

THE ECOLE POLYTECHNIQUE AND THE FRENCH REVOLUTION: MERIT, MILITARIZATION, AND MATHEMATICS

JANIS LANGINS
University of Toronto

RESUMEN

La Ecole Polytechnique, tras su reorganización por Napoleón en 1804, mostró características que tenían sólidas raíces en las tradiciones pedagógicas de las escuelas técnicas militares del Antiguo Régimen en Francia. Estas características eran: Un examen de ingreso competitivo; la importancia de las matemáticas; y la asociación de la educación matemática y técnica con la educación militar. La competencia para ingresar en las escuelas de artillería e ingenieros era ya muy fuerte antes de la Revolución, y la nobleza no garantizaba la admisión. Más aun, las matemáticas sirvieron como criterio principal en las difíciles pruebas de acceso organizadas por conocidos matemáticos de la Academia Royale des Sciences. Existen además indicios de que la educación matemática era considerada parte integral de la enseñanza militar, incluso para los oficiales que no entraban a formar parte de los cuerpos técnicos.

ABSTRACT

The Ecole Polytechnique, after its reorganization by Napoleon in 1804, displayed features that had solid roots in the pedagogical traditions of the military technical schools in Old Regime France. These features were the competitive entrance examination, the importance of mathematics, and the association of technical and mathematical education with military education. Competition for entry into the artillery and military engineering schools was already severe before the Revolution, and noble birth alone was not sufficient for admission. Furthermore, mathematics served as the dominant criterion in the difficult entrance examinations administered by well-known mathematicians of the Royal Academy of Sciences. There is also some evidence that mathematical education was considered an integral part of military education, even for those officers who did not serve in the technical corps of the armed forces.

Al ser fundada durante la Revolución en 1794, se produjo un intento de modificar estas características que duraría poco. El influjo revolucionario fue más bien de tipo ideológico, y se manifestó no tanto en la pedagogía, las estructuras o el modo de reclutamiento como en la nacionalización de la instrucción matemática. Esto supuso, en la práctica, un aumento de la centralización, la uniformidad y la vinculación estatal, al mismo tiempo que la apertura a un espectro social más amplio.

When it had been founded during the Revolution in 1794, there had been some attempt to modify these features, but the attempt was short-lived. The influence of the Revolution that persisted was of a more ideological nature. It manifested itself not so much in pedagogy, structures, and manner of recruitment, but in the nationalization of mathematical instruction. In practice this meant increasing centralization, uniformity, association with the state, and availability to a wider social spectrum.

Palabras clave: Ecole Polytechnique, Revolución francesa, Educación técnica, Educación matemática, Educación militar, Exámenes.

There is no need to stress the centrality of the Ecole Polytechnique in French education, culture, and the history of science and technology¹. Not only did it serve as the model for the French system of *grandes écoles*, still very vital today, but it was also a seedbed of eminent scientists and engineers. From 1794 to about 1830 no institution in Europe could compete with its reputation for excellence in the exact sciences and mathematics. Although it appeared during the Thermidorean Convention under the name of the *Ecole Centrale des Travaux Publics*, it is now known that its foundations were being laid during the Jacobin Terror as well, and that it was inspired by even earlier ideas². Thus, it can truly be said that the school is also one of the great educational creations of the French Revolution -or perhaps more precisely- of all the French Revolutions that occurred in the decade after 1789.

Yet, in spite of its remarkably coherent organization presented by Fourcroy to the National Convention in September 1794, the Ecole Polytechnique -like most such establishments- evolved from the germs of a number of ideas and circumstances that contributed to its foundation and it continued to evolve after its official creation. Both popular stereotypes and scholarly studies of the school stress three characteristic features of this seminal and unique institution. They are: 1) the rigorous selection process for entrance; 2) the military nature of the school; and 3) the stress on mathematics in its curriculum.

In this paper, I will attempt to evaluate to what extent these features that defined the Ecole for most of its history and are still characteristic to a great extent today can be attributed to its Revolutionary origins. I will argue that the Revolutionary influence was rather limited in the case of the three traits I have just listed. They bring to mind familiar developments of the Old Regime rather than attributes we normally associate with the Revolution. Yet the influence of Revolutionary ideologies did consolidate and diffuse the heritage of the Old Regime. Even the massive growth of a scientific teaching profession during and immediately after the Revolution noted by some scholars thus appears as a derivative result of these more fundamental ideological influences of the Revolution³.

*Grand Bézout [...] aux aspirants tu donnes secours*⁴

The rigorous process of selection known as the *concours* that still strikes fear into candidates for the *grandes écoles* was by no means a creation of the Revolution. It had existed at least as far back as the foundation of the military engineering school at Mézières in 1748⁵. All candidates to this school were subjected to an oral examination by a member of the Royal Academy of Sciences upon entrance into the school, again for promotion into the second year of studies, and finally for passing out as full-fledged officers in the corps of military engineers. Similar examinations were held for the artillery corps as well as for the Navy⁶. Indeed, the idea of examining candidates for the technical branches of the army was older than the technical schools themselves: Louis XIV's great military engineer Sébastien Le Prestre de Vauban (1633-1707) had wanted to subject candidates desiring to enter the corps of military engineers to an examination and a probationary period before admitting them. He himself had examined candidates and after his promotion to Marshal of France began the practice of having academicians administer the examination⁷. After his death, there seems to have been a certain amount of carelessness in the administration of the examinations and some reversion to the more traditional avenues of favoritism and family relationships for entry to the corps, although the principle of examination for merit was never abandoned or even questioned⁸.

After Marc-René de Voyer, comte d'Argenson (1694-1764) annexed the Department of Fortifications as a regular department of the Ministry of War in 1743, competitive examinations were made an even more stringent prerequisite for entrance into the corps⁹. For a time even solidly attested noble birth gave an edge in the competition for admission only if intellectual merit as determined by the examination equalled that of non-noble competitors¹⁰. Even after the notorious Ségur edict of 1781 restricting the officer corps of all

branches of the army without exception to candidates who could document four generations of noble birth, the requirement of severe examination of intellectual merit stayed in place. Only on very rare occasion were a few foreign nobles and certain high-born members of the court nobility admitted to the school but even the latter were required to pass the entrance examination¹¹. People did try, apparently, to use their personal influence with examiners, but it is doubtful whether they had much success¹². In fact, the attempt to influence the examiner, rather than the Minister or his officials, is in itself rather significant. It lends support to Roland Mousnier's contention that a new class of *fonctionnaire*, best exemplified by the state engineers, with uniform and rational standards of recruitment was being created in the eighteenth century¹³.

Significant features of these examinations were their difficulty and the dominance of mathematics in their subject matter. The examiners were always mathematicians of exceptional calibre and passing the exam before a Laplace, a Monge, or even a Bézout or a Bossut was by no means easy¹⁴. Rouget de Lisle -composer of the *Marseillaise*- only succeeded on his fifth attempt to pass the entrance examination into the military engineering school of Mézières. Even a person of the quality of a Lazare Carnot (1753-1823) succeeded only on his second attempt¹⁵.

In what ways did the *concours* at the Ecole Polytechnique differ from those at the technical schools of the Old Regime?¹⁶ The most obvious difference, not surprisingly, was the elimination of the requirement of noble birth to be admitted to the entrance examination. Indeed, at the first entrance examinations for the Ecole Polytechnique there was the symmetrically opposite requirement that students were to be examined on their loyalty to the new Republic. Almost immediately, however, the selection criteria were effectively reduced to solely intellectual ones¹⁷. The results of the examination in *civisme* of the students played no role in admission and were eventually replaced with easily obtainable certificates of good conduct from municipal authorities¹⁸.

In this way, the Ecole Polytechnique maintained intellectual rigour of the old *concours* while becoming a truly national institution open in theory to all Frenchmen. Its insistence on acquired knowledge and especially intellectual criteria made it different from the *revolutionary courses* on cannon and gunpowder manufacture founded during the Terror and the Ecole normale of the Year III, where admission was on a purely territorial basis with the approval of local political authorities¹⁹. It differed from the pre-Revolutionary system, however, in two important ways. The initial plans of the school do not specify a passing out examination after completion of the three year course;

promotion from year to year and graduation apparently was to depend on the results of continual evaluation of the work of students at the school²⁰. Furthermore, the requirements for admission are vaguer and examiners were initially probably more indulgent than was the case for students attempting to enter the royal artillery and engineering schools²¹.

To some extent this can be attributed to the exceptional circumstances caused by the intensive warfare of the Revolution. Demand for technically trained manpower was very great and there was pressure to loosen entrance requirements in the emergency situation. Indeed, both Bossut and Laplace, examiners of the military engineering corps and the artillery respectively, had been dismissed from their post during the Terror as much for their insistence on adhering to the old strict standards of admission as for their suspected coolness towards the republican regime. There is also evidence indicating that the founders of the Ecole Polytechnique deliberately wanted to downplay the importance of book learning and seek out candidates on the basis of native intelligence²². Consonant with republican ideologies that attacked pedantry and stressed the release of socially and academically repressed intelligence, this attitude may also have arisen from a dissatisfaction with the existing texts that served as the basis for the examinations. Unlike candidates for commissions in the Royal Artillery Corps who were specifically tested on the contents of Bézout's *Cours de mathématiques*, the admission requirements to the Ecole Polytechnique are couched in general terms and refer to no particular text. Indeed, one of the founders of the school made denigratory remarks in public about Bézout's book²³.

All these symptoms are visible at the foundation of the school. But things were to change rapidly after the reinstatement of the former examiners for the technical services of the army after Thermidor and the revival of passing out examinations. Laplace was particularly active in attempting to mould the Ecole Polytechnique in the form that he wanted²⁴. He called for a reduction in the number of entrance examiners (initially there had been 22 local examination centres throughout the country, each with their own examiner), an increased role for the passing out examiners, who were also to sit on the admissions committee, and more detailed and extensive requirements for students preparing for the examination. In all these demands, as well as others concerning the pedagogy of mathematics, Laplace was to get his way. The widely publicized knowledge of the entrance requirements for the Ecole Polytechnique coupled with the Revolutionary and Napoleonic attempts to create a centralized, uniform system of education, did much to impose national standards of mathematical instruction in France. Moreover, the use of textbooks both for preparation for entrance as well as for the courses taught at the school itself became not only respectable but even mandatory²⁵.

In short, after a very brief attempt to change the nature of the examination system to allow more long-term evaluation of performance rather than punctual confrontations with an omnipotent examiner, there was a reversion to the previous system. The continuity introduced by the presence of the same examiners before and after the Revolution, as well as the strong personality of Laplace, who had little love for the Ecole Polytechnique and even less for the Revolution, and appears to have attempted actively to bend the school to his will, explains much of this phenomenon. Even though there were official examiners in the other subjects taught at the schools -physics, chemistry, and descriptive geometry, a branch of mathematics with practical applications- their role was effaced²⁶. Lacking the academic credentials and the prestige of the so-called *permanent* examiners in mathematics, they only examined for promotion to higher years and leaving the school, not for the entrance examination. And the unmistakably dominant subject on all the examinations was mathematics in the form of analysis and rational mechanics. It is clear that the patterns of the Old Regime survived into the nineteenth century.

A Military School

Many foreign visitors to the Ecole Polytechnique today are still somewhat unsettled to discover or even to be reminded that the premier institution for mathematical and scientific education in France is technically a military school under the jurisdiction of the Ministry of Defence. For a long time this has struck many as a highly anomalous situation. Napoleon is credited or blamed for the militarization of the Ecole Polytechnique in 1804, although students already held official military rank since 1799 and were supposed in theory to wear the uniform of the civic militia of Paris (the National Guard) from the day the school was founded. Yet Napoleon's militarization, although the culmination of an ongoing process, was nevertheless a distinct turn away from the ideals of the founders. Before 1805, students were not boarders at the school, they lived in town, generally avoided wearing any kind of uniform and enjoyed a free and even turbulent life that may have eventually provoked Napoleon to put them into barracks.

In doing so Napoleon was renewing well-established practices of the Old Regime. The *internat* (or boarding school) was popular with parents of scholars in pre-Revolutionary France and Napoleon himself had gone through such a system of education at Brienne and the *Ecole royale militaire*²⁷. During the Revolution the Ecole Polytechnique had been exceptional in being a civilian school both in its administration (controlled by its professors) and in the lifestyle and discipline of its students. Monge, extremely influential in

organizing and administering the schools, who had had his problems as a teacher at the military engineering schools at Mézières with the military staff, appears to have had little desire to militarize the school²⁸. Even the former military engineer Prieur de la Côte-d'Or, also influential in the foundation of the school, preferred to have students wearing civilian clothes from government stores rather than National Guard uniforms²⁹. Since many of the students were destined for the military services, pressure for militarization of the schools appeared early, but once again, it was during the Revolution and the first years of the school that it enjoyed the ephemeral situation of a civilian institution.

Une école monoteknique?

It was not only in the existence of the arduous concours and military discipline that the Ecole Polytechnique after the Revolution resembled the military technical schools of the Old Regime. Even more important was the focal role of mathematics in the curriculum. The view that *Among all the sciences necessary to military persons, without doubt mathematics have the most considerable rank* was common not merely in the artillery and military engineering schools, it was coming to reflect royal policy of military education for all branches of the armed forces³⁰. From his studies of French military professionalism on the eve of the Revolution, David Bien argues that there was a *rising mania for mathematics* at this time among military educators³¹. The interest in mathematics arose not merely because of its direct usefulness to the small minority of future officers who would enter the artillery and the military engineering corps. Mathematics, and especially instruction in mathematics, was seen to have valuable moral uses. It sharpened powers of reasoning and inculcated an orderly manner of thinking that would be useful even for infantry officers. Furthermore, the learning process of what most young nobles preparing for a military career would have considered an arid and difficult subject would foster habits of work and self-control that the army was coming to value more and more in an institution that was growing increasingly rationalized and bureaucratized. In short, mathematics was seen as the right kind of *hair shirt* for young, turbulent, and undisciplined boys being trained for subordination, regularity, and industriousness in an army increasingly concerned with professionalism rather than charisma. More and more, mathematical culture was being identified with military culture in opposition to the juridical culture of the *noblesse de robe*³².

At the Ecole royale militaire in Paris in 1785 about one-eighth of the regular students' time was normally spent on mathematics -6 hours per week- in addition to courses on fortification, drawing, grammar, geography and

history, and German, as well as lessons in fencing and dancing³³. Those preparing for the *concours* for the technical schools had an even greater load in mathematics: additional lessons above the regular ones and replacing some of the other subjects, such as fortification, brought their mathematics instruction to 50% of their class time - about 20 hours per week³⁴.

This proportion of half is exactly the same as that specified for the *connaissances mathématiques* at the nascent Ecole Polytechnique in 1794. But at the Ecole Polytechnique this figure included all the civil and military engineering subjects as well as the extensive course in descriptive geometry in the first year that also included stone-cutting, perspective, and topography. In fact, only a twelfth of the student's time in 1794-95 was supposed to be devoted to analysis and rational mechanics³⁵.

This situation changed very rapidly. By its second school year (1795-96) this proportion had jumped to 29.4% of the students' time and by 1806 had reached the figure of 44.5%³⁶. This, as well as some shrinkage in weight of descriptive geometry and the gradual disappearance of the more practical engineering courses, led Théodore Olivier to describe the school some years later as an *école monoteknique* and to deplore the attention it gave to analysis and rational mechanics³⁷. The original intentions of the founders, as displayed in the first plan of study at the school, manifest a desire for a truly polytechnical university with as much emphasis on the physical sciences, especially chemistry, as on the mathematical sciences³⁸. Even within the mathematical sciences, the subjects that are really engineering subjects - drawing, for example, was included as part of the mathematical sciences - have the lion's portion of the students' time. Thus, mathematics, if we exclude the important exception of Monge's descriptive geometry, did not have the dominant role it had in the old military schools. Olivier attributed the reasons for this change to the pernicious influence of Laplace and his students, but the reasons for this change are more complex³⁹. Yet Laplace's pivotal position as examiner for the artillery was not without some weight in restoring the *status quo ante* regarding the proportion of students' time devoted to mathematics other than descriptive geometry.

It might appear, then, that the Revolution was an abortive interlude of innovation in French technical education. Yet such a view would be simplistic. Even though the revolutionary programme for a polytechnical university was radically whittled down very rapidly, some elements of this programme persisted and in conjunction with other more general aims of the Revolution did have some impact on French technical education in general and the teaching of mathematics in particular. In spite of pressure from the military services, the initial ideal that the school should also be a research

establishment with its teaching policy determined by its academic staff persisted to some degree. Along with senior officers and officials of the state technical services, staff members and members of the *Institut* sat on the *Conseil de Perfectionnement* to determine teaching policy and course content⁴⁰. Although in principle, the vast majority of students were committed to the state technical services, abler students were encouraged to develop their talents and were sometimes kept in junior teaching posts at the school itself or directed to other parts of the educational system.

It was, however, the ideological residue of the Revolution, that had a more fundamental if indirect impact on the development of the teaching of mathematics and the exact sciences in France. It was this aspect, which, in spite of profound structural similarities, ensured that the post-Revolutionary situation in French scientific and technical education was not a simple Restoration of the previous system. The boldness and scale of Revolutionary enterprises, of which the Ecole Polytechnique is just one example, gave an impetus and a visibility to mathematical instruction that were not present before. The school was located in Paris, the centre of French cultural and political life, and not in isolated frontier towns and military garrisons. It was truly a *grande école* with initial enrollments set at 400 students with the most illustrious staff that could be mustered in the country. At the Ecole Polytechnique there were 18 regular professors and a host of subsidiary staff. This can be contrasted with the military engineering school at Mézières, where there was a single mathematics master assisted by a *répétiteur*. As soon as this professor had achieved any eminence, as was the case with both Bossut and Monge, he left for the more exciting intellectual life of the capital and the Academy of Sciences. With the new school, this would no longer be the case, for one of the prime centres of scientific activity in the country was the school itself.

Because of the reorganization and centralization of the system of state technical schools as *écoles d'application* for the Ecole Polytechnique in 1795, the standards and practices of the school were spread to other schools beyond the artillery and military engineering school. Teaching at the *Ecole des ponts et chaussées* and the School of Mines, where mathematics instruction had formerly been left to external mathematics masters, no doubt benefited from the solid mathematical preparation of their students at the Ecole Polytechnique, through which all candidates were obliged to pass after 1795. Similarly it benefitted from a new generation of teachers, such as Navier, who had passed through the schools as well. Thus, there was a systematic extension of the type of instruction formerly limited to military institutions to the other teaching institutions in the country, both because they were obliged to recruit from the Ecole Polytechnique or, on at another level,

prepared students for the Ecole Polytechnique. Furthermore, after abandoning its initial repugnance to official texts, the Ecole Polytechnique continued the tradition, of which Bézout was the prime example during the Old Regime, in creating what the *Conseil de Perfectionnement* would call *classical texts* for French students⁴¹. In general, the increased size of the school and its prominent position in the educational system of the country led to a hitherto unmatched attention to pedagogical problems and the involvement of eminent mathematicians and scientists in teaching.

Militarism, one of the unforeseen by-products of the Revolution, helped to consolidate and generalize the intimate connection of meritocracy, mathematics and the military during the Napoleonic period when France had a political regime with a pronounced military character⁴². Both the prestige of a military career for some people in Napoleon's military Empire and the fear of some others that their sons would supply cannon fodder in the infantry or as ordinary conscripts increased the attractiveness of entrance into the Ecole Polytechnique (Better graduates could enter the civilian technical services and even the others could look forward to being officers rather than ordinary soldiers). A personal anecdote of Arago illustrates this well⁴³. As a young man, he had seen what appeared to be an abnormally young officer on the ramparts of Perpignan. Upon enquiring how this person had earned his epaulettes so quickly, he was told that he had gone to the Ecole Poyltechnique. The young Arago had asked: *What is this school? It is a school where one enters by examination*, came the reply. Thereupon was born the desire to go to this previously unknown institution. Even though Arago was no lover of the army in later life, he, and probably many like him, were first attracted to a mathematical education by the lure of the army.

Perhaps a more fundamental and more genuinely Revolutionary contribution to the consolidation of the Ecole Polytechnique in its central position in French mathematical education in the early nineteenth century was the Revolution's massive endeavour to create a truly national institution of education. R.R. Palmer, who sees *nationalization* as one of the key aspects of the Revolution's aims in education, identifies a number of distinct concepts encompassed in this word. Nationalization meant the tendency to centralization by the central power at the expense of local authorities, the assertion of public authority over private, the desire to make educational facilities geographically more available, as well as more uniform, and to make it socially more useful⁴⁴. In almost all these ways one can see the Ecole Polytechnique as a typically national institution. But it was national in another and perhaps even more important way. Its aim was to provide an education in the sciences to all qualified citizens of the *grande nation*, and not merely to an exclusive professional and social caste, as had been the case with

the military schools of the Old Regime. At the same time its influence was to become truly national in scope because of its function as a focus of scientific education: it was for a long time the goal toward which secondary scientific education inexorably tended and the platform from which higher technical education began.

Mathematics has always formed a strong element in the intellectual culture of the nation of Descartes and Pascal, but it is with the Revolution and the Ecole Polytechnique that we can say that this feature ceases to be the prerogative of a limited elite but becomes, at least in theory, truly national and democratic in scope.

NOTAS

* A shorter version of this paper was presented to the 18th International Congress of the History of Science at Hamburg in August 1989.

1 Besides the classic history of the Ecole Polytechnique by FOURCY, A. (1828) *Histoire de l'Ecole Polytechnique*. Paris, recently reprinted with an introduction by Jean Dhombres (Paris: Belin, 1987), treatments of the history of the school can be found in SHINN, T. (1980) *Savoir Politique et Pouvoir Social: L'Ecole Polytechnique 1794-1914*. Paris. In English, good descriptions of aspects of the school in Revolutionary and Napoleonic times can be found in CROSLAND, M. (1967) *The Society of Arcueil: A View of French science at the time of Napoleon I*. London and BRADLEY, M. (1976) "Scientific Education for a New Society: The Ecole Polytechnique 1794-1830", 5, 11-24.

2 LANGINS, J. "La préhistoire de l'Ecole polytechnique". *Revue d'histoire des sciences*, (In Press).

3 On the professionalization of scientists in the framework of teaching institutions during the Revolution see Crosland, (n.1), HAHN, R. (1971) *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666-1803*. Berkeley, and BEN-DAVID, J. (1970) "The Rise and Decline of France as a Scientific Centre". *Minerva*, 8, 160-179.

4 "Grand Bézout, achève ton cours/ [...] aux aspirants tu donnes secours". These are the opening lines of a doggerel poem scribbled by the young Napoleon Bonaparte on his copy of Bezout's mathematics text, which he was using to prepare for his entrance examination to the artillery at the *Ecole royale militaire*. (Quoted by CHUQUET, A. (1898) *La Jeunesse de Napoléon*, t. 1. Paris, 3 vol, p. 226).

5 On Mézières R. Taton (1964) "L'Ecole du Génie de Mézières". In: *Enseignement et Diffusion des sciences en France au 18^e siècle*. Paris.

6 HAHN, R. (1964) "L'Enseignement scientifique aux écoles militaires et d'artillerie au XVIII^e siècle" et "L'Enseignement scientifique des gardes de la marine au XVIII^e siècle". In: R. Taton, ed., *Enseignement et Diffusion...*

7 TATON, R. "Ecole de Mézières", pp. 561-562.

8 BLANCHARD, A. (1979) *Les ingénieurs du Roy de Louis XIV à Louis XVI*. Montpellier, pp. 166-167.

9 Marc-Pierre de Voyer de Paulmy, comte d'Argenson (1696-1764), Louis XV's Minister of War from 1743 to 1757. On further details of the organizational history of the corps of military engineers during the Old Regime, see Blanchard (above) and AUGOYAT (Col.) (1860-1864) *Aperçu historique sur les Fortifications, les ingénieurs et le corps du génie en France*. Paris, 3 vol.

10 Letter of the examiner Camus to Fourcroy de Ramecourt dated 16 December 1751 cited by Taton, "Ecole de Mézières", pp. 575-576.

11 DORBEAU (General) (1937) "L'Ecole de Mézières". *Revue de Génie*, Mai-Juin, p. 344.

12 One such case is that of the future member of the Committee of Public Safety during the Revolution, Prieur de la Côte-d'Or, whose aunt tried to use her influence at court, with Guyton de Morveau, Prieur's relative and colleague of the examiner Bossut at the Academy of Sciences, as well as with the engineering officer Deshaustschamps, who was a friend of Bossut. BOUCHARD, G. (1946) *Prieur de la Côte-d'Or*. Paris, pp. 39-40.

13 MOUSNIER, R. (1974-1980) *Les Institutions de la France sous la monarchie absolue*, t. 2, livre 7: "L'Apparition des fonctionnaires". Paris, 2 vol.

14 For biographies of Pierre-Simon de Laplace (1749-1827), Gaspard Monge (1746-1818), Etienne Bézout (1739-1783), and Charles Bossut (1730-1814) see GILLISPIE, Ch. (ed.) (1970-80) *Dictionary of Scientific Biography*. New York, 16 vol.

15 Better known in history as Robespierre's colleague on the Committee of Public Safety during the Terror, Carnot was also a gifted engineer and scientist. See GILLISPIE, Ch. (1971) *Lazare Carnot Savant*. Princeton.

16 Perhaps it would be more correct to speak of examination, for the word *concours* appears initially to have been quite specifically avoided. The law of 21 ventôse an 2 [11 March 1794] mentioning the creation of the Ecole Centrale des Travaux Publics (usually considered the founding document of the future Ecole Polytechnique) does mention the *mode d'examen et de concours* for future students. But the earliest surviving drafts of the organization of the Ecole Polytechnique, in the sections dealing with the entrance examination, have the word *concours* carefully scratched out and replaced, in what appears to be the handwriting of Monge, with the word *examen*. MS "Ecole des Travaux Publics: Institution de l'Ecole Nationale des Travaux Publics", Archives of the Ecole Polytechnique, Cote I.2. Carton 1.

17 In the 1794 examinations for *republican morality*, required along with the examination in mathematics, one of the *morality* examiners, L.P. Dufourmy de Viliers (1739-1797?) rejected all twelve students he examined, but overruled. Letter from the chairman of the Commission of Public Works dated 22 frimaire an III [12 December 1794] in MS Folio "Correspondance: Vendémiaire an 3 au 14 frimaire", Cote X2C/11, Archives of the Ecole Polytechnique.

18 In the bill for the Law of 30 vendémiaire an IV [22 October 1795] setting up the *écoles d'application*, Fourcroy omitted all mention of political

reliability as a criterion for admission, but the Convention corrected this oversight (?) in the final version of the law by specifying that *seront exclus des écoles des services publics les citoyens qui auraient manifesté des opinions ou qui auraient tenu une conduite anti-républicaines*. The Law of 25 frimaire an VIII (16 December 1799) reorganizing the Ecole Polytechnique required candidates to present a certificate from their municipality attesting their good conduct and attachment to the Republic.

19 On these courses, see Hahn, (n. 3), pp. 280-81.

20 See article 15 of the organizational decree of the Ecole Polytechnique voted on 28 September 1794 in A.F. Forcroy, *Rapport... et Projet de décret pour l'ouverture de cette Ecole [centrale des travaux publics], et l'admission des Elèves...*, Paris, 1794, p. 225 in LANGINS, J. (1987) *La République avait besoin de savants*. Paris. See also "Avant-Propos" (written by Prieur de la Côte-d'Or) in *Journal de l'Ecole Polytechnique*, cahier 1(1795), p. iv and the law of 15 fructidor an III [1 September 1795] reproduced in the *Journal de l'Ecole Polytechnique*, cahier 4(1796), p. x.

21 In 1794, these were, according to Fourcroy, (n. 20), ... *les premiers éléments d'arithmétique, d'algèbre et de géométrie*. A year later the requirements were raised in theory. According to the Law of 15 fructidor an III [1 September 1795] students hoping for admission were supposed to know arithmetic; algebra, including the solution of equations to the fourth degree, the theory of series; geometry, including trigonometry, analytical geometry, *application de l'algèbre à la géométrie*, and conic sections. Candidates for the artillery were specifically examined on the first volume of BEZOUT, E. (1764-69) *Cours de mathématiques à l'usage des Gardes de Pavillon de la Marine*. Paris, 6 vol., (numerous reprintings with slight variations in the title). The first volume dealt with arithmetic, geometry, and rectilinear trigonometry.

22 "Une description pure et simple des connaissances acquises par les candidats ne peut suffire. Il est encore essentiel de s'assurer de leurs dispositions naturelles pour en accroître l'étendue. Le but de l'institution de l'Ecole centrale de Travaux publics étant de donner une grande instruction, le choix doit se fixer plutôt sur les candidats dont les heureuses dispositions les rendent propres à mieux profiter de cette instruction, que sur ceux qui, avec plus de connaissances, auraient cependant moins de moyens intellectuels de les augmenter; et c'est dans ce sens que celui qui sait le mieux doit être naturellement préféré à celui qui sait le plus. C'est donc à reconnaître le degré d'intelligence et la disposition des candidats que tu dois principalement t'attacher...". Circular to examiners in 1794 quoted by A. Fourcy (n. 1), p. 34.

23 See Fourcroy's speech presenting the Law of 30 vendémiaire an IV [22 October 1795]. GUILLAUME, J. (1891-1907): *Procès-verbaux du Comité d'Instruction publique de la Convention nationale*, t. 6. Paris, 6 vol., p. 842. Truc, Forcroy was a chemist; but it is therefore all the more likely that he was expressing the opinion of some of his mathematician friends, who may have been more reticent to attack a former colleague publicly.

24 LANGINS, J. (1987) "Sur l'enseignement et les examens à l'Ecole polytechnique sous le Directoire: à propos d'une lettre inédite de Laplace". *Revue d'histoire des sciences*, 40, 145-177.

25 Cf. the attitudes towards *livres classiques* in reports of the *Conseil de Perfectionnement* for the years 1806-07 (p. 6) and for the years 1811-12 (p. 17). In the former report, the council categorically rejects official texts in order to have the freedom, necessary in a school that *must follow the progress of the sciences and arts*, to pick the best books available and change them from year to year. In the latter, the council looks forward to the day when the school will be able to present a *cours d'études de l'École polytechnique* for both students and graduates.

26 Suggestions for the two extra examiners were proposed by the administrative council of the *École Polytechnique* in 1798 (MS "Procès-verbaux du Conseil d'administration de l'École polytechnique, 18 thermidor an VI [5 August 1798], Archives of the *École Polytechnique*) and made law the following year (Decree of 7 fructidor and VI [24 August 1798]). The first examiners appointed were Barruel for physics and chemistry and Ferry for descriptive geometry, the graphic arts, and drawing.

27 SNYDERS, G. (1965) *La Pédagogie en France au XVIII^e et XVIII^e siècle*. Paris, pp. 35-48.

28 See the revealing letter of Monge to Lacroix at the beginning of the Revolution reproduced in TATON, R. (1947) "Une lettre inédite de Monge sur la situation en France, en 1791, après la fuite du roi". *Revue d'histoire des sciences*, 1, 358-9.

29 MS Letter of Prieur (Dijon) to Guyton-Morveau (Paris) le 27 frimaire an 4 [18 décembre 1795], Private Collection. (I am indebted to Patrice Bret for a copy of this letter). Claude-Antoine Prieur de la Côte-d'Or (1763-1832) was the other military engineer, besides Lazare Carnot, who was a member of the Committee of Public Safety during the Terror.

30 "Entre toutes les sciences nécessaires aux militaires, les Mathématiques tiennent sans doute le rang le plus considérable", Article "École royale militaire" par Paris de Meyzieu in the *Encyclopédie* of Diderot and d'Alembert.

31 BIEN, D. (1979) "The Army in the French Enlightenment: Reform, Reaction and Revolution". *Past and Present*, 85, 68-98 on p. 85.

32 BIEN, D., "Military Education in 18th Century France: Technical and Non-Technical Determinants". In: M.D. Wright and L. J. Paszek, (ed.), *Science, Technology and Warfare-Proceedings of the Third Military History Symposium. USAF Academy, 8-9 May 1969*. Washington, D.C.

33 Chuquet, (n. 4), p. 186.

34 Ibid., p. 188.

35 *Développemens sur l'enseignement adopté pour l'École centrale des travaux publics...*, Paris, 1794, reprinted in J. Langins, *La République*, (n. 20), pp. 227-269.

36 Langins, "Laplace", (n. 24), pp. 172-173.

37 OLIVIER, Th. (1851) *Mémoires de géométrie descriptive, théorique et pratique*. Paris, p. xii.

38 *Développemens...*, (n. 35).

39 OLIVIER, Th. (1850) "Monge et l'École polytechnique". *Revue scientifique et industrielle du Docteur Quesneville*, February.

40 The *Conseil de Perfectionnement* was set up in 1799 as an external body to give annual reports on the school's performance and to suggest ways of improving it. It was originally composed of representatives of the *Institut* (effectively the French Academy of Sciences), the teaching staff, and the state technical and military services.

41 See note 21. On the long-lasting influence of Bézout's texts, some of which were edited by writers associated with the Ecole Polytechnique, see DHOMBRES, J. (1985) "French mathematical Text-books from Bézout to Cauchy". *Historia Scientiarum*, 28, 91-137.

42 On the incipient militarization of French society during this period see CORVISIER, A. (1976) *Armées et société en Europe de 1494 à 1789*. Paris, p. 138.

43 ARAGO, F. (1854-59) "Histoire de ma jeunesse". In: *Oeuvres complètes*, t. 1. Paris, 12 vol., pp. 3-4.

44 PALMER, R.R. (1985) *The Improvement of Humanity: Education and the French Revolution*. Princeton, esp. ch. 2.