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The Study of the History of Mathematics in America: A Centennial Sketch

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0. INTRODUCTION

Anniversaries provoke reflections on the past. The centennial of the American Mathematical Society (AMS) provided an appropriate opportunity to review past contributions made in the United States to the study of the history of mathematics and to reflect on the changing status of the subject over the years. History of mathematics has been especially closely tied to mathematics, to mathematics education, and to history of science. But the alliances have been uneasy and have shifted over the years. Early in this century, history of mathematics in this country derived its strength from the singular energy of a few men, their close affiliation with the mathematical community here and abroad, and a tradition of history as a literary form. Its chief supporters tended to share a belief in progress and rationalism. In its current renewal, there are many workers in the field, a multiplicity of methodologies, and numerous motivations for promoting the subject. It is too soon to tell whether contemporary collective efforts will result in the desirable balance of sound exposition and rigorous research for which our predecessors prepared us.



Florian Cajori



D. E. Smith



R. C. Archibald



D. J. Struik

(Photograph of F. Cajori courtesy of Special Collections, The Colorado College Library; photograph of D. E. Smith courtesy of Special Collections, Teachers College, Columbia University; and photograph of R. C. Archibald courtesy of Boston University, Archives.)

This cursory sketch is not an attempt to present a history of history of mathematics in America. Rather, it is intended to call attention to a few of the currents that affected the subject over the past century, to note something of the relationship of past American historians of mathematics to the AMS and to the community of scholars at large, and to recall a few of the major contributions to the subject made in this country. The discussion focuses on the early part of this century, when America's leading historians of mathematics were active in the mathematical community. The post-1945 period is characterized only briefly, and very little is said about the contemporary scene. Although no specific references are made to publications of the last twenty years, it should be noted that these include some of the most interesting contributions to history of modern mathematics that have been made in the United States.

1. THE PRE-WORLD WAR I PERIOD

In 1890 the United States Bureau of Education issued a monograph entitled *The Teaching and History of Mathematics in the United States*. The author was Florian Cajori (1859–1930), a native of Switzerland, trained in the United States, who had recently assumed a professorship for physics in Colorado. The work not only was the first comprehensive history of mathematics in the United States, but the first major work dealing with history of mathematics to be published in this country. Its publication marks the beginning in America of the organized study of the history of mathematics, and the life of its author spans the formative years of history of mathematics in the United States.

Cajori's pioneering study was published in a period during which there were widespread attempts to expand the intellectual life of the country. These took many forms; in most areas they were accompanied by efforts at control on the part of increasing groups of "professionals." It is symptomatic of the period that between 1870 and 1890 more than 200 "learned societies" were founded; these included the New York Mathematical Society (1888), the American Historical Association (1884), and the National Education Association (1870). Other factors, of special relevance to history of mathematics, include the rise of graduate education, the establishment of professional schools in engineering and business, and the conversion of the nineteenth century teachers' training institutes and normal schools to graduate "schools of education." Educated Americans banded together in professional groups not only to exercise control over the future development of their subject, but to communicate with colleagues in their fields of research, and to enhance the resources available for study and research. In conjunction with these aims, many strove to enlarge awareness of their fields of study among laymen; a

historical approach was generally regarded as a useful means of achieving these ends.

Just as the celebration of the nation's centennial in 1876 had fanned historical sparks in the United States, so the closing of the century and the self-consciousness of the "new" professionals in many academic disciplines in the 1890s led to orations and papers on "Review of Progress in Subject x " or "History and Future Outlook of Topic y ." In addition, national magazines such as *The Nation* or *Century* not only guided their readers in matters pertaining to literature, politics, and the arts, but also sprinkled their widely read issues with occasional essays or biographies pertaining to science or mathematics. Since it was still fashionable at the time to discuss most topics against a historical framework, it is not surprising that such articles, too, frequently added to the literature of mathematical history.

In examining American contributions to history of mathematics prior to World War I, one observes that, with one notable exception, they came from those trained in mathematics and allied fields rather than from historians. American historians in the 1890s tended to be preoccupied with the shift from episodic narrative history to a more unified approach to political and, occasionally, military history. While anxious to alter the pattern of amateur elder statesmen being the chief writers of history, many of the new professional historians, in fact, attempted to invert this pattern and were busy convincing the country that their insight was needed to lead the nation into the twentieth century [Higham 1965]. Despite this divergence of priorities, work done by historians in developing generally available research materials helped the efforts of those working in the history of mathematics. This is especially true of the part played by historians in rescuing from destruction archival records and other forms of primary research materials, in encouraging the proliferation of libraries, and in expanding the means of publication for various disciplines. For example, the fact that Cajori's 1890 work was published by the Bureau of Education serves as a reminder that American reform educators for half a century had published reports and essays describing the history leading to whatever state of their subject they were discussing; it must also be noted, however, that at this time the connection between the Bureau and the historical community was being strengthened through the work of the historian Herbert Baxter Adams of the Johns Hopkins University, who prepared a series of monographs for the Bureau.

History of mathematics turned up in a variety of forms and places. Most American contributions to the subject prior to World War I were expository in nature, rather than devoted to conveying new research results. Depending largely on the publication outlet, the expositions could be research-oriented or general. Most expository history designed for the mathematician was found in the *Bulletin of the American Mathematical Society*; this was consonant with the *Bulletin's* purpose, iterated on its masthead, to provide "a historical and

critical review of mathematical science.” Less technical articles appeared in the *American Mathematical Monthly*, although, in time, some of these became more research-oriented. Research results in history occasionally appeared in the *Bulletin*. Most of America’s leading historians of mathematics also had papers in *Bibliotheca Mathematica*, an international journal for the history of mathematics founded and edited by the Swedish mathematician Gustav Eneström, who maintained high standards of scholarship; it was published by Teubner in Germany.

Maxime Bôcher, in his AMS presidential address of 1911 dealing with the early history of Sturm-Liouville theory, called attention to an interesting example of the occasional integration of historical study with mathematical research [Bôcher 1911]. Years earlier Bôcher had noticed that there was a lacuna among Sturm’s extant papers. Bôcher’s student, M. B. Porter, set about to reconstruct the missing paper; his partial reconstruction appeared in the *Annals of Mathematics* [Porter 1902]. Porter, in turn, interested Helen A. Merrill in the subject, resulting in her paper “On Solutions of Differential Equations which Possess an Oscillation Theorem,” published in the *Transactions of the AMS* [Merrill 1903].

Another variety of historical publications was designed to facilitate research. This included bibliographic work, translations, and some book reviews. Bibliographies and translations often appeared as separate monographs; however, the *Bulletin*, especially in its early years, frequently carried translations of historically slanted articles by contemporary European mathematicians; for the most part, the authors were men like Felix Klein or Emile Picard who had connections with American mathematicians. The *Bulletin* consistently presented book reviews dealing with historical topics.

The most pervasive and traditional historical papers dealt with the life or work of an individual. Earlier in the nineteenth century, obituaries of mathematicians had appeared in a few serial publications such as the *American Journal of Science* or in privately printed memorial volumes such as that issued by the Bowditches upon the death of Nathaniel in 1839. By the turn of the century, biographic sketches might appear in one of this country’s mathematical journals such as the *American Mathematical Monthly*, a general scientific journal like *Science*, or in a nontechnical magazine like *Century*. In general, accounts of individual mathematicians ranged from simple declarations that the person had been a scholar and a gentleman to incisive mathematical evaluations. The *Bulletin* usually carried articles stressing the mathematical contributions of the individual more than the details of his life history. Occasionally, there was an article such as Wilczynski’s paper on Lazarus Fuchs [Wilczynski 1902] that managed to convey a great deal about the individual in a few lines, while presenting a clear mathematical exposition with historical perspective of the person’s contribution to a research area.

Nontechnical expository articles dealing with the role of mathematics in civilization, or with special mathematical topics, usually were intended to provide motivation for the lay person and were frequently education-oriented. They might appear in *Science*, *Popular Science Monthly*, or one of the general magazines. There were also expository articles dealing with mathematical history geared to the mathematical or larger scientific community; presidential addresses constituted a special sub-genre of this type of history.

On the border line between general exposition and original research were historical summaries of specific subjects. These could take the form of brief historical references serving to introduce a subject or to support a form of mathematical argument, or they might be detailed subject reviews that traced the roots of then current research. The American Association for the Advancement of Science (AAAS), following the pattern established by the British Association, produced periodic historical reviews. Thus we find E. W. Brown giving a "Report on the Recent Progress of Solids and Fluids" in the *Proceedings of the AAAS for 1897*, which essentially outlines work in hydrodynamics during the preceding fifteen-year span. The following year, A. G. Webster provided a similar report "On the Mathematical Theory of Electricity and Magnetism" and, in 1899, G. B. Halsted reported on "Progress in NonEuclidean Geometry."

Histories of specific mathematical topics were provided by a number of mathematicians. Examples are in the work found of Halsted on non-Euclidean geometry, Miller and his student Josephine Burns on group theory, and Emch on geometry. Occasionally one might also find an essay dealing with aspects of institutional history.

Narrative historical articles or large-scale histories of mathematics based on existing histories began to appear before the turn of the century as well. These tended to be carefully crafted and provided a valuable resource for students, mathematicians, and lay people. Their flaws were those of their nineteenth century predecessors, on whom they improved in many instances. For many years, the chief American authors of such general historical surveys were Florian Cajori and David Eugene Smith.

Cajori had come to this country when he was sixteen. He attended White-water Normal School in Wisconsin and taught school before matriculating at the University of Wisconsin, where he obtained a B.S. degree in 1883. After a year's graduate study at the Johns Hopkins University from 1884 to 1885, he spent three years as an assistant professor of mathematics and professor of applied mathematics at Tulane. During this period, he contributed several papers in the history of mathematics to the *Journal of Education*, published in New Orleans, and to the New Orleans Academy of Science; in 1886, he was granted an M. S. degree from Wisconsin. A year's stay in Washington, during which he was a researcher at the United States Bureau of Education, resulted not only in [Cajori 1890] but in several smaller articles. He spent the

next three decades at Colorado College, serving as professor of physics from 1889 to 1898, and as professor of mathematics from 1898 to 1918. In addition, he was dean of the department of engineering at the college from 1903 to 1918. Despite a heavy teaching and administrative load and lack of major regional research facilities, while at Colorado College Cajori produced nearly 100 research and expository papers, two dozen book reviews, and several books and monographs, not counting reprints and translations into foreign languages. His nonhistorical work included elementary textbooks of mathematics and some research on semiconvergent series. In [Cajori 1890], which broke new ground in dealing with American mathematics, he relied heavily on the use of questionnaires and letters to gather his data. The fact that he was asked to contribute [Cajori 1908] to the volume of Cantor's *Geschichte* dealing with the late eighteenth century attests to his international reputation early in the century.

A Ph.D. degree awarded to Cajori by Tulane University in the 1890s was apparently honorary. Evidence of the regard that American mathematicians had for him at this time, when he worked in relative isolation, is provided by the fact that in 1903 he ranked 36th in Cattell's survey of mathematicians and was elected to the council of the AMS, serving from 1904 to 1906.

Cajori's contemporary, David Eugene Smith (1860–1943), was the most prolific historian of mathematics America has produced. Because of his long-lasting influence on history of mathematics and mathematics education, it is frequently overlooked that he was only a year younger than Cajori. In many ways, he had more kinship with the nineteenth century historical scholarship that was rooted in literature and philology than he did with higher mathematics or modern historical research techniques. Without specialized formal training in either history or mathematics, his strength lay in the classical training he had received as a child. He studied art and classical languages at Syracuse University, where he graduated in 1881. Although admitted to the bar in New York state three years later, he preferred to teach mathematics at the State Normal School in Cortland, while pursuing further graduate work at Syracuse. He received a Ph.D. degree from Syracuse with a thesis on classical art. In 1891 he became professor of mathematics in the State Normal College at Ypsilanti, Michigan. He collected a degree in pedagogy there before becoming principal of the State Normal School, which, subsequently, led to his assuming the professorship of mathematics at Teachers College of Columbia University.

Among his major works of the pre-World War I period one must single out *Rara Arithmetica, a Catalogue of the Arithmetics Written before the Year MDCI with a Description of Those in the Library of George Arthur Plimpton of New York*. (1908). Not only has this work remained a standard reference among bibliographers, book collectors, and historians of early modern mathematics, but it served to cement his friendship with Plimpton, who was the

chairman of Ginn and Company from 1914 to 1931. Both men were collectors; for years, Smith assisted Plimpton in developing the mathematical parts of his library. Not surprisingly, Ginn published many of Smith's books.

Another publication of this period, [Smith and Mikami 1914] is representative of the great service Smith performed in calling attention to the history of mathematics in the Far East. He was instrumental in promoting research in the history of mathematics in China, India and Japan, and encouraged many of the contributions on the subject that appeared in American journals prior to World War II.

In the AMS, which he had joined in 1893, Smith served on the Committee on Publication from 1903 to 1909; he was an editor of the *Bulletin* from 1910 to 1920, having assisted briefly in 1902. Earlier, in 1896–1897, he had been part of the group instrumental in forming the Chicago Section of the Society. From 1902 to 1920 he was librarian of the AMS. His contributions in that capacity have been noted by Archibald [1938:90–92]. It seems appropriate that his first major acquisitions for the Society should have come from the library of G. W. Hill. For it was Hill who, in his presidential address before the AMS in 1895, had commented on the difficulties American mathematicians faced in trying to do historical research without proper library resources [Hill 1896].

The offices Smith held in national and international organizations that he used to promote the history of mathematics are too numerous to recount here. Suffice it to note that, as member of the International Commission on the Teaching of Mathematics, Smith collaborated with the other two American commissioners, William Fogg Osgood and J. W. A. Young, in writing and editing numerous reports of the Commission. His influence is seen in journals such as *School Science and Mathematics*, which he served as associate editor; it published historical articles such as [Benedict 1909].

Aside from his publications and his organizational activities, Smith exerted strong influence on mathematics education and history of mathematics through his teaching. His courses were extremely popular. A survey of 113 schools, published in 1915, indicated that Smith's course had the largest enrollment among 47 courses in the history of mathematics; in enrollment among over 175 courses in the history of science, mathematics, and psychology, it ran second only to the course in the history of chemistry taught by Theodore W. Richards of Harvard. [Brasch 1915]. Usually, the history of mathematics was introduced into the curriculum either as part of a course in the history of science or as a course by itself. A separate course had been taught at Yale, where James Pierpont was interested in history, since 1892. A history of science course was introduced by Tyler and Sedgwick at MIT in 1905. [Tyler 1910–1911]. Smith's course outlasted these and most others like them. Like other such courses, his had a reputation for being easy;

but, unlike many others, it conveyed to the students knowledge and appreciation for the subject. Although his strongest influence was exerted on the students enrolled in Teachers College, it was not limited to these. Numerous students from the mathematics department in Columbia College attended Smith's courses; for example, E. T. Bell [1945] described his experience when sent there by Cassius Jackson Keyser (1862–1947), long-time member of the Columbia mathematics faculty, who taught history of mathematics himself at times and steered students to Smith.

For twenty years, Smith's graduate students at Teachers College produced respectable theses devoted to the history of mathematics education. Typical of these are two of the earliest, [Jackson 1906] and [Stamper 1906]. Smith's influence and collaborations extended beyond his regular graduate students, however.

In the academic year 1909–1910, an instructor from the University of Michigan spent a year's leave of absence at Teachers College. The stay resulted in a joint publication by Smith and Louis Charles Karpinski (1878–1956) on *The Hindu-Arabic Numerals*, which was widely hailed as the best exposition on this frequently treated topic. Karpinski was a graduate of Cornell University who had presented a dissertation on distributions of quadratic residues to obtain his Ph.D. degree from the University of Strassburg in 1903. He, too, had gained his first teaching experience as a young man, when he had taught mathematics at Berea College in Kentucky. After his return from Strassburg, he spent a year as instructor at the New York State Normal School in Oswego, after which he joined the faculty of the University of Michigan, where he remained the rest of his life. His interest and competence in the medieval period was demonstrated further in 1912 when his paper on "The 'Algebra' of Abu Kamil Shoja' ben Aslam" appeared in Eneström's *Bibliotheca Mathematica*.

Soon after the turn of the century another member of the Columbia University faculty was placed in a position to provide substantial support to the history of mathematics. This was Robert Simpson Woodward (1849–1924), who became president of the Carnegie Institution in 1904, two years after Andrew Carnegie had provided the funding for "an Institution to promote study and research." Woodward, an applied mathematician with special research interests in geophysics, geodesy and astronomy, had served with the U.S. Geological Service and the U.S. Coast and Geodetic Survey before joining the Columbia faculty in 1893; in 1895 he had become dean of the school of pure science at Columbia. His expository and historical skills and interests had been apparent for some time; his vice-presidential address on "The Mathematical Theories of the Earth" presented to the American Association for the Advancement of Science in 1889, met with sufficient interest to be printed in several of the leading scientific publications of the day. He produced a

“Historical Survey of the Science of Mechanics,” which was published in *Science* in 1895. As co-editor, with Mansfield Merriman, of a volume on *Higher Mathematics*, it was he who had asked David Eugene Smith to contribute an article on the history of modern mathematics; this project fixed Smith’s historical direction and renewed his contact with Felix Klein, whom he asked for assistance. In the meantime, Woodward himself was preparing the article on mathematics for the *History of the Smithsonian Institution, 1846–1896*, which appeared in 1897. His awareness of history may have received some reinforcement through the fact that he had been elected president of the AMS for 1899–1900 and president of the AAAS for 1901. At any rate, he did not miss the opportunity of welcoming the new century in the properly progressive spirit when he chose the topics “The Century’s Progress in Applied Mathematics” for his presidential AMS address and “The Progress of Science” for his presidential AAAS address. Both addresses were widely read; the first was published in the *Bulletin*, the second in *Science*, as one would expect; but, in addition, there was a reprint in *The Scientific Monthly*, and there were more reprints and translations in England, Germany, and Poland. During his first ten years as president of the Carnegie Institution, that body supported the publication (1907–1909) of the *Collected Mathematical Works* of George William Hill, and of Derrick Lehmer’s factor tables and tables of primes.

There was another man in the pre-World War I period who, aided by substantial financial support, was to further publications in this country in the history of mathematics. This was Paul Carus (1852–1919). He came to the United States from Germany, where he had obtained a Ph.D. in Tübingen in 1876. He was a believer in the monism of mind and matter, convinced that philosophy could be put on a scientific basis. He soon became the editor of the *Open Court*, a journal founded in 1887 by the zinc mogul A. Hegeler of Chicago, who was equally convinced that religion could be put on a scientific basis. In 1888, Carus had married Hegeler’s daughter, Mary, subsequently a major benefactor to mathematical expository writing. The following year Hegeler founded a new, more technically oriented journal, the *Monist*, and Carus became its editor. Carus expanded the orientation of the journal. It was a general journal of philosophy, and one of the directions of special interest to the editor was the philosophy of mathematics along with related history.

As a result, the *Monist* featured articles such as G. B. Halsted’s [1902/1903] translation of an extract from Gino Loria on the history of geometry prior to 1850, and L. Robinson’s translation [Robinson 1909] with a commentary by D. E. Smith of Heiberg’s account of the palimpsest on Archimedes’ *Method*, discovered in Constantinople in 1906. Before the turn of the century, Hegeler and Carus expanded their activity even further, establishing the Open Court Publishing Company.

Under its imprint appeared numerous monographs in the history of mathematics. Many were translations into English of classics in modern mathematics. Among the first such Open Court monographs were [McCormack 1898], a translation of Lagrange's elementary lectures at the *Ecole Normale*, and [Beman 1901], a translation of Dedekind's "*Was sind und was sollen die Zahlen*" and "*Stetigkeit und Irrationalzahlen*."

The year that Karpinski spent at Teachers College with Smith, another Ph.D. from Strassburg, Raymond Clare Archibald (1875–1955), was doing postgraduate work at the Sorbonne, where he came under the influence of Jules Tannery, but also heard Borel, Darboux, Goursat, Picard, and Poincaré [Sarton 1956]. A native of Nova Scotia, Archibald had returned to Canada after obtaining his doctorate in 1900 and spent seven years at Mount Allison Ladies' College at Sackville. There he furthered the three areas that most interested him for the rest of his life: mathematics, music, and the study of books. In 1908, he received an appointment at Brown University, where he remained more than three decades. During the pre-World War I period he came to attention with a biobibliography of Simon Newcomb, published in the *Transactions of the Royal Society of Canada*, and with numerous minor historical notes and reviews that appeared in the *Bulletin of the AMS*, the *Proceedings of the Edinburgh Mathematical Society*, and the *Mathematical Gazette*.

By 1914, these individuals and others formed an active group, promoting the history of mathematics as an independent research field, as a motivating subject for teachers of mathematics, as a stimulus for mathematical research, and as a source of general edification and pleasure. Conscious of the limited availability of reference materials and libraries, they collaborated in making requisite primary and secondary source materials more easily available, be it through book purchases, through translations, through bibliographies, through text editions and analyses, or simply through reviews.

2. WORLD WAR I TO 1930

During the post-World War I period, history of mathematics grew steadily in America and flourished within the mathematical community. It is true that World War I markedly affected research and international collaboration in history of mathematics as it did in other fields. For example, *Bibliotheca Mathematica*, whose rigorous editor had featured research contributions by Cajori, Karpinski, Miller, and Smith, ceased publication after 1914. The International Commission on the Teaching of Mathematics, in which David Eugene Smith had become of considerable influence, suspended its operations as well. Yet, during a period of institutional growth in this country, American historians of mathematics reached a peak of professional involvement and sharpened their research.

The pioneer historians of mathematics continued to be involved in the activities of the American Mathematical Society. Both Cajori (1919) and D. E. Smith (1922) served as vice-presidents of the Society. Archibald had a term on the council (1918–1920) and in 1921 succeeded Smith as librarian, a position he retained for twenty years; in 1925 he edited an expanded catalogue of the Society's library. In 1928 the Society appointed its Committee on the Semicentennial Celebration. Archibald ended up as its vice-chairman and as chairman of the program subcommittee. D. E. Smith chaired the subcommittee on exhibits, and Archibald, together with T. S. Fiske, was put in charge of the history of the Society. The result was [Archibald 1938]. Cajori was an active member of the California section of the AMS, serving twice as its chairman (1918–1919 and 1922–1923); he was an invited AMS-MAA speaker in 1922.

Upon the founding of the Mathematical Association of America (MAA) in 1915, Cajori, Smith, and Archibald became even more involved in organizational activities. All three, as well as Karpinski, Miller, and others sympathetic to mathematical history, were charter members of the Association. Cajori served as president (1917–1918) and was a member of several committees which prepared lists of suggested mathematical books for college and junior college libraries. Archibald, a member of the International Mathematical Union, served on its International Commission of Mathematical Bibliography. Archibald, Cajori, and Karpinski were elected vice-presidents of the American Association for the Advancement of Science (AAAS); Archibald served as chairman of section A (mathematics), Cajori and Karpinski, of the recently (1921) established section L (history).

The pioneers continued to be productive in research and publications as well. Cajori, who left Colorado Springs for Berkeley in 1918 to assume a newly created professorship for the history of mathematics at the University of California, maintained a steady output of research articles leading to new textbooks and monographs. These included his study of the seventeenth century English mathematician William Oughtred (1916), his *History of Elementary Mathematics, with Hints on Methods of Teaching* (1917), and his *History of the Conceptions of Limits and Fluxions in Great Britain* (1919). In 1919 he also produced a second edition of his *History of Mathematics*, which for three decades was the only English-language history that provided at least a cursory treatment of nineteenth-century mathematics. His major achievement was the publication in 1928 of the two-volume *History of Mathematical Notations*, which remains the standard reference work on the subject.

David Eugene Smith continued his bibliographic contributions with a "Union List of Mathematical Periodicals," which he produced in collaboration with Caroline E. Seely, a mathematician who served as secretary of the AMS for many years. The work was published as a *Bulletin* of the U.S. Bureau of Education in 1918. It was followed in 1923 with a "Bibliography

of the Teaching of Mathematics, 1911–1921,” compiled in collaboration with J. A. Foberg. A small monograph on computing jetons (counters), published by the American Numismatic Society in 1921, became popular with collectors and students of the subject. A *History of Mathematics*, published by Ginn, appeared in two volumes between 1923 and 1925; re-issued as a Dover paperback, this work dealing with elementary mathematics has remained a favorite with many teachers of mathematics. In addition to his books and monographs, which included successful textbooks in elementary mathematics beside his historical works, Smith published over a hundred journal articles and another hundred book reviews during the period 1914–1930.

Among the younger men, Archibald gained international attention with his English edition of Euclid's *Division of Figures* [Archibald 1915] and continued to contribute articles to the *Monthly*. In 1925, he edited a volume on Benjamin Peirce, which demonstrates his biobibliographic skills. The previous year, his memoir on Simon Newcomb for the National Academy had involved similar skills; his subject, in this case, was a man he had known in his youth, who had been the subject of his first historical publication. His major research achievement of the 1920s was his contribution to the edition of the Rhind Mathematical Papyrus produced by A. B. Chace, the Chancellor of Brown University; Archibald's 102-page bibliography on Egyptian mathematics appended to this work remains a reference source in this area of study. Minor research products by Archibald in the 1920s appeared in foreign journals like the *Mathematical Gazette* and *Nature*; after 1928, he also contributed to the *Dictionary of American Biography*, to the *Encyclopaedia Britannica* and to Smith's *Sourcebook of Mathematics*, to name but a few of his varied projects.

Karpinski made a notable contribution to the history of medieval mathematics with his translation and edition of Robert of Chester's algebra of al-Khwarizmi. [Karpinski 1915]. In the 1920s he continued to call attention to medieval sources available for study in this country. Halsted added to his editions of geometric classics with a translation of Saccheri's *Euclides Vindicatus*, published by Open Court in 1920. George Abram Miller in 1916 had published a widely noted *Historical Introduction to Mathematical Literature*. He continued to contribute historical articles to a range of journals. They tended to fall into three groups. There were technical contributions to the history of algebra; these appeared in the *Monthly*. He produced lists of errors in the literature, which he published in several journals. Finally, there was a variety of expository articles, often directed to teachers of mathematics.

Among other mathematicians making regular historical contributions was R. B. McClenon of Grinnell College, who had succeeded Karpinski as librarian of the MAA. His articles in the *Monthly* included a study on Leibniz and complex numbers, and a discussion of Leonard of Pisa and his *Liber quadratorum*. Lao Simons, who had studied mathematics at Vassar in the

1890s, been a member of the faculty at Hunter College since 1895, and extended her training in pedagogy and the history of mathematics at Teachers College, in the 1920s systematically produced research reports on the history of American textbooks. In the process, she obtained a Ph.D. degree from Teachers College. Vera Sanford, of the State Teachers College at Oneonta, N.Y., produced brief articles of high quality in the *Mathematics Teacher* in the twenties, and wrote a *Short History of Mathematics*, published in 1930. This became a successful textbook in courses designed for teachers of mathematics in the 1930s.

The *Mathematics Teacher*, which had been the journal of the Association of Teachers of Mathematics in the Middle States and Maryland, became the official journal of the National Council of Teachers of Mathematics (NCTM) in 1921. From that year on, brief expository contributions on historical topics appeared in that journal with some regularity, reaching a peak in quantity and quality in the late twenties.

Under the leadership of R. S. Woodward, the Carnegie Institution continued to support research in the history of mathematics. Two Carnegie projects should be cited in any review of history of mathematics in the 1920s: One was Leonard Eugene Dickson's three-volume publication entitled *A History of Number Theory*, which appeared between 1919 and 1923. It has remained a standard reference work, largely because it is not the narrative history the title might suggest, but instead a reasonably reliable bibliographic guide through the history of number theory.

The other Woodward-Carnegie project relates to the coming to this country of the Belgian historian of science George Sarton (1884–1956). Sarton, an admirer of Poincaré, had turned from philosophy to study chemistry and mathematics. After obtaining his doctorate with a thesis on the mechanics of Newton in 1911, he founded the journal *Isis*, the first volume of which appeared in 1912. It was conceived as an international journal for the history of science; Sarton edited it from his home outside Ghent. Upon the invasion of Belgium at the beginning of World War I, Sarton buried many of his research notes in his garden and fled to England. [Sarton 1927:45]. In 1915, Sarton came to the United States, assisted by Smith. The following year he held an appointment at the philosophy department at Harvard. Woodward created for him a position as associate in the history of science at the Carnegie, which became effective in 1918. It was this appointment that fed Sarton for many years, even after Harvard offered him research space and library facilities. In addition, the Carnegie Institution sponsored the publication of Sarton's monumental *Introduction to the History of Science*, a major bibliographic work; the scope of the project far exceeded available resources, however, and only three volumes could be completed.

Sarton is justly credited with establishing the history of science as an academic discipline in the United States and with shaping the basic research

tools needed by workers in the field. Because his journal *Isis* has been the official journal of the History of Science Society since the founding of that society in 1924, it is often assumed that the Society was his sole creation as well. In fact, however, the establishment of the Society involved several American historians of mathematics, notably the indefatigable David Eugene Smith. In 1915, Smith had called attention to *Isis* through a note published in *Science*. In December 1923, Smith sent a letter to 45 individuals, suggesting a meeting in Boston. As a result, the next month, 37 individuals met and founded the History of Science Society: besides Sarton, the organizing committee included Archibald, E. W. Brown, Karpinski, Smith, and H. W. Tyler, among others [*Isis* 6:6–7]. Cajori served as one of the History of Science Society's two vice-presidents for the first two years. Smith was the first secretary of the Society, to be succeeded by L. Leland Locke, a mathematics teacher from Brooklyn with a special interest in the history of calculating machines. Archibald served as one of the associate editors of *Isis*, a position he retained for the rest of his life.

Florian Cajori died in 1930. His death marked the end of an era during which Americans had developed impressive bibliographic skills and resources in the history of mathematics, had produced notable translations and editions of mathematical works, had demonstrated critical judgment in the analysis of ancient and medieval mathematical texts, and had authored exemplary textbooks in the history of elementary mathematics, along with other useful materials for teachers of mathematics. It would appear that they had paved the road for the next generation of American scholars to make its mark by examining conceptual developments in modern mathematics, and by subjecting to deeper analysis social, economic, and cultural issues affecting the subject. However, this road was soon covered with obstacles.

3. THE 1930S AND WORLD WAR II

Through hindsight it is possible to detect the beginning of a decline in mathematical history in the late twenties. By the end of World War II, American research results in the history of mathematics were becoming scarce, and the most widely read expository presentations sacrificed accuracy for literary bon mots or philosophic preconceptions. The best research work being done was no longer published in the mathematical journals; and the occasional expository article dealing with history tended to be chatty. The quality of courses in the history of mathematics, never very demanding, sank further. In the minds of most mathematicians, history of mathematics had lost any claim to status as a legitimate field of mathematical specialization.

In the early thirties, the change was not obvious. To be sure, in 1931 the *Bulletin* dropped from its masthead the reference to being "a historical and

critical review of mathematical science." It still carried an occasional historical book review; but neither in the *Bulletin* nor in other American research journals could one find the historical framework that had once surrounded many research articles. Yet there appeared to be other outlets for historical articles.

The *Monthly* continued to publish a variety of readable articles, covering a wide range of mathematical history, which occasionally included original research.

In 1932, a new journal was founded, entitled *Scripta Mathematica*. Its masthead proclaimed that it was "A Quarterly Journal Devoted to the Philosophy, History, and Expository Treatment of Mathematics." The editor-in-chief of the journal was Jekuthiel Ginsburg of Yeshiva University; the listing of the editorial board read like a Who's Who in the History and Philosophy of Mathematics: it consisted of Archibald, Karpinski, Keyser, Loria, Simons, and Smith. Although this board was expanded several times, eventually the burden of editorship rested almost exclusively on the hard-working Ginsburg. There was a pleasant mixture of original research and exposition in the historical articles; most active American historians of mathematics contributed to *Scripta* at some time during the thirties and forties.

The *Mathematics Teacher* brought out numerous solid articles on history of mathematics during the early thirties, thanks largely to the efforts of Vera Sanford; however, these gradually declined in quantity and quality. Yet, another new magazine oriented to mathematics teachers featured interesting research notes in the history of mathematics. This was *The National Mathematics Magazine*, published by Louisiana State University. It had been established in the late twenties as *Mathematics News Letter*, and had contained an occasional note on history. After its reorganization, contributions on history of mathematics increased substantially and from the mid-thirties to the mid-forties it featured historical notes and articles by most contributors to the field. Much of the effort was due to G. W. Dunnington, the Gauss biographer with close ties to G. A. Miller.

Among publications designed for a wider, nonmathematical, readership, *Science and Society*, a Marxian journal founded in the 1930s, contained occasional stimulating reflections or reviews on the history of mathematics. As an example of a specialized journal, which, thanks to Alonzo Church, began with a major contribution to historical bibliography, one must note the *Journal of Symbolic Logic*.

Periodically, research results in the history of mathematics appeared in *Isis*. Mathematical items also could be found in the series of companion volumes entitled *Osiris* that George Sarton began to issue in the 1930s. It, too, was published in Belgium. Each volume was dedicated to a leading figure in the history of science, and contributions to that volume usually, though

not always, related to that individual's interests. The first volume in the series was dedicated to David Eugene Smith. It, and several subsequent volumes, contained substantial articles in the history of mathematics; American authors were well represented.

Another new publication, sponsored by Julius Springer in Germany and founded in 1929 by Otto Neugebauer, J. Stenzel, and Otto Toeplitz, provided an international outlet for solid research contributions and promised to become the scholarly vehicle that the history of mathematics needed at this stage. This was *Quellen und Studien zur Geschichte der Mathematik*. Divided into two parts, one for "Quellen" the other for "Studien," it began propitiously, with articles of high quality, including some by American authors. Its life was cut short by the advent of the Third Reich, however.

The aging pioneers continued their work. Smith collaborated with Ginsburg on a *A History of Mathematics in America before 1900*, which appeared as a Carus Mathematical Monograph in 1934. In addition, he provided dozens of book reviews, encyclopedia articles, and occasional pieces, served on committees, and organized his collections. In 1931, he donated his library to Columbia University; this gift, along with the University's previous holdings, the Plimpton collection, Smith's collection of mathematical objects, and the library of the AMS, all housed on the Columbia campus, provided a substantial resource for mathematicians and historians of mathematics.

Karpinski continued his bibliographic work, culminating in his *Bibliography of Works Published in America Prior to 1850*, which appeared in 1940. Before his retirement in 1948, he had built up the mathematical rare book and manuscript collection at the University of Michigan, produced bibliographies on cartography, sold his map collection to Yale University, served a term as chairman of Section L of the AAAS and, in 1941, been elected president of the History of Science Society.

Archibald remained active throughout the 1930s and World War II. He made substantial contributions to each volume of *Scripta*. He issued another edition of the Catalogue of the library of the AMS in 1932; he brought to notice, through knowledgeable reviews, the work of Neugebauer; he contributed to the *Dictionary of American Biography*; and he produced successive editions of his *Outline of the History of Mathematics*. In 1938 his *Semicentennial History of the AMS* was published. During World War II he served as chairman of the National Research Council's Committee on Mathematical Tables and Aids to Computation, and founded the journal by the same name. Meanwhile he had watched the passing of three generations of historians of mathematics; he eulogized Cajori and Chace, Brown and Heath, and finally H. W. Tyler.

Among other mathematicians who had made earlier contributions to the history of mathematics, Julian Lowell Coolidge produced a number of works on algebraic geometry with historical overtones; his *History of Geometric*

Methods was published by Oxford in 1940. Emch contributed another research piece on Saccheri in *Scripta*. Miller still wrote occasional articles in *National Mathematics Magazine*, the *Monthly*, *School Science and Mathematics*, and *Science*. Sanford contributed to the *Mathematics Teacher*.

Although it is striking that most of those who produced more than an occasional piece in the 1930s and 1940s were near or past retirement, there was a scattering of younger mathematicians and historians who displayed interest in history of mathematics. For example, among mathematicians who played a significant part in the resurgence of history of mathematics after the 1950s, Garrett Birkhoff made a contribution to the third volume of *Osiris* [Birkhoff 1935], and Dirk Struik wrote thoughtful historical articles and reviews; after the establishment of *Mathematical Reviews*, Struik handled a large portion of reviews on modern topics for the section on history.

The individual who in the latter part of this period was most successful in bringing aspects of the history of mathematics to the attention of mathematicians as well as the general public was Eric Temple Bell (1883–1960). Born in Scotland, he came to the United States at age nineteen. During a decade spent in the western United States, he studied at Stanford and the University of Washington, taught school, and, according to his own account, was a mule skinner, surveyor, lumberjack, and minor entrepreneur. He spent a brief period in New York, where he obtained a Ph.D. at Columbia in 1912. A specialist in number theory, he returned to the University of Washington, serving on its faculty until his appointment to the California Institute of Technology in 1926. In the meantime, he had won the Bôcher prize in 1921, and was invited to give the Colloquium Lecture for 1927. He served as president of the MAA from 1931–1933. A prolific author, he devoted much of his time after 1930 to popularization and to history, besides writing science fiction novels under the pseudonym John Taine. His two works most widely read by students of the history of mathematics have been *Men of Mathematics*, which first appeared in 1937, and *Development of Modern Mathematics*, the first edition of which was published in 1940. The fluidity of Bell's prose often obscures the lack of evidence for his assertions. Struik characterized Bell's style in gentlemanly fashion by noting "the experience of the author as a creative mathematician, a teacher and interested colleague has made it possible to place lively comment, pithy summaries and challenging outlooks between an otherwise factual survey of achievements." [Struik 1940].

The interest in popularization and biography during the late thirties and forties was not peculiar to the history of mathematics. Among American historians this was a time of major controversy concerning these two issues [Higham 1965]. American historians had come a long way since the turn of the century in developing research strength and generational continuity and perhaps benefitted from vigorous debates. American historians of mathematics, however, had just begun to show their research potential. Their

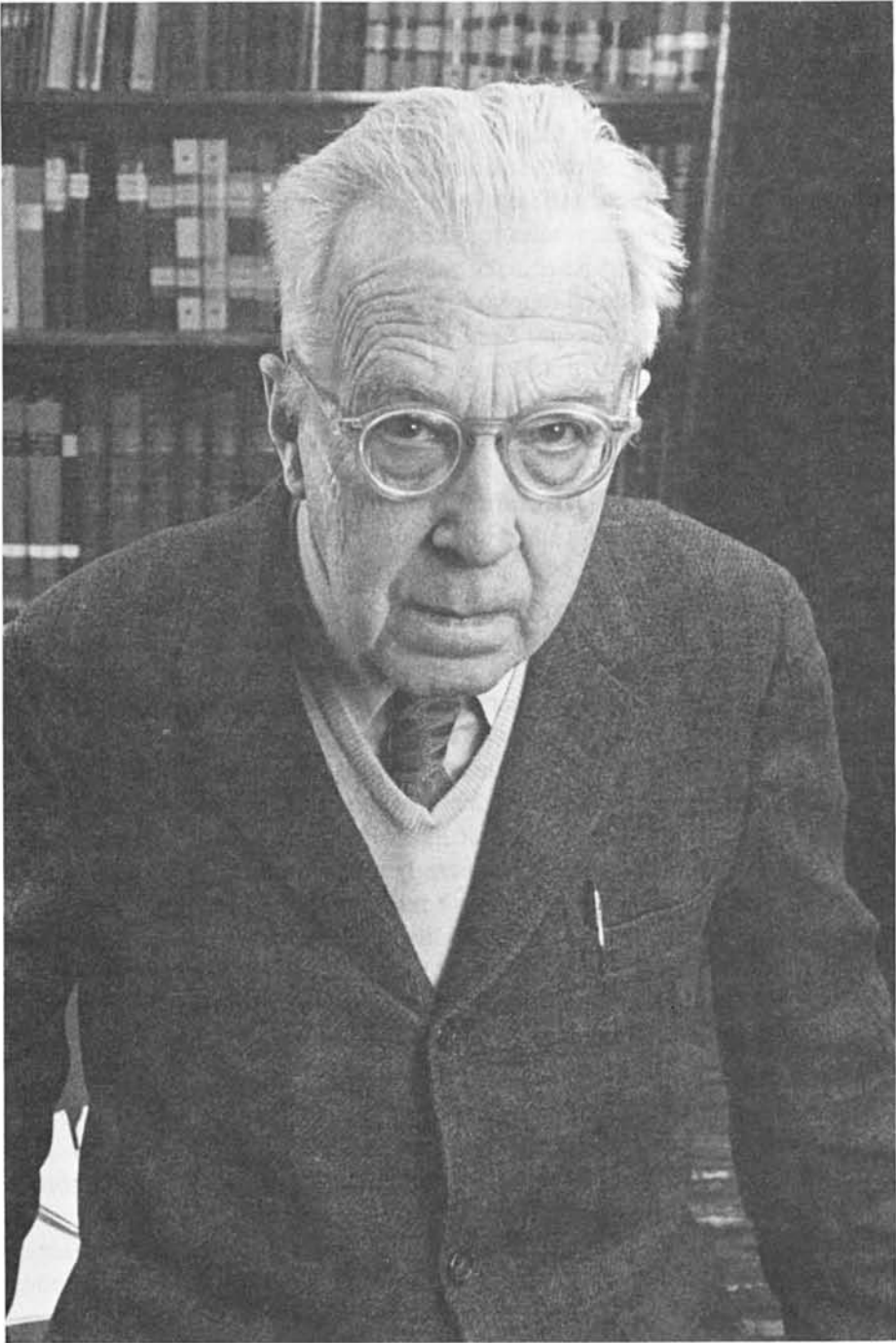
limited publication outlets for serious research contributions were being shut down by the spread of National Socialism on the European continent and the competition for increasingly limited resources at home. The disdain for historians expressed by men like Bell was hardly designed to encourage young people with an interest in mathematics to take up the study of history. All of this exacerbated the major problem, which was that there was no new generation of historians of mathematics to take the place of those who were retiring in the 1930s. Smith and Karpinski had had substantial numbers of graduate students; but even those among them who made sound contributions to the history of mathematics had been prepared to become mathematics “educators,” not historians of mathematics. Their careers were in teaching and administration; the time people like Sanford and Simons found to edit and produce historical articles is a testament to their devotion to the subject. Neither economic conditions nor the academic climate, said to have produced a “schism in scholarship” [Higham 1970], could be expected to encourage many to take up a research career in a fading field.

4. THE POST-WORLD WAR II PERIOD: 1945–1968

In the post-war period, the history of science emerged as an independent discipline. As courses in the subject multiplied, and graduate programs and departments grew, certain areas within the history of mathematics also assumed new strength; this was especially true of some aspects of the history of ancient and medieval mathematics. Yet, for the most part, history of modern mathematics existed on the fringes of history of science and became practically defunct within mathematics, where it was promoted, albeit at a rather light level, only by those concerned with mathematics education. There were spin-offs from activities in history and history of science that were to prove beneficial to the history of mathematics. But these could be utilized fully only after renewed interest among mathematicians in history and a resurgence of research activity in the history of modern mathematics became apparent in the late sixties.

The post-war period started with promise. In 1948, Struik’s *Concise History of Mathematics* made its appearance. For the first time, an American had produced a general history that introduced intellectual, social, and economic factors while remaining mathematically sound and historically perceptive. It was followed the next year by J. L. Coolidge’s charming *The Mathematics of Great Amateurs*, and by Boyer’s *Concepts of the Calculus*, about which more will be said below.

An observer of the scene in the early 1950s was still receiving mixed messages: The AMS sold its library to the highest bidder, the University of Georgia; a note in *Isis* called attention to a seminar on the history of mathematics conducted by Otto Neugebauer at Brown; at the International Congress



Otto Neugebauer

of Mathematicians in 1950, George Sarton expressed grave concern at the lumping of history of mathematics with mathematics education; carefully executed editions and analyses of medieval mechanics began to appear from Marshall Clagett and his students.

It soon became clear, however, that a revival was overdue. Smith had died in 1946, Simons in 1949. Solomon Gandz followed in 1954, Archibald in 1955, Karpinski and Sarton in 1956, and Ginsburg in 1957. Among younger mathematicians, Carolyn Eisele began her championship of the mathematics of C. S. Peirce. Phillip S. Jones promoted history among mathematics teachers. Morris Kline called attention to the relationship of mathematics to other disciplines in the history of Western culture and encouraged mathematicians with historical interests. Still, there was little fresh research in the history of modern mathematics. Popular accounts continued and were well received. *The World of Mathematics*, a successful four-volume anthology, found favor with many lay people. Books such as [Bochner 1966] interested the scientifically oriented. [Kline 1953] sold well. [Eves 1964] became an unusually successful textbook. [Aaboe 1964] was a rare example of a technical, intelligible, mathematically and historically sound introduction to topics in Greek mathematics. But research outlets for history of mathematics continued to shrink. Upon the death of Ginsburg, *Scripta Mathematica* in 1957 dropped the reference to philosophy and history from its masthead, replacing it with the statement that it was "devoted to the Expository and Research Aspects of Mathematics." *Osiris* ceased. *Isis* carried a few articles pertaining to mathematics, and began to discourage any that were technically oriented.

There was increased interest in mathematical classics as collectibles; perhaps this would have pleased Karpinski, who had retired to Florida to spend his remaining years as a book dealer. What might have surprised him and his contemporaries was the flood of reprints that appeared on the book market in the 1960s; perhaps even more surprising might have been the fact that not only was no editing or updating done on these publications, but that they occasionally appeared without the scholarly apparatus that had made the original edition so valuable to the student ([Gauss 1902] vs. [Gauss 1965], for example). Nevertheless, the availability of so much historical material in libraries and bookstores compensated the interested student for the scarcity of courses, seminars, and other organized activity in history of mathematics. Occasionally, the lucky browser encountering a genetic introduction to the calculus [Toeplitz 1963] next to a history of its concepts [Boyer 1939], both stacked on top of a good traditional calculus textbook, might gain an appreciation for an aspect of mathematics and its history not necessarily attainable through the single-minded approach of the lecture room.

Members of the History of Science Society from time to time conducted surveys dealing with their growing field. The results of one such survey [Price 1967], although not altogether reliable in its details, reflected the scarcity of

research opportunities for graduate students in the history of mathematics. There was one department for the history of mathematics; it had an exceptionally strong base in the ancient, medieval, and Renaissance periods. In other departments, the programs that came closest to providing guidance for work in the history of mathematics were those listing the history of the exact sciences as fields of specialty. Almost all of these had strength in the ancient and medieval areas, a testimony to the influence of Neugebauer and Clagett. The only listings for study in the history of the exact sciences in the seventeenth and eighteenth centuries were attributable to I. Bernard Cohen, whose influence in encouraging mathematicians and historians interested in the modern period became obvious only recently.

The one department in the history of mathematics that existed in the 1960s was that of Otto Neugebauer at Brown. Neugebauer's contributions to the history of mathematics go back to the 1920s. As a graduate student in Göttingen, he assisted Richard Courant in editing the posthumous second volume of Felix Klein's *Vorlesungen über die Geschichte der Mathematik im 19. Jahrhundert* and "was introduced [by Courant] to modern mathematics and physics as a part of intellectual endeavor, never isolated from each other nor from any other field of our civilization." [Neugebauer 1957:vii]. But beyond this, he has credited Courant with encouraging him in his study of the mathematical sciences of the Near East. Beginning with the publication by Springer in 1926 of his *Grundlagen der ägyptischen Bruchrechnung*, Neugebauer has produced a steady stream of scholarly and ground-breaking contributions to the history of ancient Egyptian and Babylonian mathematics and astronomy. As noted above, in the United States, Archibald had called attention to the significance of this work since the early thirties. Neugebauer came to this country in 1939, to serve on the faculty of Brown University and to edit the newly established *Mathematical Reviews* [Pitcher 1988:69–85]. His research production did not flag. *Mathematical Cuneiform Texts* in 1945 was his first major work published in this country, in collaboration with A. Sachs. It brought to light and interpreted a substantial collection of mathematical tablets in the United States that had not been previously analyzed. Incidentally, this publication, dedicated to Archibald, was supported in part by the MAA's Chace Fund. Neugebauer and his school continued their systematic research activities throughout the period under discussion. Their publications appeared in mathematical, historical, and philological journals. As time passed, *Centaurus* rather than *Isis* became the transmitting journal for many research results of the Neugebauer school. Neugebauer himself placed more distance between himself and historians of science. Typically, in a review written in 1955, he expressed his opposition to the dominant historical direction by commenting that "the trend toward 'synthesis' in historical studies at the expense of factual, detailed analysis shows its detrimental effects." [Neugebauer 1955].

In view of the important role played by historians of mathematics in the early days of the History of Science Society, the extent to which mathematics receded from the center of action in the history of science may seem surprising. It is explained, in part, by the growing proximity of history of science to the general field of history. In the 1920s, when the History of Science Society was founded, its connections to the scientific community were stronger than its ties to American historians. Intellectual history in America was in its youth; just twenty years had passed since James Harvey Robinson at Columbia had introduced a course in intellectual history. It was only in 1924 that Arthur Schlesinger introduced his course on social and intellectual history. By contrast, in the 1960s, intellectual history had peaked, and socioeconomic history was in the ascendant. Freshly trained historians of science found most of their jobs in history departments, although the jobs had been frequently created at the urging of the science sector, and most of the students were science majors [Kuhn 1971]. If the scenario described by Kuhn in 1971 is accurate, it is not surprising that economic and intellectual pressures moved historians of science more closely into the history camp. For the history of mathematics, there were special problems. The work done by most of the earlier pioneers in the field was pronounced methodologically worthless by various historians' spokesmen. In addition, there seemed even less reason for either the intellectual or the socioeconomic historian to be concerned with the history of mathematics than with the history of the experimental sciences. For Kuhn [1971] hypothesized that "after a science has become thoroughly technical, particularly mathematically technical, its role as a force in intellectual history becomes relatively insignificant." This notion, coupled with the statement that "Science, when it affects socioeconomic development at all, does so through technology," left little room for mathematics in two areas of history especially relevant to the history of science. Whatever the reasons, it is true that by the end of the sixties the new generation of historians of science excelled in areas where training in history was more important than training in mathematics.

It was a man trained as an intellectual historian, Carl Boyer (1906–1976), of the mathematics department of Brooklyn College, who bridged the gap, and was the primary representative in this period of the history of mathematics among historians of science. Trained in mathematics at Brooklyn College and Columbia University, he had received a Ph.D. degree in intellectual history in 1939 with a dissertation on "The Concepts of the Calculus." Originally published as a hardback, this work became better known in its Dover edition, especially after the title was changed to read *The History of the Calculus and its Conceptual Development*. Prior to the end of World War II, Boyer had contributed about a dozen notes and articles ranging over topics as diverse as "A Vestige of Babylonian Influence in Thermometry" to "Fundamental Steps in the Development of Numeration." These appeared in the

journals mentioned in the previous section—*Scripta Mathematica*, *Isis*, the *American Mathematical Monthly*, the *Mathematics Teacher*, and the *National Mathematics Magazine*—as well as more broadly based publications such as *Science* and the *Scientific Monthly*. He continued to contribute to these and other journals and produced three more books: *A History of Analytic Geometry*, published in the *Scripta Mathematica Studies* series in 1956, followed three years later by *The Rainbow: from Myth to Mathematics* (Yoseloff), and, in 1968, a *History of Mathematics* (Wiley). It was Boyer who, as book review editor of *Scripta Mathematica* from 1947 to 1970, sustained its historic component; as member of the Editorial Committee of *Isis* from 1954 to 1970 he represented mathematical interests in that group. In 1960, when the *Archive for History of Exact Sciences* was established, Boyer was appointed to its editorial board; he assumed editorial responsibilities for mathematics on the editorial board of the *Dictionary of Scientific Biography* in 1960 as well. He also served his professional organizations in other capacities: He was elected to the council of the History of Science Society (1943–1945 and 1950–1953), served as its vice president (1957–1958), and as vice-president of the American Association for the Advancement of Science (1958–1959); he contributed to the MAA and the NCTM, serving as secretary of the Metropolitan New York Section of the MAA from 1945 to 1947, and supporting publications in history in the NCTM yearbooks.

In the 1960s, two mathematicians, concerned about the decline of the level of research in the history of mathematics and the lack of appropriate journals for the field, set about to remedy the situation. The first was Clifford Truesdell, who established the *Archive for History of Exact Sciences*, published by Springer. It quickly gained a reputation for solid scholarship. In addition, it provided opportunity for publication of research papers exceeding the length allotted by most journals. The second man was Kenneth O. May. His goal was broader than the establishment of a research journal alone; he wished also to establish better communications among historians of mathematics about other matters of common interest. In 1971, the first volume of *Historia Mathematica*, now sponsored by the International Commission on the History of Mathematics, appeared. Bringing together among its editors and contributors individuals with primary strengths in mathematics, history, philosophy, and education, it set a new direction.

5. THE CONTEMPORARY SCENE: 1969–1989

During the last twenty years there has been a resurgence in the history of mathematics. This has involved a large number of individuals. What is

more interesting than the number of efforts is the fact that while few of the contributors consider themselves historians of mathematics exclusively, they include mathematicians as well as historians, historians of science, mathematics educators and philosophers. In contrast to the early decades of this century, one can no longer single out two or three "leaders" of the field. Instead, one finds numerous men and women pursuing research, teaching, and expository writing in many areas of the history of mathematics.

The resurgence has both positive and negative aspects. On the positive side, history is again finding a niche in the activities of the AMS and of other mathematical organizations. Since the mid-seventies, the annual meetings of the Society have featured historical topics with some regularity, whether in special sessions, in sessions of contributed papers, or as the choice of invited one-hour speakers. These contributions to the annual programs have drawn large audiences. Both the Society and the Association have re-established committees on history. The Society, the Association, and the Association for Women in Mathematics (AWM) have sponsored special programs and book-length publications in history. The return of the *Bulletin* to expository surveys, recent *Mathematics Magazine* policy statements stressing the desirability of historical articles, the popularity of historical notes and articles in the *College Mathematics Journal* and the *Mathematical Intelligencer* all suggest a renewed acceptance of mathematical history. *Historia Mathematica*, the *Archive for History of Exact Sciences*, and *Centaurus* provide the outlets for research articles that were in short supply in preceding decades. In recent years, *Isis* and other journals of the history of science community have had an increased number of articles dealing with post-1750 history of mathematics, largely with emphasis on surrounding social and cultural factors. Aside from numerous, sound biographic studies and historical analyses of mathematical topics, there has been a spate of collected papers, autobiographies, source books, and other book-length publications. The bibliographic abstracts in *Historia* and the *Mathematical Reviews* have greatly facilitated following the growing literature. Besides the Archives of American Mathematics at Texas described elsewhere in this volume, there are accessible collections of mathematical manuscripts and rare books at centers such as the Library of Congress, Brown, Columbia, Chicago, California, Cal Tech, Harvard, MIT, Michigan, and Wisconsin, to name only some of the major repositories. All of this, and the return of history of mathematics courses to the curriculum, especially in mathematics education, suggests a new growth phase in history of mathematics.

There are some other factors to be considered, however. Expository history has been encouraged in large part as a "royal road" to mathematics. At the same time, there is still a lack of institutional training grounds for

research in history of mathematics. Students who have located a mathematics or a history of science department, or an individual mentor, willing to support such research too often are hemmed in by methodological dogma. They might benefit from the wisdom of the French historian Marc Bloch (shot in 1944) who observed that “history seeks for causal wave-trains and is not afraid, since life shows them to be so, to find them multiple.” [Bloch 1964]. To avoid a repetition of the decline that history of mathematics faced fifty years ago, those working in the field may need to beware of both its popularity and its methodological champions. Perhaps it is not necessary to exclude historical references from the mathematics classroom in order to help eradicate the perpetuation of myths—a suggestion attributed to Gustav Eneström. But it may still serve us well to be guided by the spirit of that dedicated Swedish historian of mathematics, of whom Sarton said that “the very presence of Eneström obliged every scholar devoting himself to the history of mathematics to increase his circumspection and improve his work.” [Sarton 1923].

REFERENCES

- Aaboe, Asger. 1964. *Episodes from the early history of mathematics*. New York: Random House.
- Archibald, Raymond Clare. 1915. *Euclid's book on Divisions of figures with a restoration based on Woepcke's text and on the Practica Geometriae of Leonardo Pisano*. Cambridge: University Press.
- , 1932. Florian Cajori. *Isis* 17:384–407.
- , 1938. *A semicentennial history of the American Mathematical Society 1888–1938*. New York: American Mathematical Society.
- Bell, Eric Temple. 1945. Possible projects in the history of mathematics. *Scripta Mathematica* 11:308–316.
- , 1948. Cassius Jackson Keyser. *Scripta Mathematica* 14:27–33.
- Beman, W. W., trans. 1901. *Essays on the theory of numbers*. By Richard Dedekind. Chicago: Open Court.
- Benedict, Suzan R. 1909. The development of algebraic symbolism from Paciolo to Newton. *School Science and Mathematics* 9:375–384.
- Birkhoff, Garrett. 1935. Galois and group theory. *Osiris* 3:260–268.
- Bloch, Marc. 1964. *The historian's craft*. New York: Vintage Books. p. 194.
- Bôcher, Maxime. 1911. The published and unpublished work of Charles Sturm on algebra and differential equations. *Bull. Amer. Math. Soc.* (2) 18:1–18.
- Bochner, Salomon. 1966. *The role of mathematics in the rise of science*. Princeton: Princeton University Press.

Boyer, Carl B. 1939. *The concepts of the calculus*. New York: Columbia University Press.

Brasch, Frederick E. 1915. The teaching of the history of science. Its present status in our universities, colleges and technical schools. *Science* (ns) **42**:746–760.

Cajori, Florian, 1890. *The teaching and history of mathematics in the United States*. Washington, D.C.: Government Printing Office.

——, 1908. Arithmetik, Algebra, Zahlentheorie. In: *Vorlesungen über Geschichte der Mathematik*. Ed. by Moritz Cantor. **4**:37–198.

Eisele, Carolyn, 1950. Lao Genevra Simons. *Scripta Mathematica*. **16**:22–30.

Eves, Howard, 1964. *An introduction to the history of mathematics*. Rev. ed. New York: Holt, Rinehart and Winston.

Gauss, Carl Friedrich. 1902. *General investigations of curved surfaces*. Trans. by A. Hiltebeitel and J. Morehead. Princeton: University Library.

——, 1965. *General investigations of curved surfaces*. Trans. by A. Hiltebeitel and J. Morehead. New York: Raven Press.

Halsted, G. B., trans. 1902/3. Extract of 'Sketch of the origin and development of geometry prior to 1850' by G. Loria. *The Monist* **13**:80–120 and 218–234.

Higham, John with Leonard Krieger and Felix Gilbert. 1965. *History: The development of historical studies in the United States*. Englewood Cliffs, N.J.: Prentice-Hall.

Higham, John. 1970. The schism in American scholarship. Pp. 1f. in: *Writing American history. Essays on modern scholarship*. Bloomington, Ind.: Indiana University Press.

Hill, G. W., 1896. Remarks on the progress of celestial mechanics since the middle of the century. *Bull. Amer. Math. Soc.* (2) **2**:125–136.

Jackson, L. L. 1906. *The Educational significance of sixteenth century arithmetic from the point of view of the present time*. New York: Columbia University.

Jones, Phillip S. 1976. Louis Charles Karpinski, historian of mathematics and cartography. *Historia Mathematica* **3**:185–202.

Kline, Morris. 1953. *Mathematics in Western culture*. New York: Oxford University Press.

Kline, Morris. 1976. Carl B. Boyer. *Historia Mathematica* **3**:387–394.

Kuhn, Thomas S. 1971. The relations between history and the history of science. *Daedalus* **100** (Spring): 271–304.

Levey, Martin. 1955. Solomon Gandz. *Isis* **46**:107–110.

May, Kenneth O., ed. 1972. *The Mathematical Association of America. Its first fifty years*. np.: The Mathematical Association of America.

McCormack, Th. J., trans. 1898. *Lagrange's Lectures on elementary mathematics*. Chicago: Open Court.

Merrill, Helen A. 1903. "On solutions of differential equations which possess an oscillation theorem." *Trans. Amer. Math. Soc.* **4**:423–433.

Neugebauer, Otto. 1957. *The exact sciences in antiquity*. Second rev. ed. Providence, R.I.: Brown.

——, 1955. [Review]. *Isis* **46**:71.

Pitcher, Everett. 1988. *A history of the second fifty years. American Mathematical Society 1939–1988*. Providence: American Mathematical Society.

Porter, M. B. 1902. On the roots of functions connected by a linear recurrent relation of the second order. *Annals of Mathematics* (2) 3:55–70.

Price, Derek J. de Solla. 1967. A guide to graduate study and research in the history of science and medicine. *Isis* 58:385–395.

Robinson, Lydia G., trans. 1909. *Archimedes. Geometrical solutions derived from mechanics*. From the German translation by J. L. Heiberg. Chicago: Open Court.

Sarton, George. 1923. For Gustav Eneström's seventy-first anniversary. *Isis* 5:421.

——, 1927. *Introduction to the history of science. Volume I. From Homer to Omar Khayyam*. (Carnegie Institution of Washington. Publication no. 376). Baltimore: Williams & Wilkins.

——, 1956. Raymond Clare Archibald. *Osiris* 12:5–31.

Smith, David Eugene and Y. Mikami. 1941. *A history of Japanese mathematics*. Chicago: Open Court.

Stamper, Alva Walker. 1906. *A history of the teaching of elementary geometry*. New York: Columbia University.

Struik, D. J. 1940. *Math. Reviews* 2 no. 4: 113.

Toeplitz, Otto. 1963. *The calculus. A genetic approach*. Chicago: University of Chicago Press.

Tyler, H. W. 1910–1911. On the course in the history of mathematics in the Massachusetts Institute of Technology. *Bibliotheca Mathematica* (3) 10-11:48–52.

Wilczynski, E. J. 1902. Lazarus Fuchs. *Bull. Amer. Math. Soc.* (2) 9:46–49.

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Sources for the History of Mathematics in the Archives of American Mathematics

FREDERIC F. BURCHSTED

The *Archives of American Mathematics* (University Archives, University of Texas at Austin) is dedicated to the preservation of the American mathematical heritage for the use of mathematicians and historians of mathematics. The AAM serves as a national repository for papers of mathematicians and records of mathematical organizations for which preservation at the home institution is not available. The preservation of sets of papers, including correspondence, teaching materials, records of professional society affiliation, as well as manuscripts, is of the first importance in preserving the full record of American mathematics in its intellectual, institutional, and social contexts. The AAM is interested in hearing of collections needing preservation. Requests for information on any aspect of historical documentation in mathematics are welcome.

The AAM was initiated in 1975 with the preservation of the papers of H. S. Vandiver and Robert Lee Moore, the University of Texas number theorist and point-set topologist, at the University of Texas at Austin Humanities Research Center. The Vandiver and Moore papers were conceived as the starting point of an archival collection documenting the history of American mathematics. Papers of several prominent mathematicians were rapidly added, and in 1978 the Mathematical Association of America named the AAM as the official repository of its archival records. In 1984, custody of the AAM was transferred to the University of Texas at Austin University Archives where it now resides. Accounts of the establishment of the AAM have been published by Albert C. Lewis, the first curator (Lewis, 1978a, 1978b).



Left to right: Wilfrid Wilson, J. W. Alexander, W. L. Ayres, G. T. Whyburn, R. L. Wilder, P. M. Swingle, C. N. Reynolds, W. W. Flexner, R. L. Moore, T. C. Benton, K. Menger, S. Lefschetz. This picture was taken at the mathematical meetings in Cleveland, Ohio, December 1930.

(Photograph courtesy of the University of Texas at Austin, Archives.)

The bulk of the collection dates from after approximately 1920. Sources for earlier work include some notebooks of R. L. Moore (including diaries) from his graduate student years (1903–1905) at the University of Chicago, together with correspondence (1898–1920) with George Bruce Halsted and, in lesser amounts, with D. R. Curtiss, L. E. Dickson, E. H. Moore, E. B. Van Vleck, and others. The R. L. Moore papers include a collection of publications and clippings on G. B. Halsted. H. J. Ettlenger pursued his graduate studies at Harvard University (1910–1913), and the AAM has his student notebooks (7 in.) which record courses of G. D. Birkhoff, M. Bôcher, C. L. Bouton, W. E. Byerly, J. L. Coolidge, H. N. Davis, D. Jackson, W. F. Osgood, and B. O. Peirce. In the University of Texas University Archives, although not in the AAM, are Harvard University graduate student notebooks (1895–1898) of H. Y. Benedict, a University of Texas professor of applied mathematics and astronomy, on courses of M. Bôcher, W. E. Byerly, A. Hall, W. F. Osgood, and B. O. Peirce.

The AAM has particular strengths in several mathematical fields as follows:

Analysts represented include H. J. Ettlenger (1889–1986) and his students William T. Reid (1907–1977) and William M. Whyburn (1901–1972). The Ettlenger papers (1909–1979; 3 ft.) include teaching notes for University of Texas courses, and notes and technical reports concerning his aerodynamics work with the University of Texas Defense Research Laboratory. Also included are mimeographed lecture notes and handwritten notes on some lectures given in 1925 at the Massachusetts Institute of Technology on the operational calculus of Oliver Heaviside, a subject later used by Ettlenger in his own work. The papers (1926–1977; 28 ft.) of William T. Reid include some of Reid's notes made during his studies with Ettlenger and substantial quantities of notes and drafts related to his research on differential equations, calculus of variations, and optimal control. Also included are notes of his analysis seminars, some taught with G. M. Ewing, E. D. Hellinger, and W. T. Scott, at Northwestern University, University of Iowa, and University of Oklahoma. Reid's World War II work on ballistics and aerial photogrammetry is represented. The William M. Whyburn papers (1923–1970; 10 ft.) are dominated by his administrative work at Texas Technological College and the University of North Carolina, but also include some material on his differential equations research and his consulting work with the Air Force, Navy, and Oak Ridge National Laboratory. The papers (1951–1980; 6 ft.) of Charles B. Morrey, Jr. (1907–1984) contain records of his research in the calculus of variations and of his textbooks, written with M. H. Protter. The papers (1936–1986; 16 ft.) of W. F. Eberlein (1917–1986) include manuscripts and notes for papers on ergodic theory, mean value theorems, numerical integration, and functional and harmonic analysis, together with teaching notes. Papers (1915–1949; 5 in.) of Ernst D. Hellinger (1883–1950) are included in the William T. Reid papers and the Max Dehn papers. These are mainly

research and lecture notes, including work on the theory of spectra, on Hermitian operators in Hilbert space, and on Stieltjes continued fractions. The Otton Martin Nikodým papers (see below: **Mathematical physics**) contain material on measure theory and operators in Hilbert space. In a small collection (10 in.) of Abraham Robinson's (1918–1974) manuscripts are some items on nonstandard analysis. A film of the Conference on Orthogonal Expansions and their Continuous Analogues (Southern Illinois University, Edwardsville, 1968) is held. A small collection (1950–1967; 1 in.) of the papers of Louis L. Silverman (1884–1967), whose interest centered on divergent series, includes biographical clippings and three lectures in Hebrew.

Mathematical physics is represented by the papers of the relativity theorists George Yuri Rainich (1886–1968) and Alfred Schild (1921–1977). Rainich's papers (1941–1967, bulk: 1960's; 5 ft.) are largely notes for relativity seminars at the Universities of Michigan and Notre Dame, together with work for a projected book on relativity. Schild's papers (1944–1977; 21 ft.) contain notes and drafts for lectures and publications on relativity and gravitation, in particular, algebraically special solutions, quantization, conformal techniques, Fokker action principles, and string models of particles. There are also records of the preparation of his book *Tensor Calculus* (1949), written with J. L. Synge. The papers (1925–1974; 12 ft.) of Otton Martin Nikodým (1887–1974) contain notes and drafts for his *The Mathematical Apparatus for Quantum-theories* (vol. I, 1968), which utilizes a theory of operators in Hilbert space based on abstract Boolean lattices. The nearly finished manuscript for the unpublished second volume is included. The W. F. Eberlein papers (see above: **Analysts**) contain notes and drafts for works on models of space-time, relativity, and quantum mechanics, particularly internal symmetry and spinor analysis.

Number theory is represented by the correspondence files (1942–1988; 4 ft.) of Emil Grosswald (1912–) which include letters from P. Bateman, H. Rademacher, and C. L. Siegel, among many others. Records of Grosswald's editing of Hans Rademacher's *Collected Papers* and *Topics in Analytic Number Theory* are also included. The H. S. Vandiver (1882–1973) papers (1900–1965; 17 ft.) contain over 2300 letters written between 1910 and 1965, together with notes and drafts for publications, including his unfinished book on the history of Fermat's Last Theorem. A small collection (1904–1925; 3 in.) of Albert E. Cooper's (1893–1960) papers documents his involvement with the preparation of L. E. Dickson's *History of the Theory of Numbers*. Francis L. Miksa (see below: **Amateur mathematician**) also worked in number theory.

Rational mechanics is represented by papers (1939–1984; 18 ft.) of C. Truesdell (1919–). Truesdell's papers consist largely of manuscripts of his books and articles, texts of lectures, notes on his courses, notes taken by

Truesdell during his own education, and biographical material and reminiscences. There is an annotated item list prepared by Professor Truesdell.

Topology is a particular strength of the AAM. The papers (1898–1974; 32 ft.) of Robert Lee Moore (1882–1974) contain notes and drafts for his publications, over four feet of correspondence, and notes on his teaching. The AAM also holds the papers of R. H. Bing (1914–1986), R. G. Lubben (1898–1980), and Raymond Louis Wilder (1896–1982)—all students of R. L. Moore. The Bing papers (1948–1986; 4 ft.) consist largely of material from after his return to the University of Texas in 1973, and include manuscript material for his *The Geometric Topology of 3-Manifolds* (1983), records of the organization of several topology conferences and institutes, and records of his work in preserving the memory and papers of R. L. Moore. The R. G. Lubben papers (1922–1974; 6 ft.) include mathematical notes and manuscripts, together with his teaching notes. The R. L. Wilder papers (1916–1982; 19 ft.) stress his work on the foundations and history of mathematics, but there is a substantial quantity of correspondence, manuscripts, and research notes on topological subjects. A small quantity of papers (1948–1979; 20 in.) of the algebraic topologist Norman Earl Steenrod (1910–1971) includes a draft of his *Foundations of Algebraic Topology* (1952), written with S. Eilenberg, records of the preparation of *Reviews of Papers in Algebraic and Differential Topology, Topological Groups, and Homological Algebra*, and texts of several lectures. There are small collections of items documenting the careers of Clark M. Cleveland (1892–1969, papers: 1927–1930; 1 in.), another R. L. Moore student, and Albert W. Tucker (1905–, papers: 1946–1979; 5 in.).

Mathematical logic and foundations of mathematics are represented by papers of Jean van Heijenoort (1912–1986) and Raymond Louis Wilder (1896–1982). The Jean van Heijenoort papers (1946–1983; 16 ft.) include his published and unpublished writings, his notes and unfinished manuscripts, and his correspondence files, which include letters from A. Church, B. Dreben, K. Gödel, S. C. Kleene, R. Martin, C. D. Parsons, and W. V. Quine, among others. The Wilder papers (1916–1982; 19 ft.) contain material on his publications and courses on the foundations of mathematics and on his later work on the application of anthropological theory to the history of mathematics. Otton Martin Nikodým's interest in logic is reflected in his papers. The Abraham Robinson papers include manuscripts on mathematical logic and model theory.

The Robert E. Greenwood papers contain a collection of printed matter on the **history of computing and numerical analysis**, including technical reports by H. H. Goldstine, J. von Neumann, and others.

It is well-known that many **immigrant mathematicians** have made important contributions to American mathematics. The AAM holds papers (1899–1954; 15 in.) of Max Dehn (1878–1952), which contain notes, drafts of publications and lectures, and correspondence on geometry, topology, group

theory, and the history of mathematics. Dehn came to the United States in 1940. Material from Dehn's European and American years is included, with the bulk dating from 1921–1952. Otton Martin Nikodým (see above: **Mathematical physics**) came to the United States in 1948. Although little pre-1948 material is included, Nikodým maintained his ties with his European colleagues, and his correspondents include J. L. Destouches, M. Fréchet, H. Hasse, G. Ludwig, C. Y. Pauc, W. Sierpiński, and A. Tònolo. Emil Grosswald, Ernst D. Hellinger, George Yuri Rainich, Abraham Robinson, and Alfred Schild have already been mentioned. A small collection (1915–1917, 1930; 1 in.) of Eduard Helly (1884–1943) papers includes a manuscript of a published paper and some postcards dating from his World War I imprisonment in Siberia.

The papers (1937–1975; 40 ft.) of Francis L. Miksa (1901–1975), an **amateur mathematician** of Aurora, Illinois, comprise records of his work in problem-solving, magic squares, dyad squares, Pythagorean triangles, Stirling numbers, and several number theory topics. His magic squares work led to a group theory method for systematically constructing complete sets of magic squares without duplication. His correspondence documents his interaction with problem-solvers, other amateurs, and professional mathematicians including Leo Moser, with whom Miksa collaborated on several papers, and Robert E. Greenwood, who has donated his Miksa letters.

The institutional and social contexts of mathematics are important subjects for historical research which rely heavily on archival sources. The context of mathematical research is documented particularly in correspondence files, records of professional society affiliation, and departmental records.

Professional Societies. The AAM is the archival repository for the records of the Mathematical Association of America (MAA). The MAA Headquarters records (1916–1967; 7 ft.) include correspondence of, and biographical information on, past secretaries (1916–1976; bulk: 1916–1967), and records (correspondence, programs, photographs, newspaper clippings) concerning MAA conferences and annual meetings (1916–1960; bulk: 1930–1960). Records of the MAA History of American Mathematics in World War II Committee (1980–1981; 5 in.), and the William Lowell Putnam Mathematical Competition (1938–1980; 20 in.) are also held. The AAM holds records of the following MAA presidents: Raymond Louis Wilder (1965–1966), Henry L. Alder (1977–1978), and Dorothy L. Bernstein (1979–1980). There are also records of Emil Grosswald's work (1965–1977; 5 in.) with the Board of Governors and the Ford Award committee, and of Phillip S. Jones' work (1955–1967; 5 in.) with the Committee on Instructional Films and the Committee on Educational Media. Several of the sets of personal papers also contain files on MAA committee work.

Records of the American Mathematical Society include papers of the following presidents: R. L. Moore (1937–1939), R. L. Wilder (1955–1956), and Saunders Mac Lane (1973–1974).

Departmental records. Records of mathematics departments are included in several of the collections of personal papers, but the mathematics departments of the Universities of Michigan, 1928–1982 (R. L. Wilder papers), North Carolina, 1949–1971 (William M. Whyburn papers), and Texas, 1920–1986 (R. H. Bing, H. J. Ettlenger, R. G. Lubben, and R. L. Moore papers), are especially well-represented. H. J. Ettlenger and Albert C. Lewis's list of doctoral descendents of University of Texas at Austin mathematics faculty is available. The AAM has a copy of *The Princeton Mathematics Community in the 1930s: An Oral-History Project* (administered by Charles C. Gillespie, edited by Frederik Nebeker, 1985) which comprises transcripts of interviews with forty-three mathematicians. The C. Truesdell papers contain his reminiscences of the mathematics departments at Brown University (1942), and Princeton University (1944).

Mathematics education. Records of the MAA reflect the Association's interest in mathematics education. The AAM holds records (1958–1977; 130 ft.) of the School Mathematics Study Group (SMSG, the "New Math" movement of the 1960s) comprising the files of its director, Edward G. Begle, together with a collection of its textbooks. The records (1957–1976; 5 ft.) of the New Mathematical Library, edited by Anneli Lax, before it was taken over by the MAA are held. This was conceived as a monograph series to accompany the SMSG curriculum.

A small collection documents the founding of the Duke Mathematical Journal (1927–1934; 1 in.).

The AAM houses a considerable quantity of published and unpublished biographical sketches and portraits which are being indexed.

Fuller descriptions of most of the collections mentioned above are printed in Burchsted (1987). Complete inventories are available for several of the collections. New acquisitions will be announced in *Historia Mathematica*, *Focus*, *History of Science in America News and Views*, and the *History of Science Society Newsletter*. Inquiries are welcome and may be addressed to the archivist:

Frederic F. Burchsted, Archivist.

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REFERENCES

Burchsted, F. F., 1987. "Archives of American Mathematics," *Historia Mathematica* **14**, 366–374.

Lewis, A. C., 1978a. "Establishment of the Archives of American Mathematics," *Historia Mathematica* **5**, 340–341.

——, 1978b. "An Archive for American Mathematics," *The Mathematical Intelligencer* **1**, 175–176.