but, as Brougham put it, through the 'examples calculated to strike the imagination'.[21] This may be the crucial statement which influenced the destiny that awaited Descriptive Geometry in England. Already in 1820, William Farish,[22] who was a professor of Natural History at the University of Cambridge, wrote that the orthographic projection 'would be unintelligible to an inexperienced eye'.[23]

And while Descriptive Geometry could be used, as indeed in France it was, to practical purposes, its strength was in the underlying mathematical principles, and not in the way the picture of an object was presented. Contrary to this, Nicholson's technique did give this final picture of the object — and it was this technique that eventually substituted Monge's in England, in all but the name. It was further modified in the next twenty years to finally be

[19] George Birkbeck (1776–1841) promoted, together with his friend Lord Brougham, the foundation of the University of London in 1820s. He also worked on the board of the Society for the Diffusion of Useful Knowledge (as opposed to the Society for the Promotion of Christian Knowledge).

[20] Henry Peter Brougham, First Baron, was a lawyer, British Whig Party politician, and Lord Chancellor of England (1830–1834). Educated at the University of Edinburgh, he practiced at the Scots bar (from 1800) and helped to found *The Edinburgh Review* (1802). He sponsored the Public Education Bill of 1820; made antislavery speeches and advocated parliamentary reform. During the 1820s he helped to found not only the University of London but also the Society for the Diffusion of Useful Knowledge, intended to make good books available at low prices to the working class. (Sources: Encyclopaedia Britannica on-line 2001, Dictionary of National Biography, 1950.)

[21] See Brougham (1825).

[22] William Farish (1759–1837), Jacksonian professor of natural and experimental philosophy at the University of Cambridge from 1813 to 1836. One of the founders of the Cambridge Philosophical Society in 1820, he published on his technique in the first transactions of the said society in 1820.

[23] Farish (1820), p. 2.

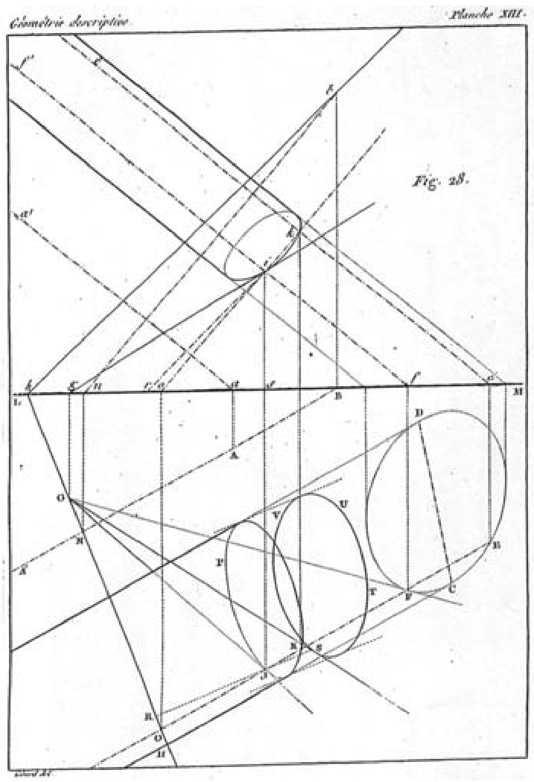

Figure 3 – Plate 28 from Monge's *Géometrie Descriptive* showing the intersection of two cylinders

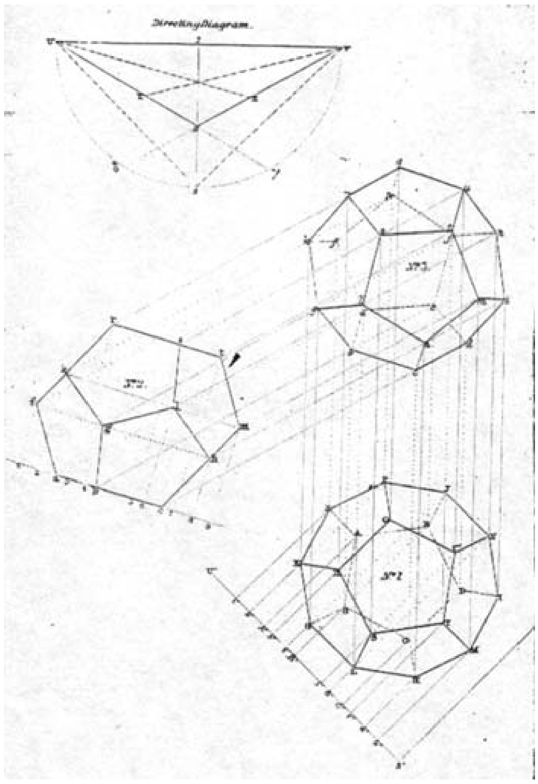

Figure 4 – Plate 20 from Nicholson's *Parallel Oblique Projection*, showing the body in three views; the system also offers an easy method to obtain real measurements

accepted only as a graphical technique, for the use in the building professions, and, unlike to the case of the 'original' Descriptive Geometry, it was never taught at the lower levels (such as schools) or to mathematicians and trainee mathematics teachers. In England, graphical geometry, (geometrical drawing and descriptive geometry in combination) was accepted as a method for solving practical problems in architecture and engineering, but gained almost no validity in terms of its applicability to mathematics and projective geometry. In France however, Monge's work was linked to that of his pupil Jean Victor Poncelet (1788–1867), if not in a clear line of succession, than certainly as a kind of inspiration to the invention of Projective Geometry in 1822.

Nicholson's method was, by the 1860s fully accepted and taught at both the professional (the engineering and the architectural) schools and in the Mechanics' Institutes under the name of 'Descriptive Geometry'. The treatises on it were republished many times by Binns and Bradley, but as Nicholson's system of projection became widely adopted, any reference to its inventor disappeared in the manuals and syllabuses. And so, Descriptive Geometry did, briefly, find a place in the educational system of English architects, engineers and even mathematicians, but in a very modified form; unlike its French counter-part neither the technique nor its inventor gained the due recognition or prominence.

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