

## MATHEMATICAL PROGRESS IN AMERICA

PRESIDENT THOMAS S. FISKE

In the remarks that follow, I shall limit myself to a brief consideration of progress in pure mathematics. This I may do the more appropriately, inasmuch as one of my predecessors, Professor R. S. Woodward, at the annual meeting of 1899, gave an account of the advances made in applied mathematics during the nineteenth century. In his address, which was published in the BULLETIN for January, 1900,<sup>1</sup> is included a description of the more important advances made by Americans in the field of applied mathematics.

In tracing the development of pure mathematics in America, it seems convenient to recognize three periods. The first period extends from colonial days up to the establishment of the Johns Hopkins University in 1876; the second period extends from the establishment of the Johns Hopkins University up to 1891, when the New York Mathematical Society took on a national character and began the publication of its BULLETIN; the third period extends from 1891 up to the present time.

The most valuable source from which the general reader may secure information in regard to the first period, is a work entitled *The Teaching and History of Mathematics in the United States*.<sup>2</sup> This work, written by Professor Florian Cajori, was published in 1890 by the United States Bureau of Education.

Before the founding of Johns Hopkins University there was almost no attempt made to prosecute or even to stimulate in a systematic manner research in the field of pure mathematics. Such mathematical journals as were published were scientifically of little importance and as a rule lived but a year or two. The only exception that we need mention was the *Analyst*, edited by Dr. J. E. Hendricks and published at Des Moines, Ia., from 1874 to 1883; and the publication of this journal began practically at the close of the period referred to above.

However, there were a certain number of men, for the most part self-trained, who were eminent among their fellows for their mathematical scholarship, their influence upon the younger men with whom they came in contact, and their capacity for research. Of these the most conspicuous were Adrain, Bowditch, and Peirce. Adrain is known for his apparently independent discovery of the law of distribution of errors; Bowditch is known for his translation of Laplace's *Mécanique Céleste*, accompanied by a commentary of his own; and Peirce is now known chiefly for his classical memoir, *Linear Associative Algebra*, which was the first important research made by an American in the field of pure mathematics.

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Presidential Address delivered before the American Mathematical Society at its eleventh annual meeting, December 29, 1904.

<sup>1</sup>BULLETIN, series 2, vol. 6, pp. 133–163.

<sup>2</sup>U. S. Bureau of Education, Circular of Information No. 3, 1890.

With the arrival of Professor Sylvester at Baltimore, and the establishment of the *American Journal of Mathematics*, began the systematic encouragement of mathematical research in America. Professor Sylvester drew about him a body of deeply interested students, and through his own untiring efforts and his inspiring personality a most powerful stimulus was exerted upon the mathematical activities of all who were associated with him. His work in this country, however, continued only seven years. In 1884 he returned to England to take the chair offered to him by Oxford University.

The first ten volumes of the *American Journal of Mathematics*, published from 1878 to 1888, contained papers contributed by about ninety different writers. Of these thirty were mathematicians of foreign countries. Almost one-third of the remaining sixty were pupils of Professor Sylvester; the others were mathematicians some of whom had come under the influence of Benjamin Peirce, some of whom had been students at German universities, and some of whom were in large degree self-trained. They seemed to need only an opportunity of publication and a circle of readers to induce them to rush into print. In fact several of them had already sent papers abroad for publication in foreign journals. Among the contributors to early volumes of the *American Journal of Mathematics* we should especially mention Newcomb, Hill, Gibbs, C. S. Peirce, McClintock, Johnson, Story, Stringham, Craig and Franklin.

We must at this point make some mention of the rapidly increasing influence of the German universities upon American mathematical activity. For some time a considerable number of young Americans, attracted by the superior opportunities offered by the German universities, had been going abroad for the study of the more advanced branches of mathematics. The lectures of Professor Klein were in particular the Mecca sought by young Americans in search of mathematical knowledge. I think that it may be said safely that at present ten per cent of the members of the AMERICAN MATHEMATICAL SOCIETY have received the doctorate from German universities, and that twenty per cent of its members have for some time at least pursued mathematical studies in Germany. It is not surprising that as a result a large portion of the American mathematical output shows evidence of direct German influence, if not of direct German inspiration.

In 1883, as we have already indicated, the publication of the *Analyst* was discontinued. In the following year a new journal, the *Annals of Mathematics*, under the editorial management of Professor Stone of the University of Virginia, began publication. This journal was of a somewhat less ambitious character than the *American Journal of Mathematics*. It is interesting to note in connection with it that to a considerable extent its pages were given to papers on applied mathematics. In 1899 the *Annals* passed into the editorial control of the Mathematical Department of Harvard University. Since that time it has been largely expository or didactic. It has not sought to publish new investigations of an extended character, although it has not hesitated to publish brief papers announcing new results.

Let us now turn to a brief outline of the history of the Society which brings us together on this occasion.

At a meeting held November 24, 1888, six members of the Department of Mathematics of Columbia University formed a society which was to meet monthly for the purpose of discussing mathematical topics and reading papers of mathematical interest. At the meeting held a month later they resolved to call their society the New York Mathematical Society and to invite the coöperation of all persons living

in or near New York City who might be professionally interested in mathematics. By the end of the year 1889 the membership of the Society had increased to sixteen. By the end of 1890 it had increased to twenty-two.

At the meeting held in December, 1890, the first president, Professor J. H. Van Amringe, retired from office, and Dr. Emory McClintock was elected his successor. At the same meeting the publication of a mathematical bulletin was proposed. The officers of the Society a month later made a report in which they recommended that this bulletin, if established, should not seek to enter into competition with the existing mathematical journals, but that it should be devoted primarily to historical and critical articles, accounts of advances in different branches of mathematics, reviews of important new publications, and general mathematical news and intelligence. They showed at the same time that the expense connected with such a publication would necessitate an extension of the membership of the Society together with an increase in the annual dues. It was suggested, accordingly, that a general circular be issued, describing the aims of the Society and inviting suitable persons to become members.

After hearing the report, the Society authorized the secretary to undertake a preliminary correspondence with a few of the principal mathematicians of the country with a view to determining whether their favor and assistance might be secured for the proposed enterprise. A month later the secretary reported that he had received favorable responses from Professor Simon Newcomb, Professor W. Woolsey Johnson, Professor Thomas Craig and Professor H. B. Fine. As a result of these favorable responses, approval was given to the plan recommended by the officers of the Society for the extension of its membership and for the publication of a historical and critical review of pure and applied mathematics. A circular letter of invitation such as had been recommended was issued shortly thereafter. The proposals which it contained seemed to meet with general favor, and by June, 1891, the membership of the Society had risen to one hundred and seventy-four. The first number of the BULLETIN was issued in October, 1891. Its appearance increased the interest already excited, and by the summer of 1892 the membership of the Society had risen to two hundred and twenty-seven.

Professor Klein and Professor Study, who visited the United States in 1893 for the purpose of attending the International mathematical congress held in Chicago, were present at the meeting of the Society held in October of that year. They both delivered addresses before the Society and expressed great interest in its work.

By the spring of 1894 it was felt generally that the operations of the Society had assumed a national character, and a new constitution was adopted providing for a change of name from the New York Mathematical Society to the AMERICAN MATHEMATICAL SOCIETY. In June of the same year the Society undertook to provide means for the publication of the papers read at the Chicago Congress the preceding year, and arrangements were made for holding in conjunction with the Brooklyn meeting of the American association for the advancement of science the first "summer meeting" of the Society.

At the annual meeting held December, 1894, Dr. Emory McClintock retired from the presidency, being succeeded by Dr. George W. Hill. At this meeting Dr. McClintock delivered an address which was published in the BULLETIN for January, 1895.<sup>3</sup> It was entitled "The past and future of the Society" and contains

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<sup>3</sup>BULLETIN, series 2, vol. 1, pp. 85–94.

an account of the Society during the first six year of its existence. Upon the occasion of Dr. McClintock's retirement from the presidency the Society adopted a resolution expressing its appreciation of the great services that he had rendered while presiding officer, and its recognition of the fact that largely to his initiative were due the broadening of organization and extension of membership which made the Society properly representative of the mathematical interests of America.

The next event of special importance in the history of the Society occurred in 1896. Immediately after the summer meeting of that year, which was held in connection with the Buffalo meeting of the American association for the advancement of science, the Society's first "colloquium" took place. Interesting and instructive courses of lectures were delivered by Professors Bôcher and Pierpont, and at the close of the colloquium those participating in it recommended that similar arrangements be made periodically in connection with subsequent summer meetings. In the same year for the regular October meeting was substituted a special meeting at Princeton in connection with the sesquicentennial celebration of Princeton University. At that meeting addresses were delivered by Professor Klein and Professor J. J. Thomson.

In the spring of 1897 the Chicago Section of the Society was established. At the same time it was determined to replace the meetings held monthly in New York by meetings held four times a year at intervals of two months. The summer meeting of 1897 was held at Toronto in connection with the meeting of the British association for the advancement of science. This meeting was attended by a number of distinguished visitors from Great Britain, among whom were Professors Forsyth, Greenhill, and Henrici.

A colloquium was held in the summer of 1898 at Harvard University. There was much discussion among those attending it in regard to the need of larger and better facilities for the publication of mathematical researches. The following winter the Society proposed to the Johns Hopkins University that the *American Journal of Mathematics* should be enlarged and issued more frequently and that the Society should be given a share in the editorial control of the *Journal*. It was found impossible, however, to reach an agreement with the Johns Hopkins University, and in April, 1899, the Society determined to establish an organ of its own for the publication of the more important original papers presented at its meetings. The financial resources of the Society were not sufficient to carry on the work already begun and at the same time to provide for the new publication; but it was found possible to secure assistance from ten colleges and universities which promised to join in support of the undertaking. The new publication, known as the *Transactions of the American Mathematical Society*, made its first appearance in January, 1900.

Simultaneously with the meeting held in October, 1899, was held the first meeting of the newly organized American Physical Society. On this occasion the Mathematical Society met with the Physical Society for the purpose of listening to the address of President H. A. Rowland, of the Physical Society. Again, two months later, on the occasion of the annual meeting of the American Mathematical Society, the two societies met in joint session for the purpose of listening to the presidential address of Professor R. S. Woodward, of the Mathematical Society. In this connection it may be of interest to recall that the organization of the American Physical Society was modelled, in a general way, after that of the Mathematical Society. The two societies, which have many members in common, have enjoyed uninterruptedly the most cordial relations.

In 1901 the Mathematical Society was compelled to turn its attention to the management of its rapidly growing library. An agreement was made with Columbia University whereby the library was entrusted to the care of that institution. The University undertook to bind and catalogue the books belonging to the Society and to make the arrangements necessary for the loan of the books to members. In return therefore the University is permitted to make use of the Society's collection in the way of a reference library. In October, 1901, the American Physical Society met again in joint session with the Mathematical Society for the purpose of listening to a paper by Professor Hadamard, who was visiting America as a delegate to Yale's bicentennial celebration.

In May, 1902, the San Francisco Section of the Society was established. In December of the same year Professor E. H. Moore delivered his address<sup>4</sup> as president of the Society. Very largely as a result of this address, the influence of the Society was exerted to bring about the organization of associations of teachers of mathematics with a view to improving the methods of mathematical teaching. The Association of teachers of mathematics in New England was organized in April, 1903. The Association of teachers of mathematics in the Middle States and Maryland was organized in November of the same year. Several similar associations have been organized more recently in various sections of the country.

Two events have occurred during the year now closing which are of sufficient importance to deserve mention here. One is the determination of the Society to publish in book form the mathematical lectures delivered at the colloquium held in Boston in 1903. The other is the meeting held last summer in connection with the International scientific congress at St. Louis.

In connection with this brief survey of the Society's history it seems desirable to indicate in figures the growth of the Society and its work. During the past ten years the membership of the Society has doubled, rising from about 250 in 1894 to almost 500 at the present time. Ten years ago the number of papers presented each year at the meetings of the Society was in the neighborhood of 30, of which about a dozen were subsequently published. During the year ending July 1, 1904, the number of papers presented at meetings of the Society was 154, and the number of papers published by its members was 85. In January 1902, when the present administration of the Society's library began, the number of volumes in the library was 121, while at present it is almost 2000.

If any one wishes to have pass before him in review the scientific activities of the Mathematical Society, he has only to consult two pamphlets issued a few months ago. I refer to the general index to the first thirteen volumes of the Society's BULLETIN, compiled by Dr. Emilie N. Martin, and to the index to the first five volumes of the *Transactions* compiled under the direction of the editor-in-chief of the *Transactions*. The Society today serves to bring together into a harmonious whole all the mathematical activities of America. It is only infrequently that a mathematical paper of importance is published without having been read previously at one of its meetings. To give an account of the present condition of the Society is practically the same as to give an account of the present condition of American mathematics.

Notwithstanding the great progress recently made in America by our science, we are far from being in a position that we can regard as entirely satisfactory. We

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<sup>4</sup>BULLETIN, series 2, vol. 9 (1903), pp. 402-424.

have only to look about us in order to see that improvement is not only possible but necessary in almost every direction.

In the first place, the most pressing demand seems to be that those engaged in lecturing on the more advanced branches of mathematics at American universities should be given greater opportunities for private study and research. At present, the time of almost every university professor is taken up to a very large extent with administrative matters connected with the care of comparatively young students. Discussions in regard to admission requirements, the course of study, discipline, and the control of athletics, absorb a large part of the time and strength of the faculty of every university. It is possible that this situation will in the course of the next twenty years be greatly relieved by a change, which many consider is already in sight. This change is nothing more nor less than the relegation of the first two years of the ordinary college course to the secondary schools and the establishment of university courses that will begin with the present third year of the college. The progress made in recent years by the public high schools makes it plain that before long they will be able without difficulty to duplicate the first two years of the present college course, and as more highly trained teachers enter these schools there is no doubt that there will be a constantly increasing effort to take up college work. If this be done, not only will the condition of the secondary schools be greatly improved, but our university teachers will secure the relief so greatly needed for the advancement of the highest interests of our science.

In the second place, it is of the greatest importance that the mathematical journals already established in this country—the BULLETIN, the *Annals of Mathematics*, the *American Journal of Mathematics*, and the *Transactions* should all be encouraged and assisted to extend their influence and increase their efficiency. It is the duty of every member of the Society to interest himself to the greatest possible extent in the work of each of these journals. It is important also that we should strive to secure for these journals more adequate financial support. In other countries it is not unusual for the government itself to give financial support to such publications.

In the third place, we must have improved methods of teaching, better textbooks, and more good treatises on advanced subjects. The members of the Society, working as individuals, can do much along these lines. The Society as a whole, let us hope, will some day be able to render important assistance in the publication of mathematical works of the best type. It is quite possible that in some cases direct translation from foreign languages would be highly beneficial. Many of the most important mathematical works published in German, in French, or in Italian are at once translated so as to be accessible in all three of these languages. Is there no lesson in this for us? An English translation of the new German encyclopedia of mathematics would probably do much to spread throughout this land of seventy-five million inhabitants a knowledge of, and an interest in, advanced mathematics.

Finally, we must not relax our efforts to increase and improve the opportunities offered those interested in mathematics to meet one another for the purpose of exchanging their views upon mathematical topics. The Society must encourage, even to a greater extent than hitherto, the holding of mathematical colloquiums, sectional meetings, largely attended general meetings, and international congresses.

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