

With the close of the Mathematical Congress and the Evanston *Colloquium*, the mathematicians at the University of Chicago threw themselves back into the task they had begun just one year earlier, namely, the development of a department devoted to mathematical training and original research. At the undergraduate level, they fashioned a program which would not only expose the student body to mathematics as part of general culture but also prepare the mathematically inclined for more advanced work at the graduate level. For those already at this higher stage, they put together a broad range of courses designed to bridge the gap between studying mathematics and doing mathematical research. Finally, at the post-doctoral level, they strove to heighten research activity both within the department, through the regular meetings of their *Mathematical Club*, and nationally, through their involvement in the American Mathematical Society. Within the conducive and supportive, research-oriented atmosphere of William Rainey Harper's University, E. H. Moore and his colleagues Oskar Bolza and Heinrich Maschke succeeded in realizing their goals.

When the University opened for instruction on 1 October 1892, almost six hundred young men and women—among them 242 undergraduates and 170 graduate students in arts and sciences—enrolled to take part in Harper's carefully crafted educational institution. In addition to the undergraduates and graduate students in arts and sciences, 84 graduate divinity students and 62 unclassified students were also in attendance during the first quarter of operation. See *ibid.*, p. 175. These figures differ somewhat from those given in Thomas Wakefield Goodspeed, *A History of the University of Chicago Founded by John D. Rockefeller: The First Quarter-Century* (Chicago: University of Chicago Press, 1916), p. 248. The University of Chicago was coeducational from the beginning. Indeed, the President had tried to detail every aspect of the school's operation in drawing up his series of *Official Bulletins*, seemingly leaving nothing to chance and little to the discretion of individual faculty members. (Recall from Chapter 6 that it was precisely this ultra-preparedness which had caused Bolza to question, in January of 1893, whether the faculty would enjoy the curricular freedoms he felt were so essential to the success of the German educational system.)

He was to supervise the entire work of his department in general, prepare all entrance examination papers and approve all course examinations prepared by other instructors, arrange course offerings from quarter to quarter, examine all theses offered in the department, determine the textbooks to be used, edit any appropriate papers or journals, conduct a club or seminar, consult with the librarian about needed books and periodicals, consult with the President on appointments of instructors, and countersign the course certificates in the department.

In practice, the Head Professor did not play the dictatorial role suggested by this prescription; in practice, Harper's system was, as he put it, "flexible." Under the Head Professor's direction, each department enjoyed the freedom to devise its own curriculum, choose its own textbooks, and establish its own standards of evaluation. E. H. Moore faithfully implemented Harper's directives in Chicago's Department of Mathematics while setting and maintaining the most exacting standards.

From the start, every participant under Moore's direction—from colleagues to young Assistants and Associates to Fellows and graduate students—had to live up to his expectations or suffer the consequences. This management style never presented a problem for Bolza or Maschke, both of whom shared Moore's vision for the department. For Harris Hancock, however, the situation was quite different and illustrates well both Moore's level of expectation and what could be his feisty personality.

As mentioned earlier, Hancock had been chosen to serve on the first faculty in the post-doctoral rank of Associate. Contrary to what he had led Harper and Moore to believe in the correspondence prior to his appointment, though, he did not ultimately succeed in earning his Berlin doctorate under Lazarus Fuchs in 1892. He thus asked for a leave of absence during Chicago's first year in order to complete his work. Moore did not favor this idea, and Harper denied the request. To add insult to injury, in Hancock's view, his rank was lowered from Associate (or Tutor) to Assistant for the 1892–1893 academic year, due to the fact that he did not yet have the required credential. Taking an approved leave the following year instead, Hancock finally took his doctorate in 1894 and resumed his assistantship later that fall. He also studied under Schwarz and Frobenius while in Berlin. See Harris Hancock, "Short Biographical Sketch of Harris Hancock, with Especial Reference to His Scholastic Attainments," dated 1 May 1896, Special Collections Division, The Milton S. Eisenhower Library, The Johns Hopkins University. Unfortunately, this first post-graduate year also went

*badly when he failed to shine as a teacher and when the lectures he subsequently gave on his research failed to impress Moore favorably. Although he was promoted to an associateship in 1895, Moore condemned his work in reports to Harper, calling it “essentially compilation,” and refused to promote Hancock at the rate the young man believed he merited. In response to this, Hancock kept up a steady correspondence to Harper over the five-year period from 1895 to 1900, in which he extolled his own virtues, asked for promotions, and denounced Moore’s treatment of him. Harris Hancock finally left Chicago in 1900 to take a professorship at the University of Cincinnati where he remained until his retirement in 1937.*

As the saga of Hancock’s association with the University of Chicago suggests, Moore unwaveringly maintained the standards he had set for his department, and he did not choose to suffer those who failed to meet them. With those who did make the grade, however, he worked collegially and effectively. The ultimate success of his administrative style was well reflected in his coordination of the formulation of a comprehensive mathematics program at Chicago, which not only met the demands of a varied student body but also satisfied the faculty’s need for research time.

Following the example set by the mathematicians at the Johns Hopkins and gradually adopted at such established institutions as Harvard and Yale, the Chicago group under Moore put together a serious mathematics curriculum at the elementary and intermediate as well as at the graduate level. To begin with, the University required undergraduates to take a basic “course in Algebra, Plane Trigonometry, and Coordinate Geometry of the Point, Line and Circle... , as a means of general culture.” Then, the Chicago student wishing to major in mathematics had to take a first course in calculus prior to embarking on the intermediate work. With these prerequisites completed, the major proceeded to “Second courses in Algebra, Analytic Geometry, the Calculus; courses in Differential Equations, Applications of Calculus to Geometry, Analytical Mechanics, Elements of Projective Geometry, Elements of Elliptic Functions, Elements of Theory of Functions” with electives possible in number theory and the mathematical theories of electricity and potential. With few exceptions, the level of mathematical sophistication suggested by this undergraduate course of study was unprecedented in the history of higher education in the United States. Yet, as more universities and colleges fell under the influence of the curricular advances at the undergraduate level made at institutions like Hopkins and Chicago, the educational foundation needed to produce mathematical researchers grew more solid. By the turn of the century, the construction of American research mathematics was well under way.

The strengthening of the undergraduate curriculum represented only one crucial step in this process, however. In logical progression, the next step was the improvement of the graduate offerings. Here, Moore, Bolza, and Maschke faced their most daunting challenge, namely, to reverse the trend that had allowed Gottingen and other German universities to monopolize this final phase in the training of America’s best mathematicians. The Chicagoans realized that for their program in mathematics to attract the cream of American talent, its offerings had to rival those of the ever-attractive German institutions. Thus, they fashioned a course of studies intended to give the student a comprehensive view of modern mathematics, to develop him to scientific maturity, and to enable him to follow, without further guidance, the scientific movement of the day, and, if possible to take an active part in it by original research. To this end general courses on the most important branches of modern mathematics such as: Theory of Functions, Elliptic Functions, Theory of Invariants, Modern Analytical Geometry, Higher Plane Curves, Theory of Substitutions, Theory of Numbers, Synthetic Geometry, Quaternions, Theory of the Potential, are given at least once in two years, while other courses of a more special character and the Seminars are intended to introduce to research work.

As the course listings at Chicago and Gottingen for 1894–1895 reflect, the Chicago curriculum, at least in pure mathematics, compared favorably with the course offerings at Gottingen: (1) Chicago—elliptic modular functions, projective geometry, configurations, groups, theory of functions of a complex variable, quaternions, substitutions, analytic geometry of three dimensions, higher plane curves, advanced integral calculus, Weierstrass’ theory of elliptic functions, algebraic surfaces, analytical mechanics, number theory, theory of equations, and calculus of variations (*Bulletin of the New York Mathematical Society* 3 (1894):260), and (2) Gottingen—theory of numbers, introduction to higher

*mathematics, calculus of variations, algebra, descriptive geometry, introduction to function theory, hydrodynamics, partial differential equations, thermodynamics, applications of potential theory, higher geodesy, determination of orbits of planets and comets* (*Bulletin of the American Mathematical Society* **1** (1894):55); Abel's and Riemann's functions, optics, theory of electricity, *theoretical astronomy, kinetic theory of gases, elliptic functions, theory of determinants, mechanics, analytical geometry, chapters from Lie's theory of continuous groups* (*Bulletin of the American Mathematical Society* **1** (1895):238).

At least five students came to Chicago as Fellows to pursue this higher course of studies during the first year of operation: *N. B. Heller and John Irwin Hutchinson followed Bolza from Clark to work on topics related to his research; Herbert Ellsworth Slaught relinquished his post as Principal of a New Jersey school to bring his young family to the Midwest; James Archy Smith came and stayed for two years before abandoning his plans for a Chicago Ph.D.; and Mary Francis "May" Winston became an "Honorary Fellow" for one year, leaving her fellowship at Bryn Mawr to take advantage of the coeducational policy and educational promise of the new institution in her native Illinois. Of these first Fellows only Smith appears to have dropped out of mathematics. Heller became Professor of Mathematics at Temple University; Hutchinson had a long career at Cornell; Slaught stayed on and moved through the ranks at Chicago; and Mary Winston (later Newson), after earning her Ph.D. under Klein in Gottingen, taught successively at Kansas State College (1897–1900), Washburn College (1913–1921), and Eureka College (1921–1942). Like all of the other participants in Harper's University, these Fellows, too, had a clearly defined role to play. Harper prescribed that they "spend five-sixths of their time in original investigation under the guidance of the Professor, one-sixth being reserved for service in connection with the University."* By setting these guidelines, Harper sought to insure that his Fellows not lose sight of the goal in view, namely, the pursuit of their own studies and original researches. Perhaps due to the complete coverage of the department's teaching obligations and the well-balanced sequence of courses that Moore, Bolza, and Maschke had put together for them, the five mathematics Fellows probably had little need for Harper's rather paternalistic prescription. They were already there to devote themselves fully to mathematics.