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ROBERT ADRAIN: AMERICAN MATHEMATICIAN

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Summaries

Robert Adrain immigrated to the United States from Ireland in 1798, when he was about twenty-three years of age. He became a leader in the American mathematical community as a teacher, proposer and solver of problems, and as an editor of mathematical journals. He published two proofs of the exponential law of error independently of Gauss.

Robert Adrain ist 1798 in die Vereinigten Staaten aus Irland eingewandert, als er ungefähr dreiundzwanzig Jahre alt war. In der amerikanischen Welt der Mathematik wurde er als Lehrer, Antragsteller und Löser von Problemen und auch als Redakteur verschiedener mathematischen Zeitschriften bekannt. Unabhängig von Gauss veröffentlichte er zwei Nachweise des Fehlerexponentialgesetzes.

Robert Adrain and Nathaniel Bowditch share the distinction of being the first two men to have published original mathematical research in the United States. Although during their lifetimes Bowditch was generally recognized as the superior mathematician of the two, both in the United States and Europe, at least two twentieth-century authors have judged Adrain to be the outstanding American mathematician of the first third of the nineteenth century [Smith and Ginsburg 1934, 91; Coolidge 1926, 75]. The primary purpose of this essay is to investigate the relationship of Adrain and his work to the mathematics of the United States during the first third of the nineteenth century.

Adrain was born in Carrickfergus, Ireland, on September 30, 1775. His father was a school teacher [Babb 1926, 2], and he apparently received a good education until he was fifteen (Campbell [1923] quotes Adrain's obituary which says sixteen) when both of his parents died. At this time he supported himself and his four siblings [Babb 1926, 2] as a school teacher and private tutor until the Irish uprising of 1798. While serving as an officer in the insurgent forces, Adrain was wounded, almost fatally, by one of his own men. After being nursed back to health, he, his wife and infant child escaped to America [Anon. 1844, 646-647].

Adrain had no formal instruction in mathematics beyond arithmetic. And during his teaching years in Ireland he began the task of teaching himself mathematics [Anon. 1844, 646]. Hence, Adrain, like so many contemporary Americans, was self-taught in mathematics.

After immigrating to the United States, Adrain taught at the academy at Princeton, N.J. until about 1800 when he moved to York, Pennsylvania, to become principal of the academy there. During this time Adrain began to contribute to the *Mathematical Correspondent* [Coolidige 1926, Anon. 1844]. He posed and solved several problems and contributed several articles, including the first article published in America on diophantine algebra [MC 1, 212-241; 2, 7-17; also AN 7-15] [1].

In 1805 Adrain became the principal of yet another academy, this time at Reading, Pa. Here he continued his contributions, described above, to the *Mathematical Correspondent*, and succeeded George Baron as editor of that journal. Adrain published only one issue of the *Mathematical Correspondent*, and then, in 1808, began editing his own journal, the *Analyst or Mathematical Museum*. The first issue of this journal was identical to the last issue of the *Mathematical Correspondent*.

Taken in the context of its time and place the *Analyst* is quite remarkable. The first volume of the *Analyst*, considered as an entity, is certainly the best collection of mathematical work produced in the United States up to that time. There are some individual papers in the *Analyst* that are particularly noteworthy, some of which are described below, including Adrain's proofs of the exponential law of error--published independently of Gauss' [AN 93-109] [2]. But even more significant and striking is the journal's overall high quality. The very best contemporary mathematicians were contributors: Nathaniel Bowditch, Robert Patterson, John Gummere, and Frederick Rudolph Hassler. But the journal was dominated by Adrain, and his ability to generalize and his ingenuity are largely responsible for the journal's excellence.

By 1809, the year after the *Analyst* commenced publication, Adrain's reputation as a mathematician was strong enough that he was called to a professorship at Rutgers (then Queen's) College. During the next several years, Adrain was given wide recognition. He was awarded an honorary M.A. from Queen's College in 1810. He replaced Dr. Kemp at Columbia in 1813, despite inducements from Rutgers to keep him [Babb 1926, 11; Campbell 1923, 2]. Columbia awarded him an LL.D. in 1818. In 1812 he was elected a Fellow of the American Philosophical Society and the next year of the American Academy of Arts and Sciences. The anonymous article [Anon. 1844, 648], an article by one of Adrain's grandsons [Brinkerhoff 1891, 57], and Adrain's obituary [quoted by Campbell 1923, 5] mention that Adrain was a member of several learned societies in Europe. These are never specifically

identified, however, and Adrain does not identify himself as a member of such societies, although he frequently did append LL.D., F.A.P.S., F.A.A.S. to his name.

Despite Adrain's growing reputation, his *Analyst* ceased publication in the year it began [2]. Only one volume, comprised of four issues, was published. He attempted to revive the publication, in 1814, after his transfer to Columbia, but published only one additional number. While at Columbia Adrain contributed to the *Portico* and under the pseudonym "Analyticus" to William Marat's *Scientific Journal* [Coolidge 1926, 72]. In 1818 Adrain also published two articles in the *Transactions of the American Philosophical Society* [n.s. 1 119-135, 352-366].

In 1819, Adrain endorsed and contributed to M. Nash's *Ladies' and Gentlemen's Diary or U.S. Almanac* [No. 1, p. 62; No. 2, pp. 54-55, 67; No. 3, p. 53]. *The Ladies' and Gentlemen's Diary* was issued only three years (annually). Adrain then contributed problems and lent moral support to the mathematical section of the *New York Mirror*, and *Ladies' Literary Gazette*, which commenced publication in August 1823. The mathematical questions were dropped in the second volume, January 1825, apparently in deference to Adrain's new venture with a mathematical journal: *The Mathematical Diary* [*New York Mirror*, Jan. 8, 1825, 191].

A twentieth-century mathematician who examines the *Mathematical Diary* after having read the *Analyst* is apt to be disappointed [Smith and Ginsburg 1934, 87]. Although, as with the *Analyst,* the best contemporary American mathematicians were contributors to the journal, it lacks the over-all high quality of the *Analyst* and particularly lacks the mathematical sophistication and elegance from Adrain that were evident in the *Analyst*. There are, of course, several possible explanations for this. One is simply that although Adrain was only fifty, his best years were behind him. He certainly did his best work before he was fifty. And he did become senile and lose all his mathematical facility before his death at sixty-seven [Anon. 1844, 650].

But it should be observed that although the *Analyst* stands out as one of the early technical successes in American mathematics from the viewpoint of the twentieth-century mathematician, with respect to duration of publication the journal was a failure, having published fewer issues than its substantially mathematically inferior predecessor, the *Mathematical Correspondent*. There were probably too few people in the United States interested in a journal on the mathematical level of the *Analyst* to make the venture economically viable. Adrain states in a letter to John Vaughan, secretary of the American Philosophical Society [June 12, 1810, original in Library of American Philosophical Society, quoted by permission]:

> *I regret my not being able to publish the Analyst, which was much approved by the mathematicians. My family is so numerous that I must devote all my time to whatever will procure me a little. Now I would write out the whole of it for 10 dollars per number and arrange all as usual, and as I could in such a case* afford to buy paper *I could write it as large as you please....*
>
> *If the bookseller will give me only the sum mentioned above, they may depend upon the continuance and success of the work.*

Therefore, it seems reasonable that Adrain was attempting to seek a wider audience for the *Mathematical Diary* than was enjoyed by the *Analyst*, at the cost of a lower over-all quality to the journal. Adrain was not adverse to seeking a larger audience for his *Analyst*, although not so much for economic reasons as to achieve a broader interest in mathematics. Although he never put his plan into practice, he states in his introduction to the *Analyst* [1808, v]:

> *It would perhaps contribute something to the progress of science, if the Editor were enabled by the sale of the work to have two Prize Questions in each number, a greater and a less. By this plan many who are not able to contend for a prize depending on certain obtruse researches might be usefully and honorably employed in resolving a prize problem of less profundity. On the other hand, mathematicians of eminence, who would not accept a prize for what cost them scarcely a thought, might find in the problems of the higher prize something worthy of attention.*

Adrain never realized this goal, but he does seem to have incorporated its spirit into the *Mathematical Diary*. In each issue the problems range from the simple to the difficult. This system of course resulted in some very easy problems, but there were also some reasonably advanced ones. This arrangement might have been a factor which contributed to the journal's relative success. The *Mathematical Diary* was issued quarterly from 1825 to 1832, far longer than any comparable previous journal. Adrain edited the journal until 1826 when he left Columbia and New York City. But he remained a prolific contributor to the journal through the rest of its publication under the editorship of James Ryan.

The *Mathematical Diary* also included some other features that are worth noting. It was the first American mathematical journal to include reviews of mathematical publications, including European works [1, No. 1, 18-21; 2, No. 10, 108;

2, No. 12, 182-190, 194; 2, No. 13, 304-307]. The Leibnitzian notation for the calculus is also used extensively.

In this journal we also see the first publication of Benjamin Peirce, while he was a student at Harvard [1, 277]. Significantly, about three-fourths through the first volume, we begin to see several contributions by college students, who, for the first time, identify themselves as such; indicating that the center of American mathematics was beginning to shift from the amateurs toward the colleges. There is some evidence that students, even in the academies, had contributed to the *Mathematical Correspondent* [Pettingell 1943, 113]. And they possibly continued to contribute to the American mathematical journals and columns more or less regularly. But this is the first time we see contributions by college students identifying themselves as such.

During Adrain's productive life in the United States the influence of French mathematics on American mathematics was both considerable and beneficial. Adrain was certainly influenced by such French mathematicians as Laplace, Lagrange and Legendre [Struik 1973, 66; Coolidge 1926, 69; Cajori 1890, 103], but his part in the dissemination of French mathematics in the United States seems small. Unlike Nathaniel Bowditch, he translated no French mathematical works. Adrain did include an essay on descriptive geometry in his third edition of Hutton's *Course of Mathematics*, which appeared in 1822. But other than this I can find no evidence that he made any significant contributions in the introduction of French mathematics and notation into American higher education, as was done by John Farrar at Harvard, and Sylvanus Thayer, Charles Davies, and Claude Crozet at West Point.

Adrain did edit an American edition of the *Course in Mathematics*, by Charles Hutton, LL.D., F.R.S., Professor of mathematics in the Royal Military Academy. Despite the book's popularity, it was not a particularly progressive or exciting book compared to contemporary French works. He also edited Thomas Keith's *A New Treatise on the Use of Globes, or a Philosophical View of the Earth and the Heavens* (which was published in 1832). Keith's book is not a particularly inspiring one; for example, it starts out with forty-four pages of uninterrupted definitions. And it is natural to ask why a man of Adrain's caliber chose to edit such books as Hutton's *Course of Mathematics* and the book by Keith [Coolidge 1926, 70].

It is not unlikely that Adrain had a higher regard for eighteenth-century and nineteenth-century British mathematical texts than a twentieth-century mathematician would if he compared them with contemporary French texts. Adrain undoubtedly learned mathematics from these texts and may well have always retained a preference for some aspects of eighteenth-century British mathematics [3].

It is also quite possible that Adrain did not foresee the

full potential of translating such a work as Laplace's *Méchanique Céleste*. In a letter to Nathaniel Bowditch, he writes: "I know not how to express my sentiments respecting your Laplace. I had no previous conception of the great merit of such a work." [9 Aug. 1830, letter in Boston Public Library]. But Adrain was certainly familiar with and appreciative of contemporary French texts. The University of Pennsylvania has a list of books from Adrain's library that includes many French titles. And, in a letter to Dr. William Harris, president of Columbia College, [undated, letter in Columbia University Library] Adrain expresses his preference for the French works and notes the importance of the continental notation:

> *This work of LaCroix* [Course of Mathematics] *contains an excellent system of theoretical or pure mathematics, with the exception of theoretical mechanics. If the work were in English I should prefer it as a text book to any other with which I am acquainted.* [4].

Later he notes:

> *To read these* [the works of Laplace and Lagrange] *with understanding, it is indispensable to pursue the French system of variable quantities as taught by Bussut, Garnier, LaCroix and others, and particularly by Lagrange himself in this Theory of Functions.*

An obvious and probable explanation for Adrain's editing Hutton's and Keith's books is that his strapped financial circumstances made it much more desirable for him to edit a popular English work which was not radically different from the contemporary books being used, and hence might sell well; than to translate and edit a French work, an undertaking that would be more time consuming and face an untried and uncertain reception. Somewhat similarly John Farrar translated the older, more conservative French texts [Simons 1931, 121-122].

Hutton's work was extremely popular. It underwent thirteen British and four American editions. And although it does not compare well with its French contemporaries, it was a book of some value. An anonymous review of Adrain's edition of Hutton concludes with the remarks [Anon. 1813, 282]:

> *There are yet some defects in the Arrangement, arising from the articles published in the third volume of the English edition, though these defects, as they exist in that edition, have been considerably remedied in the present work, by several judicious alterations made by professor Adrain, and we have it in our power to say, what can rarely be said of works of science republished in this country, that in general, the typography is equal and the*

arrangement of the matter superior, to that of the English edition; and, on the whole we can recommend this work as the most complete source of practical mathematics that has been published in this country.

In 1825 Queen's College was reorganized and adopted the name of Rutgers College. At this time Rutgers offered Adrain, who was then at Columbia, the professorship of mathematics and expended considerable effort to raise extra funds to pay a sufficient salary to attract him. He was offered $2000 plus a house at Rutgers as opposed to $1500 plus a house at Columbia. His letter of resignation to Columbia indicates that his salary had recently been cut there in some way [undated, letter in Columbia University Library].

Adrain accepted the position at Rutgers [Babb 1926, 12; Campbell 1923, 3-4]. But shortly after his arriving there, he received repeated offers from the University of Pennsylvania, and following a lengthy correspondence with the University of Pennsylvania Adrain accepted a position there in 1827, although most of his family remained in New Brunswick [a typescript of this correspondence is in the Rutgers University Library; Campbell 1923, 4; Babb 1926, 14-16; Anon. 1844, 649-50]. Adrain became vice provost of the University of Pennsylvania in 1828 and remained there until 1834.

There is some evidence that Adrain was rather eccentric and unsuccessful in the classroom. Dr. Benjamin Haight, of the class of 1828 at Columbia, said of him [Quoted by Campbell 1923, 2-3]:

Of the entrance examinations I have no recollection but of one; that of Mathematics and the English studies also, conducted by the remarkable man Prof. Adrain, better known afterwards as "Old Bobbie".... In the examination on Geography, to the astonishment of the candidates, and their consternation, he took us up to the polar regions. He had, probably, just been reading a volume of Parry's Discoveries, and in his eccentricity, took that part of the earth as the theme of his questioning of those who might have been justly supposed as ignorant of that part of the earth as of the moon. He sent down two or three of the class, and when it came to my turn he asked, first, where Mackinize's River was. I had fortunately been reading the volume which I suppose he had, and, to my relief I could tell him. He had become to be somewhat irritated at the inability of the boys to answer his questions and when he found one that could give a reply his broad face beamed with delight, and my fortune was made.... Eminent in his chosen line of study, and very fond

> *of its pursuit, he had little or no faculty of imparting his knowledge to others. If one was thoroughly prepared in his recitation, all was well, but if the student was in doubt, or needed a word of explanation in a difficult problem, he not only did not get assistance but was send down with some remark of the sort "If you cannot understand Euclid, Dearie (a term he frequently used when out of temper) I cannot explain it to you." The consequence was that a small portion of the class only could keep up with his course, those who had entered college thoroughly versed in the elements of mathematics, and who studied very diligently after they had entered his lecture room, in my class not more than one fifth of the number. I ought to add, however, that those who went to him in private always found him kind in manner and ready to answer their questions and help them out of their difficulties.*

During his last year at the University of Pennsylvania, Adrain had considerable trouble with discipline in his classes, especially with the junior class. Benches were overturned and broken, and eggs were thrown. Attempts by the faculty and administration to aid Adrain in his disciplinary problems proved to be futile. Since it was feared that the disturbances would spread to other classes, Adrain was requested to resign [5].

Despite Adrain's failure at the University of Pennsylvania, the evidence indicates that this was the only collegiate position that he did not leave by his own choice. Also I have been unable to find any evidence that he was unsuccessful with any of his posts in the various academies [Babb 1926, Campbell 1923].

After his troubles at Pennsylvania, Adrain returned to his home in New Brunswick where he rented a school room and did private tutoring until 1836. Then he returned to New York and taught at the Columbia College Grammar School. He did at least receive pecuniary compensation for this labor, averaging better than five hundred dollars a quarter [Babb 1926, 19]. He retired finally in 1840 to New Brunswick and died there three years later in 1843.

Adrain's researches played no part in the mainstream of mathematics in Europe. Adrain's principal achievement, his proofs of the exponential law of error [AN 93-109], seems to have received little notice [Anon. 1844, 684; Campbell 1927, 7], either in Europe or the United States, until Cleveland Abbe's article on Adrain's work appeared, in which Abbe republished one of Adrain's two proofs [Abbe 1871]. Shortly after Abbe's article, several others were published that mentioned Adrain's accomplishments, including an article by J. W. L. Glaisher

[Glaisher 1872], that reviewed the history of the exponential error law and method of least squares in light of the recent announcement by Abbe of Adrain's work, and an article by Mansfield Merriman [Merriman 1877].

But Adrain's labors were important to the development of American mathematics. One of his chief contributions to American mathematics was his work with mathematical journals both as a contributor and editor. Even though these journals were short-lived, they were of importance. They facilitated the dissemination of mathematics and offered men, like Adrain himself, who had little or no formal training in mathematics an opportunity to publish work and gain recognition.

Of course the journals, and other mathematical work done in this country in the early nineteenth-century, generally exhibited a low level of mathematical sophistication. All of the mathematical journals published in the United States during Adrain's life time were largely problem-solving journals. Many of the questions published lacked any kind of imagination. Some were taken directly from the current arithmetics and other mathematical texts, sometimes evidently to settle a dispute between two parties as to the true solution. Many of the others were simple problems related to navigation, surveying and mensuration. Even when an interesting problem was proposed, it would be couched in a very specific setting. And its solver would seldom go beyond a limited solution to the problem.

Similarly the mathematical essays and articles written in the first decade of nineteenth-century America were often unproductive metaphysical speculations [Hogan]. Jared Mansfield's *Essays Mathematical and Physical* [1802] was, considering the paucity of mathematical work in the United States, a significant contribution. And many contemporary Americans regarded it as an original work. Indeed the book won him a reputation as an outstanding mathematician [Struik 1948, 86-87]. But these essays were original only in the sense that a new text book is original.

In this setting, Adrain offered at least two remarkable things to American mathematics. One was simply a broader knowledge of mathematics than was enjoyed by most other American mathematicians. Though in some ways limited, e.g., he lists Hutton and Vince as the peers of Newton and Leibnitz [AN iii], Adrain displayed a remarkable depth of knowledge of mathematics and its history. [E.g. see *Mathematical Diary* 1, 5-17; *New York Mirror* 1, 363]. This background gave Adrain far more to draw upon than most of his contemporaries. While they were being influenced by English arithmetics and algebras, Adrain was being influenced by Laplace and Lagrange.

Second, and more important, was his perception, originality and ability to generalize. In one instance Joseph Clay posed the question [AN 42]:

> *Rittenhouse's hygrometer is formed of two thin pieces of wood, of the same uniform breadth, thickness and length, glued together; the grain of one piece running with the length of the hygrometer, and that of the other with the breadth. The contraction or expansion of the latter piece causes the hygrometer to assume a curvilinear form, and one end of the hygrometer being fixed the degree of moisture is measured on the curve line generated in a plane by the other end. Required the equation, quadrature, and rectification of this curve.*

This is certainly one of the better problems published during the first third of the nineteenth-century in American mathematical periodicals. Adrain published a solution to the problem by John Craig and some additional comments from the solution of the proposer [AN 55-57]. But neither of these men gave more than a specific solution to the problem. Adrain, however, appends several observations of his own. First he generalizes the type of curve described in Clay's problem: if any family of curves (e.g. circles, parabolas) pass through a point A, then any curve generated by the end points of equidistant segments of the curves from point A is called *isotomous*. Adrain then points out that instead of having two uniform strips of wood which would result in a circular arc upon the expansion of the lamina; that the thickness of the two pieces of wood could be varied so as not to be uniform, and then the expansion of one of them due to the absorption of moisture would produce a non-circular curve, the end point of which would etch out a curve. He also notes that if two different strips of metal were joined together a similar curve would be generated by one endpoint of the metal strips if the other end were fixed, when the two different metals expanded at different rates from an increase in temperature. He calls all curves so generated *Hygrometrical*.

Adrain then notes that all hygrometrical curves are isotomous and asks, but does not attempt to answer, whether all isotomous curves are hygrometrical. Adrain then continues with several observations about isotomous curves of circular arcs.

Adrain's ability to see problems and methods of solution in a more abstract setting differentiates him from most of his American contemporaries. Several times in the *Analyst*, he generalizes both problems and methods of solution to problems that were submitted [e.g. see AN 83, 84-87; 27-35]. Illustrative of his imagination is his generalization of a problem by Robert Patterson. Patterson asks to divide a rectangular piece of land in a certain proportion so that a spring inside the rectangle will be on the boundary line which is to be made as short as possible [AN 69-70, 84-87]. Patterson solves this problem [AN 74-75], dividing the plot with a straight line.

Adrain then notes "Although the author of this question intended that the boundary should be a straight line, yet, as there is nothing in the question itself on which this supposition is founded, we shall consider the question without regard to such a limitation..." [AN 40]. And Adrain then solves this more general problem.

Adrain's well known work on error theory is also an example of his ability to visualize and solve a problem in a general setting. Here Adrain extrapolated a general theory from another of Patterson's problems [AN 42, 93-109], proved his theory in a general setting, and then applied his theory to several diverse problems including the specific one called for by Patterson.

Adrain's mathematical interests were fairly varied, including, among others, number theory, descriptive geometry and the history of mathematics. But Adrain considered applications to be of the greatest importance: "The last and highest department of mathematical science consists in its application to the laws and phenomena of the material world." [letter: Adrain to Dr. Harris; undated, Columbia University Library]. Most of Adrain's work deals with applied mathematics and much of it was concerned with geophysics, the study of the physical properties of the earth. Geophysics and natural history dominated American science during the first six or seven decades of the nineteenth-century [Reingold 1964, 60]. And Adrain's paper on the exponential error law and least squares with applications to surveying and the correction of dead reckoning at sea [AN 1, 93-109], his articles "Research Concerning the Mean Diameter of the Earth" [APS 1818 n.s. 1, 353-366], and "Investigations of the Figure of the Earth, and of Gravity in Different Latitudes" [APS 1818 n.s. 1, 119-135], and his "Disquisition Concerning the Motion of a Ship which is Steered to a Certain Point of the Compass" [MC 1, 103-114] all deal with geophysics.

Adrain was not only interested in geophysical problems, but two of his most important papers were generalizations of two seemingly simple problems in the *Analyst* proposed by Robert Patterson and described above. Although Adrain's knowledge of European mathematics was vital to the mathematics that these problems initiated, there is a significance, beyond an indication of Adrain's ability, in their serving as an impetus to his mathematics [AN 69-70, 84-87; 42, 93-109; Molella and Reingold 1973, 349-50; Coolidge 1926, 69].

During the time that Adrain lived in the United States (1798-1843), which essentially coincides with his adult lifetime, mathematics in Europe made tremendous progress. The contributions of this period include the introduction of rigor into analysis by Cauchy and others, the discovery of non-Euclidean goemetry by Gauss, Lobatchevsky and Bolyai, substantial progress in complex function theory and partial differential equations,

and dramatic innovations in algebra by Abel and Galois.

Compared to the mathematical accomplishments in Europe, those in the United States in this period were of course inconsequential. But this overwhelming superiority of European mathematical productivity should not obscure the fact that tremendous progress in mathematics was also made in the United States during this same period.

Before 1798, when Adrain immigrated to the United States, the only mathematics of any consequence that had been done in the United States was Franklin's work with magic squares [Andrews 1917, 89-112] and a few notes by David Rittenhouse [APS 1793 o.s. 3, 155-156; 1799 o.s. 4, 69-71]. By the end of Adrain's life mathematical activity had increased considerably. As J. W. L. Glaisher [1872, 81] concurred with Cleveland Abbe [1871, 415] Adrain had independently discovered and applied "the most valuable arithmetical process that has been invoked to aid the progress of the exact sciences." [*ibid.*, 415] Other original, if modest, work had been done by Nathaniel Bowditch [Bowditch 1815]. In addition there were several other competent mathematicians in this country including Theodore Strong and Ferdinand Rudolph Hassler.

Between 1829 and 1839 Nathaniel Bowditch published his scholarly translation and commentary on Laplace's *Méchanique Céleste*. Comparing this work with Jared Mansfield's [Mansfield 1802] *Essays Mathematical and Physical* gives some indication of the progress in mathematics in the United States during the first third of the nineteenth-century.

The changes in higher education were perhaps even more striking than those in mathematical scholarship [Smith and Ginsburg 1934, 66-67; Simons 1931, 111; Guralnick 1974, 354-365]. As noted above the introduction of French texts and notation had significant impact. But by the mid 1830's many Americans were beginning to write texts instead of translating them. Regarding curricular changes Stanley M. Guralnick [1974, 354] notes:

> *And the changes* [in American scientific education] *that took place in the second quarter of the nineteenth century in this context were at once startling for those who lived through them and perplexing to those who had later to consider and interpret them....Graduating seniors who in 1815 could not solve algebraic equations of two unknowns or distinguish between Newton's fluxional notation and fly spots, were by 1840 dealing with ordinary differential equations, all in the course of a single generation.*

An attempt was also made during Adrain's lifetime to formally organize mathematicians. A society of mathematicians was formed in New York City in 1817 of which Adrain, William

Marat, W. Forest, D. Emberry, M. Nash, R. Taggart, J. Campbell, and a Mr. O'Conner were members. The society apparently held regular meetings for several years [Babb 1926, 11-12; Anon. 1844, 648].

The period during which Adrain was active was a period of transition in mathematical development in the United States. It was the period when the antiquated English influence began to be replaced by that of French mathematics, in part due to the rebirth of mathematical activity in Great Britain. It was also the period when the first original mathematics was produced in the United States. Adrain's mathematics reflects this transition. Adrain's best mathematics is at once inspired by seemingly simple problems in surveying that appeared in the contemporary mathematical journals and by the best of French mathematics and mathematicians. Despite the strong influence of French mathematics on Adrain, he chose to edit not French, but English texts. And though he did original research, it was unnoticed in both the United States and Europe for over sixty years.

Adrain lived in a country whose mathematics was rapidly developing, and he played a crucial part in that development. He was a leader in the American mathematical community of his day as both a productive scholar and an editor. That this community was far more advanced at his death than at the beginning of the nineteenth-century is in no small part due to his contributions.

NOTE ON MANUSCRIPT SOURCES

The University of Pennsylvania at one time had extensive material on Robert Adrain, which according to Coolidge [1926, 74-75] was of considerable significance. These materials were apparently in the possession of Professor M. J. Babb. Babb died suddenly in 1945, and the papers were destroyed by persons unaware of their value. The University of Pennsylvania now has one letter of Adrain's and a manuscript entitled "Adversaria Mathematica," which is a collection of Adrain's notes on various mathematical topics. The University of Pennsylvania library also has seven mathematical books that belonged to Adrain and an extensive list of books that were in his mathematical library.

The Rutgers University library has typescripts of several manuscripts relating to Adrain; they deal primarily with his election to and dismissal from his professorship at the University of Pennsylvania. The Columbia University library holds seventeen manuscript pages of letters by Adrain, most of which were apparently addressed to William Harris, then president of Columbia. The Boston Public library possesses two letters from Adrain to N. Bowditch. And the library of the American Philosophical Society has two letters of Adrain to John Vaughan and several other manuscripts related to Adrain.

NOTES

1. I will not attempt to give a complete description of Adrain's work here; this is done by Coolidge [1926]. Seinin [1965] discusses his work on error theory and gives extensive references.

2. The fourth issue of the *Analyst* bears the date 1808, but Adrain also gives New Brunswick, New Jersey as his address. Typescripts of letters in the Rutgers University Library show that Adrain did not move to New Brunswick until after October 1809. Adrain had the fourth issue printed in Reading, Pa., but due to an excess of typographical errors, decided to have it reprinted in Philadelphia, in 1809, but retained the date of 1808. [Campbell 1923, 6]. As this number was evidently not issued until the fall of 1809, Adrain's proofs of the exponential error law, which were contained in this issue may well have actually been published after Gauss' proof, which was published in 1809. This is contrary to what has been universally assumed since Abbe's paper in 1871.

3. There is an anonymous review in the *Mathematical Diary*, very likely by Adrain, that indicated a preference for Newton's fluxional notation to that of Leibnitz, at least for some uses: "Our author evidently uses the language of the differential system of Leibnitz, and thus loses the great advantage that attends the genuine fluxions of Newton...." [Vol. 1. No. 1. 20].

4. Adrain notes in the same letter that part of this work was translated into English and was being used in New England. Presumably he is referring to the *Elements of Algebra*, whose translation is attributed to John Farrar [Simons 1931, 121].

5. Rutgers University Library has typescripts of the following: a letter dated 10 April 1834 from Adrain to the Trustees of the University of Pennsylvania acknowledging the disturbances; a report dated 10 April 1834 of a committee of the Trustees which essentially suggests that Adrain resign; Adrain's resignation dated 2 May 1834; the acceptance of Adrain's resignation dated 6 May 1834; and a report to the Trustees from the faculty dated 15 April 1834. See also Babb [1926, 18].

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