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From anomaly to fundament: Louis Poinsot's theories of the couple in mechanics

I. Grattan-Guinness [a,b,*]

[a] *Middlesex University Business School, The Burroughs, Hendon, London NW4 4BT, England, United Kingdom*
[b] *Centre for Philosophy of Natural and Social Science, London School of Economics, Houghton Street, London WC2A 2AE, England, United Kingdom*

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Abstract

In 1803 Louis Poinsot published a textbook on statics, in which he made clear that the subject dealt not only with forces but also with 'couples' (his word), pairs of coplanar non-collinear forces equal in magnitude and direction but opposite in sense. His innovation was not understood or even welcomed by some contemporary mathematicians. Later he adapted his theory to put forward a new relationship between rectilinear and rotational motion in dynamics; its reception was more positive, although not always appreciative of the generality. After summarising the creation of these two theories and noting their respective receptions, this paper considers his advocacy of spatial and geometrical thinking in mechanics and the fact that, despite its importance, historians of statics who cover his period usually ignore his theory of couples.

Résumé

En 1803, Louis Poinsot publie un ouvrage de statique, dans lequel il apparaît clairement qu'il traite le sujet non seulement en termes de forces mais en termes de « couples » (selon son expression), c'est-à-dire de paires de forces, non colinéaires, égales en grandeur et en direction mais de sens opposés. Plus tard, il a adapté cette notion pour déterminer, en dynamique, une relation nouvelle entre mouvement linéaire et mouvement de rotation. Cet article présente ces développements et en examine la réception, qui a été lente parmi les mathématiciens contemporains de Poinsot et quasi inexistante chez les historiens de la mécanique.

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Keywords: Poinsot; The couple in statics; Rotational motion in dynamics; Geometry versus analysis in mechanics; Teaching mechanics; *Ecole Polytechnique*

* Correspondence to: Middlesex University Business School, The Burroughs, Hendon, London NW4 4BT, England, United Kingdom.
E-mail address: ivor2@mdx.ac.uk.

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> One should do well to convince oneself that the consideration of couples is not that of a singular case, but of an essential element that is lacking in mechanics.[1]
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> [Louis Poinsot, *Eléments de statique*, 2nd edition (1811, preface)]

Part 1. Contexts

1. Organisations

Some time in the Revolutionary Year 2 or 3, now better remembered as 1794, an orphaned teenager studying at the *Collège Louis-le-Grand* in Paris came across a flyer or a newspaper announcing the creation of a new institution of higher education. Intrigued, he applied and was accepted, and thereby set the course of his long career.

The institution was one of two efforts of the French government of the time to solve one of the social crises caused by five years of revolution and discontinuity. Purges of the aristocracy and the governing classes, and the closing of all universities and engineering colleges in 1793, left in ruins the training and support of the professional classes in all walks of life. Part of the solution was to create two large institutions of higher education, each to cover a range of disciplines. Leading members of the appropriate disciplines were appointed as teachers, and 400 students were nominated for each institution from across the country by local organisations and dignitaries. After 12 months of fast-food education in these institutions, the graduates would go back to their home areas and create similar teaching programmes and institutions there.

Each project was absurd, and bound to fail: both institutions folded within a year or so of their creation in the winter of 1794–1795. But the circumstances differed. The *Ecole Normale* was mainly oriented around humanities subjects but also included some mathematics; it quickly disappeared, although the published versions of the lectures given there were to be quite influential.[2] The *Ecole Centrale des Travaux Publics* covered physical sciences, especially civil and military engineering and chemical technology; it would have gone the same way, but its founders soon realised its absurdity and quickly converted it into a different organisation, the *Ecole Polytechnique* (Langins, 1987). The policy of seeking the most appropriate students was maintained, so that admissions examiners supplemented the teaching staff of professors and lecturers and the graduation examiners; but the annual enrolment was reduced from 400 to the order of 100–150. The crash course of 12 months was replaced by a proper three-year curriculum. No attempt was made to teach "everything"; on the contrary, the students received a basic training in 'many techniques', and after graduation they normally received more advanced training in some engineering sciences in one of the military or civilian schools that already existed and had been quickly reopened after the blanket closure. The graduates then normally followed a career in an engineering *Corps* or in the army or navy.[3]

One major consequence for the *Ecole Polytechnique* was unintended. For its first 25 years its graduates (called '*polytechniciens*') included dozens of figures who later pursued distinguished careers as teachers and professors either within the engineering system itself, and/or in an engineering *Corps*, and/or in the so-called *Université* organisation of school and faculty-level higher education that was eventually brought in following a decree of 1808.[4] Let us now meet one of these graduates.

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[1] 'On aura bien de s'y convaincre que la considération des couples n'est pas celle d'un cas singulier, mais d'un élément essentiel que manquait à la Mécanique'.

[2] Twelve volumes of the *Séances des Ecoles Normales* were published between 1795 and 1801, and some were reprinted. For a modern edition of some mathematical courses see (Ecole Normale, 1992).

[3] The literature on the *Ecole Polytechnique* is quite substantial. The first history (Fourcy, 1828), written by its founder librarian, is still valuable; so is the current website www.polytechnique.edu/.

[4] The *Université* included an elite *Ecole Normale* in Paris, which took no heritage from its predecessor; but training of scientists was insignificant there until the mid 19th century.