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## THE INFLUENCE OF THE FRENCH REVOLUTION ON MATHEMATICS

HELEN F. SMITH

A study of the early volumes of the *Journal de L'École Polytechnique* for the light they throw upon the relationship between the history of the times and the rapid development of French mathematics.

One of the first acts of the French government, after the republic was set up, was to pass a law (21 Ventose An II, which corresponds to March 11, 1794) creating a commission of public works. Among other things, they were instructed to establish immediately a central technical school to replace several small and scattered ones which were ordered closed. A committee of nine men, prominent in the field of education, was installed in the Bourbon palace, and there they worked through the terrible days from April to July, 1794, making plans for such a school. Their report was accepted without opposition, and the law confirming it was passed that September. The new institution was called *L'École Polytechnique*, and it has remained to the present. The *École Normale*, organized at about the same time for training teachers, survived only a few months.

The director of the newly founded *École Polytechnique* was Lamblardie. The mathematics staff consisted of Lagrange and Prony for analysis and mechanics and Monge and Hachette for stereotomy. The first class met on May 24, 1795. It was taught by Lagrange in the presence of all the students and professors. In his *History of Mathematics*, David Eugene Smith states that Lagrange joined the staff in 1797, but both the *Journal* and the *Livre du Centenaire* state that he was a member of the faculty from the very beginning.

The faculty organized a council of which Lagrange was chosen the first president. They decided at once to publish a bulletin giving an account of the work done at the school and an outline of courses of study as well as results of research, thus creating at the same time a powerful means of public education and a scientific publication without precedent. The first number of the *Journal de L'École Polytechnique* appeared in May, 1795. It contained an announcement of the program to be presented by the professors,

the text of the laws under which the school was to operate and provisions for entrance as well as mathematical papers. The four thousand copies were printed on government presses and widely distributed. In the foreword of the fourth number, the public is invited to make contributions to the Journal, and within a few years, many papers by graduates of the institution appeared along with those of the professors, and an occasional one by some brilliant student.

The attendance, at first, was limited to 360. Entrance was by examination. Permanent examiners sat in various parts of the country on specified dates. They afterward convened in Paris and constituted a board of admissions. The final list, in order of merit, was submitted to the Minister of the Interior, who selected the candidates, the law stating: He will choose those whose services he judges will be most useful to the country under the circumstances.

It was expected that each graduate would be given further training in some special line of public service, and then be placed in a responsible position. Students, on entrance were required to furnish from municipal officers of their own cities certificates of good conduct and loyalty to the republic. Each one was required to choose the line of work he wished to follow, and he was not allowed to change later. Applicants were required to be French, by birth, between the ages of 16 and 20. An exception was made of men who had served the republic in two campaigns or for three years. These could be admitted up to the age of 26. The number likely to be needed in each field was calculated, and admissions were based on that estimate. Entrance examinations covered elements of Arithmetic, Algebra, Geometry and Mechanics only.

The course of study included Mathematics, Descriptive Geometry, General Physics, Chemistry and Design, all the work being directed toward applications to civil works, fortifications, architecture, mines, machines and naval construction. The schedules show approximately 45% of the students' time was spent on mathematics and mechanics. A little training in the French language was added later.

In spite of its glowing motto — "For the country, the sciences, and glory" — from the very beginning, the school was under suspicion. Two or three incidents will serve to show the need for tact on the part of the professors in satisfying a government that watched every trivial detail. It was said that the aristocrats found sanctuary there. They were called in question by the Council of

500. The Director defended the students, saying reports had been exaggerated. Monge was less maladroit in his replies. In order to prove the patriotism of the students, upon receiving a promotion in 1797, he had planted in one of the courts a tree of liberty. The highest personages of the state honored the ceremony with their presence. Dazzled by their own grandeur and holding themselves up as an example, they proceeded to celebrate the civic virtues and to congratulate the young citizens upon having been cradled in liberty and delivered from tyranny. The students, under the wise counsels of Monge, who was a favorite, applauded joyously. An unexpected storm came to destroy everything. Many students, forgetting their good resolutions, looked out from the windows of their study halls and laughed at the orators whom they could not hear. Revenge came promptly. The great men considered France insulted in their persons and demanded that the school be immediately dissolved or immediately purged of its offenders. This difficulty was settled through the tactful efforts of a professor. At another time, the teachers were criticised by the council of 500 for use of  $\alpha$  and  $\beta$  in Calculus. It was unpatriotic! Were not  $a$  and  $b$  good enough? High officials often visited the school. On one such occasion, Letourneau came in person, and, in a speech designed to stimulate loyalty, he said, "I can say to you in the language most familiar to you, Liberty is the theorem proposed by nature, the Republic is its demonstration, and love of country its corollary." Some months later, however, the Empire became the demonstration and servility the corollary.

The very make-up of the Journal is a reflection of the political period. The dates of the early cahiers are given according to the new calendar, established by the Republic, for example, Month of Germinal, year III of the Consulate; the publisher was the printer for the Republic, and the title of each contributor was given as citizen. In April, 1806, the dates change to the ordinary calendar; the school is called "École Royale" or "École Imperiale"; the publisher was the imperial printer, and the contributors were given the title monsieur.

It was the original plan that cahiers 7 to 10 were to be given over to an extensive work on mechanics called "Mécanique Philosophique" by Prony. The seventh and eighth were actually published, but they were later withdrawn from the series and replaced by lectures given at the École Normale in 1795 by Lagrange and Laplace. These are dated June, 1812. The whole of the ninth cahier is devoted to Analytic Functions by Lagrange. The tenth is again

a collection of papers and bears the date November, 1810. The eleventh is dated year X of the Republic. These dates corroborate the explanation of the withdrawal of the two numbers and the substitutions for all four. Cahier 12 contains a series of 20 lessons on Calculus and bound with it a supplement printed three years later.

The Journal gave an outlet for the publication of an enormous amount of important mathematical work, as well as lesser amounts in the sciences. In the first twenty cahiers, 3,839 pages were contributed by seven men, as shown by the following table:

	NO. OF MEMOIRS	NO. OF DIFFERENT CAHIERS	TOTAL NO. OF PAGES
Prony	18	11	796
Monge	9	5	287
Lagrange	32	7	859
Laplace	13	5	217
Poinsot	4	3	159
Poisson	18	9	1,084
Cauchy	11	5	437

The first series of the Journal runs to Cahier 62 (1892), and the second series now has 33 cahiers, which come down to the present. There is a gap between cahiers 19 and 20 of the first series from 1823 to 1831, but in general the publication has been nearly regular.

The very year Napoleon was made Emperor, the school was militarized by imperial decree. The professors felt that the quality of the work was sure to suffer from it. In vain, Monge, who loved the emperor passionately, resisted. He made five different appeals, urging that the public good required the continuance of the school on the plan of its first ten years. The only reply was that it was necessary to regiment public instruction, that the discipline of the school required it. To the parents, they boasted the advantage to their sons of living in barracks, the better opportunities for health and moral welfare, and to the state of having the youth accustomed to discipline. Uniforms were required, and the next year they began charging a tuition of 800 francs. This excluded from the school the sons of the poorer citizens. The council, having charge of the school, was presided over by a governor named by the emperor and having power to dismiss professors and examiners. The head of the school was also a military officer, but, fortunately, he was a distinguished person who was very sympathetic with the professors, and he often acted as buffer between the emperor and the faculty. Then the minister of war began drawing upon the school for offi-

cers of artillery. In two years, he actually took 210 from the student body. The school was badly demoralized, and did not fully recover until after Waterloo. In spite of a continual struggle for existence, the faculty put forth such enormous effort that the scientific program actually progressed.

Most of the great mathematicians whose names have come down to us from this period were connected with the *École Polytechnique* and were also active in the service of their government in civil and military offices. Lagrange, although a native of Turin, had lived in France ever since the death of Frederick of Germany, when Louis XVI had invited him to the court of France. He had been given apartments in the Louvre and was treated with respect throughout the revolution, but during the reign of terror he decided to leave the country and only consented to remain when he was urged to help organize the two new schools, *École Normale* and *École Polytechnique*. In 1793, he was made president of the commission for the reform of the system of weights and measures, and, although Laplace, Lavoisier, Coulomb and others were expelled from the commission as insufficiently worthy of confidence for their republican virtues and their hatred of kings, Lagrange was retained. He was given the right of suffrage and was made an exception when foreigners were expelled from the country. He served in turn as member of the Bureau of Longitude, the Institute, Senate, high officer of the Legion of Honor and Count of the empire. He gave himself without reserve to the new schools and set standards of excellence in teaching and in the quality of his research which have been an inspiration to all who followed him.

Laplace, born in Normandy of poor parents, was educated by rich neighbors who recognized his gifts. Through D'Alambert, he became teacher of mathematics at the *École Royal Militaire* in Paris, and later he succeeded Bezot as examiner of artillery. It was in this capacity that he came in contact with the young Bonaparte. During the reign of terror, he retired to Melun, where he wrote and studied. After the torments of the revolution had passed, he resumed activity, being appointed to the teaching staffs of both the *École Normale* and the *École Polytechnique*. He was member of the Institute, of the Bureau of Longitude, and of the French Academy. Napoleon made him Minister of the Interior, but he was not well adapted to this position, and after six months the consul dismissed him with the comment that he carried into his work the spirit of the infinitesimal. He was later made Senator, and, in 1803, was Chancellor of the Senate. His other titles included

Count of the Empire, high officer of the Legion of Honor, and finally, under Louis XVIII, Marquis. He was a political opportunist. Although at heart a royalist, he sought and found favor with any government that happened to be in power. Compared with Lagrange, later generations have declared Laplace the greater, on account of the power of his genius and the unity and breadth of his conception, but their contemporaries favored Lagrange, partly, at least, because of his admirable personal qualities and his devotion to his students and colleagues.

Legendre, although living at this period, took no part in the revolution. He was later a councillor of the University and examiner for mathematics at the *École Polytechnique* until 1815. At the end of his career, he had some difficulty with government officials owing to a stand he took when the government dictated to the academy. As a result, he was deprived of his pension and died in poverty.

Doubtless one of the most influential men in the early days of the school was Monge. First, a teacher of mathematics, then examiner of naval candidates, he was, in 1792, elevated to the post of Minister of the Navy. The next year, at the request of the committee on public safety, he began work on defense plans. This was the beginning of his work on descriptive geometry. It was considered so valuable for fortifications that he was not allowed to publish it until many years later. He helped organize the *École Polytechnique* and was perhaps the best loved man on its staff. He loved the students like a father, giving them his best. He often paid tuition for needy students to keep them in school. A marvellous teacher, in spite of unattractive appearance and a marked speech defect, he fired his students with the enthusiasm which he had. His life was one of great contrasts. He barely escaped the guillotine, was a member of Napoleon's staff in Egypt, was made Senator in 1799, with the title Count of Péluse. While still a Senator, he gave all his money toward a fund for the return of Macdonald's defeated soldiers. The defeat of Waterloo troubled his life profoundly. After the fall of Napoleon, he was persecuted without mercy. All honors were withdrawn, and by an act of unjustifiable violence, he was expelled from the Institute along with Carnot and was replaced in office by Cauchy. The terrible injustice to himself and his grief at the fall of Napoleon, to whom he was devoted, caused his mental powers to break, and he barely existed until his death in 1818.

The *École Polytechnique* not only called to its service mathe-

maticians already distinguished for their work, but it trained a very fine group of younger men who later joined the staff of their alma mater and who served the country in important positions. Of the many, Poincot and Poisson were the first to gain distinction.

Poincot was graduated in the first class. He was a brilliant student of geometry and devoted his life to study and teaching. He taught at Lyceé Bonaparte, and was made Inspector General of the University, and in 1809 returned to the École Polytechnique as teacher of analysis. Four years later, he was made successor to Lagrange, a position which was coveted by both Ampere and Cauchy. Still later, he resigned to have leisure for research, but he continued to serve the school as examiner for admissions. In 1840, he was appointed to the Council of Public Instruction, where he exercised a profound influence on the schools and examiners. He was high official of the Legion of Honor and was placed on the first list of the Imperial Senate. He died at the age of 82, serene and untroubled. He was an enemy of vulgarity and of all that was not simple and noble. He had a gift for direct, precise language and a high sense of right.

In striking contrast to Poincot, was Poisson. Although he could barely read and figure when his uncle sent him to school at Fontainebleau, he came under the teaching of M. Billy, who, in two years, prepared him to enter the École Polytechnique at the head of the list for that year. He was very poor, and could scarcely pay his tuition, but his fellow students discovered his great ability and assessed themselves enough to make sure that he could remain in school. His course was brilliantly accomplished, and, at its close, he was given an assistantship in analysis in place of Fourier who was with the Army in Egypt. He rose rapidly, becoming very popular socially in the salons of Lafayette, Gérard, Monge, Laplace and others. He was ardent and thoughtless, but a marvellous analyst of rare productiveness. Of his over 300 papers, about 60 of the most important ones were published in the Journal. He served as member of the Bureau of Longitude, examiner for the École Polytechnique, and member of the Royal Council of Public Instruction. Before the death of Louis XVIII, he made Poisson Baron and gave him, unsolicited, a seat in the Chamber of Peers.

One could continue almost indefinitely listing such names as Cauchy, Chasles, Duhamel, Liouville, Serret, Laguerre, Halphen and others, who were graduated from the École Polytechnique.

There is, of course, the dark side of the picture. The revolution brought an end to many lives of great promise. Lavoisier and Bailly



both met their death by the guillotine. Lagrange, preparing to leave France, said of Lavoisier that the mob had removed in an instant a head that it would take a century to reproduce. The tragic last days of Monge furnishes another example. However, this study seems to show that the founding of the *École Polytechnique* did have a profound influence in at least three particulars. First, it held together the most prominent mathematicians of the country — Lagrange was ready to leave and nothing but his love of teaching and his interest in students of promise made him risk the guillotine to remain, and doubtless many others would have followed his example or gone into retirement; Second, it trained a remarkable group of younger men; and Third, it set a high standard of excellence in teaching and research which has served as an example to all who came after even down to the present. Besides the founding of this school, the next in importance seems to be the prominent part in public affairs taken by the great educators. They held so many positions of power and influence that they were able to control, to a degree, the plans for public education. Through their wisdom and devotion, they were able to save much of the best in the educational field from the general ruin and even advance the frontiers of knowledge of mathematics and the sciences.

The main sources of this paper are:

*Journal de L'École Polytechnique Cahiers 1-20,*

*École Polytechnique Livre du Centenaire Tome 1,*

*Histoire des Sciences en France Première Partie par H. Andoyer et Pierre Humbert.*

A few paragraphs are free translations from these works.

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