RANK AND FILE AMERICAN MATHEMATICIANS

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We present two lists of American mathematicians who prospered about 75 years ago:

National	Local
E. H. Moore	Joseph B. Reynolds
Leonard Dickson	Howard H. Mitchell
Oswald Veblen	Albert A. Bennett
R. L. Moore	John R. Kline
G. D. Birkhoff	Arnold Dresden

The names in the first column should be recognizable. These individuals formed the core of the American mathematical research community in the first half of the 20th century [39]. Most present-day historians would be hard pressed to identify the names in the second column. Consequently Webster's definition of rank and file pertains to them – individuals who constitute the body of a community as distinguished from its leaders.

However, the second column represents the community of college mathematics teachers whose duties and rewards were centered mostly on undergraduate teaching. This group is much harder to trace because of the small paper trail it leaves, yet by resourceful searches of the literature and university archives it is possible to paint a fairly vivid picture of their professional activities. Our examination of their lives and works will reveal numerous contributions to the American mathematical community. They deserve to be rescued from obscurity.

This quintet formed and fashioned the Philadelphia Section of the Mathematical Association of America (MAA) during the period 1926-1933. The first three founded the section; the other two nurtured it during its infancy. However, our purpose is much broader than describing the history of a section. For one, we uncover vital connections between this group and the national leaders in the first column. For another, we indicate how these five reflect major developments that took place in the American mathematical community from roughly 1900 to 1950. In particular, we show how the Moore Method developed in Philadelphia before it branched south to Austin.

This paper begins with a brief history of sections of the American Mathematical Society (AMS) and the MAA, including an account of the founding of the Philadelphia Section of the MAA. Then it describes the lives and contributions of the five individuals who were leaders locally but rank and file nationally. The biographical accounts of local leaders are adapted from [38].

Sections

Recall that the MAA was founded on the last two days of 1915. By contrast, the AMS got its start in 1888 as the New York Mathematical Society. The 27-year gap suggests that the need for a professional society catering to research occurred much earlier than an association addressing the needs of teaching. Initially the AMS was a local organization centered in New York, but the founding of three sections enabled it to spread its wings across the continent: Chicago in 1896, San Francisco in 1902, and Southwest in 1906.[1]

There was a much shorter gap between the birth of the MAA and the founding of its first sections – a matter of minutes. By the end of its first year, the MAA boasted six thriving sections. Another ten would come on board in the next decade [27].

However, up to 1926, every one of these sections was located in the South, Midwest, or West. Why did Eastern states feel such little need for separate sections? Had not the AMS originated in New York? Did the AMS, whose primary concern was research, sufficiently address the needs of college teachers?

MAA leaders answered with a resounding "No", yet they expressed apprehension about the lack of interest of their eastern colleagues. Both Herbert Slaught and W. D. Cairns showed concern about the "seeming apathy or lethargy" of mathematicians in the Atlantic States, who remained disinterested since the formation of Maryland-Virginia-DC Section in 1916 [27, p. 95].

That situation changed in 1925 when J. B. Reynolds of Lehigh University suggested the idea of forming a Lehigh Valley Section. However, Reynolds was unable to garner sufficient support for his idea. As Parshall and Rowe demonstrated so convincingly in their book, every professional organization needs a sufficiently large community to survive [29]. The missing piece to Reynolds' puzzle was a critical mass of individuals and institutions that would support his plan. He found them by looking south toward Philadelphia, a city with a population exceeding 2,000,000.

Toward the end of 1926, three individuals organized a meeting at Lehigh with the express purpose of forming an MAA section. To their delight, 20 people showed up and, after a morning of mathematical presentations, voted unanimously to petition to form the Philadelphia Section. At first MAA leadership opposed the name. One of the founders wrote:

> At the organizational meeting... a request for establishing the Philadelphia Section of the MAA was forwarded to Secretary Cairns. His first reaction was that the name was ill-chosen, since all the other Sections were named for States, and to name a section after so small a political unit as a city, would break sound precedent. I wrote back that Pennsylvania had two natural cultural centers, one at the extreme east (Philadelphia), the other at the extreme west (Pittsburgh). One could not expect much of an attendance at either of these places, from residents near the other. Philadelphia should attract persons from Eastern Pennsylvania, Delaware and southern New Jersey. Setting a new precedent might encourage the later founding of a Pittsburgh Section, attracting mathematical instructors from West Virginia and Eastern Ohio as well as from western Pennsylvania. Cairns and Slaught were not obstinate, and in December,

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[1] For the early history of these organizations, see pp. 3-9 of [2] for the AMS and pp. 18-21 of [16] for the MAA.

the Section was admitted under its proposed name, subject of course to the usual provision of By-Laws, etc., and promises of good behavior. [27, pp. 94-95]

We doubt whether the last part about "promises of good behavior" was actually stated. The author, A. A. Bennett, a decidedly colorful personality with a gift for captivating prose, was one of three founders of the section along with his Lehigh colleague J. B. Reynolds and H. H. Mitchell of the University of Pennsylvania. Just as Bennett so presciently predicted, the Allegheny Section was formed at the other Pennsylvania pole in 1933.

J. B. Reynolds (1881-1975)

Joseph Benson Reynolds was born in the western part of Pennsylvania. He graduated from high school at age 22, probably due to the need to work on the family farm. Upon graduation he crossed the state to enroll at Lehigh University, where he remained for the rest of his life.

Reynolds earned an A.B. degree in 1907. The title of his undergraduate thesis reflects an interest in applied mathematics, "The temperature compensation of the Bond sidereal clock of Sayre Observatory at Lehigh University". Reynolds accepted an instructorship at Lehigh upon graduation. He continued his studies while teaching, earning a master's degree in 1910. His master's thesis, "The determination of the elements of the orbit of a minor planet", carried a more serious astronomy theme. Incidentally, Lehigh's department was then called the Department of Mathematics and Astronomy. However, his doctoral dissertation, "The application of vector analysis to plane and space curves, surfaces and solids", submitted to Moravian College in 1919, reflects an evolving interest in pure mathematics.

As a tribute to his role in founding the Philadelphia Section, Reynolds presented the first invited lecture at the organizational meeting in 1926. The topic of his address – evolutes of certain plane curves – parallels the theme of his dissertation. Reynolds also served as chairman of the Section in 1938-1939.

What about his publications? This is where the MAA plays such a vital role as an outlet for college teachers. His first endeavor with a journal occurred when he proposed two problems for solution in the May 1915 issue of the *Monthly,* one on calculus and one in mechanics [30]. In the remainder of that year Reynolds was credited with solving three problems; his solution to a problem on mechanics posed by *Monthly* founder B. F. Finkel was published as the most elegant of the correct solutions received [31]. The following year Reynolds proposed three other problems and solved one more. But 1917 was a banner year for submissions to the Problems Department, as he was cited for 19 items – five posed problems, three solutions to problems posed earlier, four printed solutions, and seven solutions listed under "also solved by". His last solution appeared in 1965 [32], exactly 50 years after his first one. He was 84 years old at the time.

The *Monthly* accounted for almost all of Reynolds' publications, with roughly 90 of the 100 entries appearing in its Problems Department. Although there is sometimes a tendency among historians to criticize the problem orientation of early American mathematical journals, all five *of* our rank-and-file mathematicians contributed to the Problems Department of the *Monthly*.

The succession of Reynolds' other contributions to the *Monthly* traces his development as a mathematician. In his banner year of 1917 he published a small note in the Discussions Department [33]. However, it would be another six years before his first refereed paper would appear [35]. Altogether Reynolds published eight refereed articles in the *Monthly,* his last three appearing in Classroom Notes. His enduring interest in both pure and applied mathematics can be seen in a 1944 article [34] that dealt with a method for solving differential equations. Reynolds stated that his approach was appropriate for "every student who is trained for engineering or other scientific work" [34, p. 578]. Not all of his papers appeared in the *Monthly;* two were published in the *Tôhoku Mathematical Journal* and one in *Agricultural Engineering*.

Reynolds also wrote five textbooks. See Table 1. Although one was a standard calculus book, the other four were devoted to theoretical mechanics. The first of these, *Elementary Mechanics,* was revised six years after its initial publication. In between those editions he published *Analytic Mechanics* in 1931. It took eight more years to write *Forty Lessons in Analytic Mechanics.* His last book, *Elements of Mechanics,* was written with his colleague, G. E. Raynor. The proclivity toward applied mathematics might make Reynolds seem like an improbable candidate to found an MAA section, yet his interests parallel those of the first five presidents of the AMS, none of whom was a pure mathematician.

Books by J. B. Reynolds	Year
Elementary Mechanics	1928
Analytic Geometry and the Elements of Calculus	1930
Analytic Mechanics	1931
Forty Lessons in Analytic Mechanics	1939
Elements of Mechanics	1943

Table 1

Reynolds died in Wilmington, Delaware, in 1975 at age 94. His example shows a competent teacher and administrator who, though he found some time for original investigations, contributed mainly to the Problems Department of the *Monthly.* His shared interests with astronomy and applied mathematics hearken back to an earlier period in the history of mathematics in America.

The second founder of the Philadelphia Section is a mathematician with a more traditional record and a blue blooded academic heritage.

H. H. Mitchell (1885-1943)

Mitchell was born in Marietta, Ohio, in 1885. He attended local schools, graduating from Marietta College in 1906 with a Ph.B. degree. (No longer in use, Ph.B. is the abbreviation of the Latin expression for Bachelor of Philosophy.) Mitchell then enrolled in the graduate program at Princeton. He held a university fellowship there from 1908 to 1910, when he became Oswald Veblen's first Ph.D. graduate. His dissertation was published in the *Transactions of the American Mathematical Society* in 1911 [23]. Upon graduation, Mitchell was appointed an instructor in mathematics at Yale University, where he remained for only one year. He then accepted the same position at the University of Pennsylvania, where he taught for the rest of his life and supervised five Ph.D. dissertations. During World War I he served as a ballistician under Oswald Veblen at Aberdeen Proving Ground.

Howard H. Mitchell held office in both the AMS and the AAAS. He was on the Board of Trustees (now the Council) of the AMS from 1921 through 1923. He also was elected Vice President of the AMS in 1932 and 1933, and Vice President of AAAS in 1932. In addition, he served a six-year stint as editor of the *Transactions* from 1925 through 1930.

In addition to Veblen, another link to the University of Chicago occurred in 1911 when R. L. Moore, like Veblen a former student of E. H. Moore, accepted a position at The University of Pennsylvania at the same time as Mitchell. Today R. L. Moore is widely known for his method of teaching and for his contributions to topology. Up to that point, however, Moore had not published very much. Yet the University of Pennsylvania offered both instructors a most stable and substantial environment, and they prospered in Philadelphia. By the time Moore left for Texas in 1920, he had progressed from a promising mathematician to one of recognized stature. It is known that his manner of teaching exerted a dominant influence on his students. Mitchell's case shows that Moore played a similar role with some of his colleagues too. Moore's second Ph.D. student, G. H. Hallett, Jr., took courses from both Moore and Mitchell. After recalling Moore's course in an interview with D. Reginald Traylor in 1971, Hallett commented:

> One other course I took at the same time was somewhat similar. It was taught by Professor Mitchell, whom I liked very much. He took a book, I think it was by Dr. Pierpont, in the area of functions of a real variable. I guess Professor Mitchell had found on inspection that not all of Professor Pierpont's proofs held up, so the way he taught this course in that subject, he gave us this book, but asked us to go through all the proofs that were given and find out whether they were watertight proofs or not and if not, why not. This course had many elements of the other Course. [36, p. 85]

We will return to that other course shortly.

Mitchell's publication record was not prodigious; we have been able to locate only 11 items, including his dissertation cited above and his printed solution to a *Monthly* problem [26]. Between 1913 and 1918 he published seven important papers in three of the country's leading journals: two in the *American Journal of Mathematics,* one in the *Annals of Mathematics,* and four in the *Transactions of the American Mathematical Society.* Two appeared after that, an article on ideals in quadratic fields from 1926 [25], and his, final paper, which appeared in 1935 and hearkened back to his initial investigations on group theory and projective geometry [24]. Overall, Mitchell published in four of the five available journals in America. Table 2 provides reference to one paper from each journal.

Some Papers of H. H. Mitchell	Journal	Year
Finite quaternary linear groups	Transactions	1913
Primitive collineation groups	American Journal	1914
Congruence in a Galois field	Annals	1917
Linear groups and finite geometries	Monthly	1935

Table 2

Howard H. Mitchell died in 1943 at age 58. His 1926 paper in the *Annals* was sandwiched between articles by two of the towering figures in American mathematics,

Marshall Stone and Oswald Veblen. [39] The third rank-and-filer was another protégé of Veblen.

A. A. Bennett (1888-1971)

Albert Arnold Bennett was a colorful personality who lived in the Philadelphia area on two separate occasions totaling only eight years, yet he made vital contributions to the MAA section. Bennett was born in 1888 in Japan, where his parents were missionaries. At the age of 14 he came to Providence, RI, to live with relatives and complete his education. He earned two degrees from Brown University, an A.B. in 1910 and an Sc. M. in 1911. That fall he entered the graduate program in mathematics at Princeton University. Just a few months earlier Howard Mitchell had received his Ph.D. from Princeton and was in transit to a position at Yale, so it appears that Mitchell and Bennett missed each other on the first part of Bennett's initial residence in the area.

Bennett earned a Ph.D. in 1915 for a dissertation written under Oswald Veblen, who had also been Howard Mitchell's supervisor. Bennett's dissertation, like Mitchell's, dealt with algebra and projective geometry. It appeared in the *Annals* in 1915 [3]. Although only 21 pages long, the paper accounted for over 10% of the 196 pages in that volume of the journal for the years 1914-1915. That this beginner would be accorded such a reception might be due to the fact that Veblen was one of the six editors, as were Veblen's colleagues Eisenhart and Wedderburn. Moreover, Bennett published three papers in the volume for 1916-1917, all on topics in analysis. Overall his three papers and one note account for 47 of the 217 pages, over 20%.

Clearly Bennett's star was rising. He stayed at Princeton as an instructor until the fall of 1916, when he accepted an adjunct professorship at the University of Texas. Austin would serve as his home base for the next nine years. Before leaving Princeton, however, he submitted two more papers to the *Annals* that appeared during his first year at Texas. Although he was 26 years old when he moved to Austin, patriotism compelled him to enlist in the Army. After enrolling in an Officer's Training program, he was assigned to Leon Springs, Texas, and Fort Monroe, Virginia. In August 1917 he was commissioned a Captain in C.A.R.C. The following June, he was transferred to the Ordnance Corps. A recent' investigation located him in Oswald Veblen' s ballistics research staff at Aberdeen Proving Ground, where he served with Gilbert Bliss and Norbert Wiener [15]. Bennett was honorably discharged in January 1919. Nonetheless, while continuing to teach at Texas, he served as a civilian "mathematician and dynamics expert" with the Ordnance Corps from June 1919 to September 1921. During this time he wrote a book on ballistics that was initially classified "Confidential; for official use only" [8]; the Ballistics Research Lab at Aberdeen deemed his tables important enough to reproduce in 1954 [5].

The time Bennett spent in World War I undoubtedly accounts for a three-year gap in his publication record in the *Annals* between 1917 and 1920. However, like many mathematicians caught up in war, Bennett did not let military service entirely interfere with his studies. The author of a 1918 paper in the *Bulletin of the American Mathematical Society* is listed as Captain Albert A. Bennett, C.A.R.C. To emphasize his status and the isolation of his outpost, the concluding paragraph reads, "This treatment is believed to be original, but

the literature available for examination by the author is that customary to an army post, 'somewhere on the Gulf of Mexico,' – nil" [4, p. 479].

Apparently the holdings in Bennett's Gulf of Mexico outpost were not as barren as one might conclude from this statement. An examination of the *Monthly* reveals another source of mathematical activity – problems – the kind of pursuit that can be completed in short bursts of activity, unlike the sustained periods of intense mental concentration needed for deep research projects. From January 1917 to March 1918 Bennett was a regular contributor to the Problems Department, proposing seven and solving six others. All of these contributions came from the areas of algebra, number theory, and geometry. Curiously, the published solution to a geometry problem he posed was due to J. B. Reynolds, who would found the Philadelphia Section with Bennett almost ten years later [10]. Bennett's posed problem in the September 1918 issue lists his address as Galveston, thus defining his whereabouts "somewhere on the Gulf of Mexico" [7].

In the fall of 1921, his war duties completed, Bennett resumed his career at Texas. He became active in the MAA right away, being elected a member of the Council (today's Board of Governors). The following year he was elected a trustee of the MAA, appointed to its Committee on Publications, and became editor-in-chief of the *Monthly.* He was elected Vice-President of the MAA in 1925 while at the same time serving as chairman of the Texas Section of the MAA. He had to forego that position when he accepted the position of Professor and Head of the Department of Mathematics and Astronomy at Lehigh University in 1925. He held the Lehigh post for only two years before returning to his *alma mater,* Brown University, where he remained for the rest of his life.

How did the moves from Austin to Bethlehem to Providence affect his output? Initially, not very much. Bennett resumed publication in the *Annals* after returning to Texas, with six major articles appearing from June 1920 to June 1926. Although he never published in his favorite research journal again, he did contribute to the *Monthly.* Beginning in the early 1920s he became a regular contributor to its Questions and Discussions Department, an activity indicating an interest in pedagogy and the curriculum. However, Bennett's publication record at Lehigh was negligible, consisting of a minor paper in the *Annals* and three notes in the Questions and Discussions Department of the *Monthly.* Although his output increased when he reached Brown, the articles were mostly minor and short. Two stand out, however. One presented a brief history of the MAA up to World War n that was based on an address delivered at the 1965 summer meeting of the MAA [6].

The other is a *Monthly* piece on teacher training based on an invited address delivered at the 1938 joint MAA-NCTM meeting. [9] Bennett was assigned the topic of methodology but he protested, "Common decency suggests that the college professor either make a careful study of the problem of teacher preparation or refrain from making judgment" [9, p. 214]. That marked the end of common decency; in its place came a steady flow of "ungracious words" on issues related to teacher preparation. Should mathematics departments offer courses in methodology in the standard curriculum? Bennett replied in the positive, preferring a course on how to teach factoring instead of drill books. (He cited Granville's *Calculus* as an example of the latter.) He continued, "What of the future high school teacher who finds little significance in differential equations and Fourier series as these are taught, and could never even pass a respectable course in real variable theory. Is he a better teacher of high school mathematics for being rejected by the mathematics department and turned over to others to train?" [9, p. 215]. On a roll now, Bennett was unable to refrain

from characterizing most of his colleagues as improper role models for teaching. He wrote, "Some professors have atrocious table manners, or are extremely slovenly as to dress, or succeed very poorly in transmitting and evoking ideas in the classroom. But such disagreeable details are often condoned in the presence of more valued attributes" [9, p. 216]. It seems as if the central role of research in universities has not changed since the 1930s. Might there be a ray of hope with new doctorates who flooded the market in that decade? "The most supercilious, impatient, sarcastic, unprepared, and easily routed teacher is likely to be the young Ph.D. in his first teaching assignment" [9, p. 221].

Although in his 50s, the patriotic Bennett again joined the Army when World War II broke out, serving in the Ordnance Corps at Aberdeen from 1942 to 1946, during which time he was promoted from Major to Lieutenant Colonel. Once again he served under Oswald Veblen. One of the more illustrious young mathematicians to work in the Ballistics Research Laboratory under Bennett was Herman Goldstine, who, in a 1985 interview, described his boss in most ungracious terms: "From time to time I was very impatient of Albert Bennett, who was a nice old gentleman – but he was a very precise, methodical, plodding person who drove me up the wall" [37].

Bennett retired as emeritus professor from Brown in 1958. He died in 1971 at age 82, having been a member of the MAA for all of its 55 years.

In Bennett's address on teacher training he cited one textbook for presenting the appropriate spirit of mathematics. One of the authors of that book is our next rank-and-filer, J. R. Kline, who, for reasons we explain below, was not one of the founders of the Philadelphia Section.

J. R. Kline (1891-1955)

John Robert Kline was the most influential mathematician in the Philadelphia area during the 1920s. He should be much better known in the history of mathematics for two reasons – his relationship with R. L. Moore and his support for African-American students at a time when such encouragement was unusual.

J. R. Kline was born in 1891 in Quakertown, near Philadelphia. He obtained an A.B. in 1912 from Muhlenberg College and then went directly to the University of Pennsylvania. Recall that two instructors at the University of Pennsylvania at that time were H. H. Mitchell and R. L. Moore. Apparently Kline took two courses with Moore – Foundations of Mathematics, and a sequel called Theory of Point Sets. Beyond these, individual study was the fashion, with Moore encouraging his better students to work with him. Kline was the best. He obtained a master's degree in 1914 and a Ph.D. two years later. His dissertation was published in the *Annals* in September 1916 [17]. Kline acknowledged his mentor by stating, "I wish to express my deep gratitude to Professor Robert L. Moore, who suggested the problem of this paper and aided me continually in its preparation" [17, p. 31].

Upon receiving his degree, Kline accepted an instructorship at The University of Pennsylvania so he could continue his studies with Moore. He left The University of Pennsylvania in 1918, but after spending one year at Yale and one at the University of Illinois, he returned in 1920 to replace Moore, who had accepted a professorship at Texas. Although Moore remained at Texas and Kline at The University of Pennsylvania for the rest of their lives, the archives at the University of Texas contain a steady stream of letters between the two, and each sent students to study under the other, either during their graduate studies or as post-doctorates.

The correspondence between Kline and Moore never addressed the origins of the famous Moore Method of teaching mathematics. More than likely, Moore's techniques evolved over time, but we supply four bits of evidence to suggest that he developed his method for teaching axiomatic systems, particularly topological spaces, during his tenure at The University of Pennsylvania. We already cited his influence on Mitchell. A second bit of evidence comes from the dissertation topics of Moore's Ph.D. students, with those at Texas in the 1920s being very similar to his three University of Pennsylvania students. Knowing how Moore directed his students from basic axiomatic systems and initial results to doctoral dissertations, it is easy to project backwards to conclude that he developed this same system for J. R. Kline, George H. Hallett, Jr., and Anna Mullikin.

The University of Pennsylvania course catalogs provide additional evidence. When Moore first went there in 1911 the Foundations of Mathematics course was described as follows:

> The theory of positive integers as a basis for analysis. Rigid motion and correspondence with a number manifold as factors in determining the properties of space. Metrical and non-metrical spaces. A critical study of interrelations between different systems of axioms.

The next year Moore introduced the new course Theory of Point Sets, whose description reads:

> Theory of sets of points in metrical and in non-metrical spaces. Contributions of Fréchet and others to the foundations of point set theory. Content and measure. Jordan curve theory and other applications.

Moore taught these two courses throughout his tenure at The University of Pennsylvania, alternating them from year to year. They formed the basis of the Moore Method.

Interviews conducted by D. Reginald Traylor in 1971 with Hallett and Mullikin provide the final bit of evidence that the Moore Method originated in Philadelphia. Hallett stated:

> He taught in a very remarkable way. He didn't give us any books. We didn't consult books at all in that course. It was a course in point set theory and he gave us certain axioms to start with and then we were asked 'at the beginning to prove certain theorems that we were told were true, given those axioms. We would work on the proofs and come back into class and he would ask how many people had the proofs and those who said yes were given a chance, at least one or two of them, to give their proofs. And the other members of the class listened carefully to see if they made any mistakes and if a member of the class thought so, he would speak up and say why. [36, pp. 84-85]

Moore recruited his best students from his two alternating courses. A fellow junior faculty member likened him to a football coach, saying, "He was always recruiting people" [36, p. 87]. One of the recruited mathletes was Mullikin, who stated:

He had his work all published, you see, and people would go and look it up in the library and he didn't want them to do that. He wanted them to work it out themselves. And he put them out of class if he found out that they were cheating. (In one class) there were three of us, but he put everybody out but me. One was a Catholic nun and she tried to get help from me and he put her out. He said that if she needed help she didn't belong in his class. [36, p. 87]

These statements by Hallett and Mullikin contain most of the elements of the Moore Method, which Moore had developed at The University of Pennsylvania beginning with his first doctoral student, J. R. Kline. At The University of Pennsylvania Kline served as chairman of the department from 1928 until his untimely death in 1955. He took several leaves of absence, including one to Göttingen in 1925-1926 as a Guggenheim Fellow. This explains why he was not one of the founding members of the Philadelphia Section. However, he played an active role thereafter, being elected secretary-treasurer for 1927-1928 and chairman for 1932-1933.

During his tenure at The University of Pennsylvania, Kline directed 19 doctoral dissertations. His first graduate, in 1925, was longtime MAA secretary-treasurer Harry Gehman. Kline was a particularly fair and unbiased man who, unlike his academic father, R. L. Moore, permitted any qualified candidate to study under him. Two cases are particularly noteworthy. In 1928 he supervised the doctoral dissertation of Dudley W. Woodward, who became the second African-American student to receive a Ph.D. in mathematics in the United States. William Claytor became the third when he completed his dissertation under Kline in 1933.

J. R. Kline became a respected member of the international mathematical community, publishing four papers in the Polish journal *Fundamenta Mathematicae* and three in the *Proceedings of the National Academy of Science.* Moreover, Kline wrote a joint paper with his advisor, the only publication Moore ever coauthored [28]. (This is not particularly surprising in light of the extreme individual competitiveness that underlies the Moore Method.) Most of Kline's publications appeared from the time of his dissertation in 1916 to a long paper on separation axioms in topology in 1928 [19]. Administrative duties demanded most of his time and attention after that.

For our purposes, Kline's [mal paper holds inherent interest. He had become deeply involved with education, particularly graduate studies, and in late November 1945, six months after VE Day, he presented his views on rebuilding graduate work in an address at the annual MAA meeting in Chicago. His remarks were published the following March [18]. Kline felt strongly that it was incumbent upon the country to resuscitate its graduate programs. He began his remarks by examining the production of Ph.D.s in mathematics from 1900 to 1944. Not surprisingly there was a very rapid decrease from 104 in 1941 to 39 in 1944. Kline then recalled the deleterious effects of the Draft Board, which granted no deferments for mathematicians and graduate students until July 1942, and only then for those teaching at least 15 hours per week. Yet even that deferment was abolished within two years. Because of this, at the end of the war the country found itself with only 1675 Ph.D.s among 4600 college teachers at the rank of instructor or above. Moreover, due to the GI Bill, enrollments in the fall of .1945 tripled. After citing some egregious conditions that had to be

changed – frozen salaries, high teaching loads, and a need for "re-conditioning" of researchers resuming their careers – Kline called for two immediate initiatives[2]:

- Preferential demobilization.
- The establishment of fellowships for three classes of students:
    1.   postdoctoral students (like the NRC formerly administered),
    2.   full-time graduate students, and
    3.   superior undergraduates.

Kline died in May 1955 at age 63. Twelve years earlier the MAA had formed a Subcommittee (of the MAA War Preparedness Committee) on Available Teachers in College Mathematics. This subcommittee compiled and maintained a register of vacancies and availability of mathematicians for service throughout the war. Kline was one of its three members. So was our final rank-and-filer, Arnold Dresden, who, like Kline, resided in Swarthmore.

Arnold Dresden (1882-1954)

Arnold Dresden was born in the Netherlands and initially received his education there, but after three years at the University of Amsterdam he sailed to the United States in 1903 to help a friend in Chicago. Against his parents' wishes, he used tuition money for the boat passage to New York. He arrived in Chicago on his 21st birthday. During his first two years in his adopted land, he worked at various jobs, including stacking merchandise at Marshall Fields wholesale warehouse at $10 a week. He also taught six classes at the high school associated with the University of Chicago, called the Laboratory School, a task he faced with grave misgivings, not because of the long hours but because of anticipated poor behavior by the students. He stated, "In Holland we tortured our teachers." Yet in America he had no trouble maintaining discipline.

By 1905 Dresden scraped together enough money to enroll at the University of Chicago. He received his Ph.D. in 1909 under Oskar Bolza with a dissertation on the calculus of variations. Upon graduation he accepted an assistant professorship at the University of Wisconsin, where he remained until 1927. A naturalized citizen since 1913, Dresden felt obligated to volunteer during World War I, so he sailed for France in September 1918 and spent one year working for the Red Cross.

The May 1927 *Monthly* heralded his arrival in the Philadelphia area nine months after the MAA section was founded. "Professor Arnold Dresden of the University of Wisconsin has been appointed professor of mathematics at Swarthmore College. An interesting feature of his work in that college will be in connection with the honors course for juniors and seniors" [20, p. 277]. Dresden described this course in a 1931 lecture to the Philadelphia Section of the MAA. Minutes from that meeting record only that he gave "an account of the way in which this plan [for honors work] is realized, particularly in mathematics and the natural sciences" [11]. Fortunately the *Monthly* note supplies more details:

> Students in that course are not obliged to attend classes, are free to work at tasks
> assigned to them on which they have conferences with their instructors as often as

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[2] The first was never realized, however the second was with the establishment of the NSF.

may seem desirable. No grades or records are kept during these two years. At the end of the senior year they have to take a comprehensive examination covering the work of these two years and conducted both in oral and written parts by an outsider. [20, p. 277]

The honors program that Dresden designed required students to complete four seminars in mathematics and two seminars in each of two minors. That was the student's whole course load during the last two years. External examiners conducted all assessment in honors. That is still the case today. Although parts of the system have been drastically revised, external examiners remain an integral part of the program.

Arnold Dresden was one of the most respected and effective leaders in both the AMS, and the MAA. He became actively engaged with the nascent Philadelphia Section as soon as he set foot in the area. Two months after arriving at Swarthmore in September 1927, he presented an invited lecture, "On matrix equations", reporting on a method developed by his Wisconsin colleague W. E. Roth to determine solutions of polynomial matrix equations in which the constant term is missing. At the same 1927 meeting he was elected to the Section's Program Committee; he would be elected again in 1939. He also was elected chair of the Section for 1931-1932 and 1940-1941. Recall that J. R. Kline was chair 1932-1933. During Dresden's first summer in the east, in 1928, he taught summer courses at The University of Pennsylvania with both Kline and Mitchell.

Dresden was an early, ardent supporter of the MAA. In 1915 he sent a strong letter of support for the idea of forming such an Association to Herbert Slaught, who was trying to gauge the degree of backing for the idea that took root at the end of the year. However, it wasn't until his move to Swarthmore that Dresden became active with the Association, beginning with a paper he delivered at the annual meeting in 1927. He was elected vice president for 1931; A. A. Bennett followed him in 1933 and 1934. Dresden was elected president for 1933, succeeding E. T. Bell.

Dresden began his publishing career in 1907 while a graduate student at Chicago with two papers on the calculus of variations in the *Monthly*. Part of his dissertation appeared in the *Transactions* the following year [14]. Further advances would occur in papers that appeared in 1916, 1917, and 1923. In the latter year he also published two papers on symmetric forms in *n* variables. But from that time on, with only a few exceptions, all future contributions seem to appear in the *Monthly's* Problem or Discussions-Questions Departments.

One exception is notable because it reflects Dresden's deep concern for mathematical education in the country. At the 1934 annual AMS-MAA-AAAS meeting he titled his retiring presidential address, "A program for mathematics". It appeared in the *Monthly* the following April [12]. Dresden had become concerned about the state of teaching of mathematics, but more generally he was concerned about the place of mathematics in the general culture and about the mathematical community's laissez-faire attitude toward the role it should play. He wrote, "It is my firm conviction that both the content and the spirit of mathematics have a great deal to contribute to the education of the individual" [12, p. 200]. Anticipating the basic term used by J. R. Kline for graduate work, Dresden spoke about "the rehabilitation of our subject" [12, p. 199]. To address his concerns he proposed a tripartite program for mathematicians by sketching ideas he felt could serve as guidelines. Along the

way he addressed how mathematicians draw conclusions, and this led to discussions about intuition vs. deduction and existence theorems vs. constructive algorithms.

A recurring theme in Dresden's program is his belief that abstract concepts can be grasped by young people. He practiced what he preached, as evidenced by his 1936 book, *An Invitation to Mathematics* [13]. Although ostensibly aimed for a liberal arts audience, the contents include the number system, point set theory, types of infinity, foundations of geometry, non-Euclidean geometry, analytic geometry, projective geometry, calculus, differential equations, vector analysis, and theory of numbers. While few of these topics are ever broached in liberal arts courses, a reviewer concluded that due to Dresden's original approach, "incredible as it may appear, 'the preparation that is indispensable for the use of this book does not exceed what is furnished by a good high school course in algebra and in plane geometry'" [21].

At Swarthmore, as at Wisconsin, Dresden was known as much for his musical talent and interests as for his mathematics; his Monday evening chamber music sessions at Swarthmore were celebrated. Swarthmore students adored him. The alumni magazine gushed, "Of all the people on Swarthmore's faculty, one of the most beloved is a man who could easily be mistaken for Santa Claus, both in spirit and in the flesh." When asked about the history of his beard, called "the finest hirsute adornment on campus", Dresden replied, "Why, I've had it ever since I was born" [1].

Dresden resided in the town of Swarthmore from the time of his appointment in 1927 until his death in 1954 at age 71. He had retired from active teaching just two years earlier.

Summary

We have described the lives and works of five mathematicians who prospered roughly from 1900 to 1950. Three of them founded the Philadelphia Section of the MAA in 1926 – J. B. Reynolds, H. H. Mitchell, and A. A. Bennett. The other two guided the local section through its infancy. Although all of them were leaders of the section, they qualify as rank and file mathematicians on a national scale. Table 3 shows that they were born in one ten-year period and received their doctorates within a decade of each other.

	Birth	Death	Ph.D.	Institution	Supervisor
Reynolds	1881	1975	1919	Moravian	N/A
Mitchell	1885	1943	1910	Princeton	Veblen
Bennett	1888	1971	1915	Princeton	Veblen
Kline	1891	1955	1916	Pennsylvania	R. L. Moore
Dresden	1882	1954	1909	Chicago	Bolza

Table 3

The three founders were quite different. Reynolds was interested in applications of mathematics to astronomy, mechanics, and engineering. Mitchell was a specialist in group theory. Bennett switched from being primarily a researcher to an administrator with a strong interest in educational issues, particularly teacher training. Kline and Dresden were alike; not only did they live in the same small town of Swarthmore, but they developed deep concerns for the state of mathematics education in America, Kline at the graduate level and Dresden the undergraduate. Dresden designed a program for honors students at Swarthmore College

that served as a model for highly selective, small, liberal arts colleges. Kline suggested initiatives for rehabilitating graduate education after World War n that were realized shortly with the advent of the National Science Foundation.

Reynolds had no ties to national leadership but the other four had direct links to the Chicago school of mathematics initiated by E. H. Moore in 1892. Mitchell was Oswald Veblen's first Ph.D. student at Princeton, Bennett his fourth, and both worked with Veblen at Aberdeen during the world wars. Kline, R. L. Moore's first doctoral student, played a pivotal role in the genesis of the Moore Method in Philadelphia. Finally, although Dresden graduated under O. Bolza, it was E. H. Moore's interests in undergraduate education that saw light of day with Dresden's program at Swarthmore and his proposed program for liberal-arts mathematics.

No professional organization can survive without a significant community of rank and file participants who are receptive to the work of the leaders and who are willing to participate in all aspects of the organization. Our quintet played this role for the AMS. While they might have stood on the lower rungs of the AMS ladder, they ascended to the upper rungs of the MAA, holding some positions of leadership and contributing notable papers to its journals. Locally, they stood on the top rung of the Philadelphia Section. The American mathematical community benefited greatly from their efforts, and they deserve to be rescued from their present obscurity.

References

1. Anon, Dresden: Mathematics and the man, *The Garnet Letter,* February 1950, pp. 5, 10.
2. R. C. Archibald, *A Semicentennial History of the American Mathematical Society, Vol. I, History,* American Mathematical Society, New York, 1938.
3. Albert A. Bennett, An algebraic treatment of the theorem of closure, *The Annals of Mathematics* **16** (1914-1915), 97-118.
4. Albert A. Bennett, An elementary derivation of the probability function, *Bulletin of the American Mathematical Society* **24** (1918), 477-479.
5. Albert A. Bennett, *Bennett Tables for Interior Ballistics by the Method of Albert A. Bennett,* Aberdeen: Ballistics Research Laboratory, 1954.
6. Albert A. Bennett, Brief history of the Mathematical Association of America before World War II, *American Mathematical Monthly* **74** (1967), Part II: Fiftieth Anniversary Issue, 1-11.
7. Albert A. Bennett, Problems and solutions, *American Mathematical Monthly* **25** (1918), 302.
8. Albert A. Bennett, *Tables for Interior Ballistics,* Washington, DC: Government Printing Office, 1923.
9. Albert A. Bennett, The college teacher of mathematics looks at teacher training, *American Mathematical Monthly* **46** (1939), 213-224.
10. Albert A. Bennett and Jos. B. Reynolds, Problems and solutions, *American Mathematical Monthly* **24** (1917), 469.
11. P. A. Caris, The sixth annual meeting of the Philadelphia Section, *American Mathematical Monthly* **39** (1932), 61-62
12. Arnold Dresden, A program for mathematics, *American Mathematical Monthly* **42** (1935), 198-208.
13. Arnold Dresden, *An Invitation to Mathematics,* New York: Henry Holt and Co., 1936.
14. Arnold Dresden, The second derivatives of the extremal-integral, *Transactions of the American Mathematical Society* **9** (1908), 467-486.
15. David Alan Grier, Dr. Veblen goes to war, *American Mathematical Monthly* [to appear].

16. Phillip S. Jones, Historical background and founding of the Association, in [22], pp. 1-23.

17. J. R. Kline, Double elliptic geometry in terns of point and order, *Annals of Mathematics* **18** (1916), 31-44.

18. J. R. Kline, Rehabilitation of graduate work, *American Mathematical Monthly* **53** (1946), 121-131.

19. J. R. Kline, Separation theorems and their relations to recent developments in analysis situs, *Bulletin of the American Mathematical Society* **34** (1928), 155-192.

20. H. W. Kuhn, ed., Notes and news, *American Mathematical Monthly* **34** (1927), 275-280.

21. H. F. Mac Neish, Reviews, *American Mathematical Monthly* **44** (1937), 324.

22. Kenneth O. May, ed., *The Mathematical Association of America: Its First Fifty Years,* Washington, DC: MM, 1972.

23. Howard H. Mitchell, Determination of the ordinary and modular ternary linear groups, *Transactions of the American Mathematical Society* **12** (1911), 207-242.

24. Howard H. Mitchell, Linear groups and finite geometries, *American Mathematical Monthly* **38** (1931), 295-297.

25. Howard H. Mitchell, On classes of ideals in a quadratic field, *The Annals of Mathematics* **27** (1926), 297-314.

26. Howard H. Mitchell, Problems and solutions, *American Mathematical Monthly* **38** (1931), 295-297.

27. Harriett F. Montague, The sections, in [22], pp. 78-103.

28. R. L. Moore and J; R. Kline, On the most general plane closed point-set through which it is possible to pass a simple continuous arc, *Annals of Mathematics* **20** (1919), 218-223.

29. K. H. Parshall and D. E. Rowe, *The Emergence of the American Mathematical Research Community, 1875-1900: J. J. Sylvester, Felix Klein, and E. H. Moore,* American Mathematical Society, Providence, 1994.

30. J. B. Reynolds, Problems and solutions, *American Mathematical Monthly* **22** (1915), 61-62.

31. J. B. Reynolds, Problems and solutions, *American Mathematical Monthly* **22** (1915), 319.

32. J. B. Reynolds, Problems and solutions, *American Mathematical Monthly* **72** (1965), 54

33. J. B. Reynolds, Relating to a curve with unusual properties, *American Mathematical Monthly* **24** (1917), 343-344.

34. J. B. Reynolds, Reversion of series with applications, *American Mathematical Monthly* **5l** (1944), 578-580.

35. J. B. Reynolds, The area of ruled surfaces by vectors, *American Mathematical Monthly* **30** (1923), 185-189.

36. D. Reginald Traylor, *Creative Teaching: Heritage of R. L. Moore,* Houston: Univ. of Houston, 1972.

37. Albert Tucker and Frederik Nebeker, An interview with Herman Goldstine, in *The Princeton Mathematics Community in the 1930s,* Transcript Number 15, Princeton University, 1985.

38. David E. Zitarelli, *EPADEL: A Semisesquicentennial History, 1926-2000* [To appear].

39. David E. Zitarelli, Towering figures of American mathematics, 1890-1950, *American Mathematical Monthly* **108** (2001), 606-635.