A SHORT HISTORY OF THE UNIVERSITY OF KENTUCKY

DEPARTMENT OF MATHEMATICS

Dedicated to the Memory of Wimberly C. Royster and of his sixty years of service to the Department of Mathematics, to the University, and to the people of Kentucky

Introduction

These notes grew out of a 2012 luncheon hosted by Wimberly Royster at which he proposed to a few members of the UK Mathematics community that consideration be given to the writing of a Departmental History.

Much of what I have included is the result of my own recollections and information garnered from many conversations with faculty members - both active and retired - and especially with Dr. Royster whose career spanned more than half the Department's modern history. Information about the early history of the American Mathematical Community was obtained on-line and from publications of the American Mathematical Association. I have also benefited enormously from the treasure of information available in the University of Kentucky archives.

Like a life lived, the UK Department of Mathematics has enjoyed periods of great success and risen from staggering defeat. Accounts of both are included, fairly I hope.

Beginning in 1865 the University of Kentucky offered a bare-bones mathematical program that hardly changed until 1912. And for most of that period the courses were delivered by one professor, James G. White, and the mathematical monotony of that period suggested 1912 as a reasonable starting point for this work.

1. The Early Years: 1912-1931

In 1913, the year of his death, James G. White, professor of mathematics and astronomy, completed forty-five years of unbroken service to the University of Kentucky (then known as the State College of Kentucky), including other administrative duties such as Dean of Men and acting President. For most of his tenure he was the solitary instructor, responsible for a remarkably stable curriculum of algebra, trigonometry, analytic geometry, calculus, mechanics and astronomy. Following the construction of the current Administration building in 1882, he held forth in a classroom on its second floor, which also served as his office.

Professor White labored in mathematical isolation as well, in a small university with fewer than thirty professors whose enrollment had only recently exceeded 1,000 students. His program, at its inception in the late 1860s, differed little from that

offered by other burgeoning land grant institutions such as Cornell University and the University of Wisconsin.

But Wisconsin, Cornell and like institutions had moved on, benefiting from more robust budgets and their consequent participation in the renaissance of American mathematics that took place at the end of the 19th century. Cornell granted its first Ph.D. around 1900; UK would not produce its first Ph.D. until 1930.

That renaissance was driven by a talented group of American students seeking advanced training with the best European mathematicians, mostly in France and Germany. Simultaneously, talented European mathematicians were seeking employment in the U.S., with the result that dynamic new graduate programs were developed at Harvard, Princeton, Cornell, University of Chicago, Johns Hopkins University, and other institutions seeking well-trained faculty.

At Harvard, W. F. Osgood (1864-1933) and Maxime Bôcher (1867-1918), both back from earning doctorates under Felix Klein at Göttingen in the early 1890s, were producing a flurry of quality research. A partial list of other American students who did their doctorate work with F. Klein, along with the universities where they taught, include:

- Frank Nelson Cole (1861-1926), Harvard
- Edward Krasner (1878-1955), Columbia University
- William Edward Story (1850-1930), Clark University
- Edward Van Vleck (1863-1943), University of Wisconsin
- Henry B. Fine (1858-1928), Princeton University
- Virgil Snyder (1869-1950), Cornell University

A German student of Klein, Oscar Bolza (1857-1942), made his way to the U.S. in 1889 and eventually went to the University of Chicago, where he joined E. H. Moore, an 1885 Yale Ph.D., and another German mathematician Heinrich Maschke in a newly formed graduate program. They quickly turned out a string of first-rate Ph.D.s. Here is a partial list, and the career institution of each:

- L. E. Dickson (1874-1954), University of Chicago
- Gilbert Bliss (1876-1951), University of Chicago
- Oswald Veblen (1880-1960), Princeton University
- R. L. Moore (1882-1974), University of Texas
- George D. Birkhoff (1884-1944), Harvard University
- T. H. Hildebrandt (1888-1980), University of Michigan

These men proved to be key players in the rise of mathematics in the United States at the beginning of the 20th century, many as front-line researchers, and a few as outstanding administrators. Together, they and others supervised a prodigious number of Ph.D. students. For example, Virgil Snyder at Cornell turned out 39, including 13 women. From 1910 to 1927 Chicago produced 115 Ph.D.s; in 1928, of the 45 Ph.D.s granted in the entire country, Chicago produced 14. In all, L. E. Dickson supervised 53 Ph.D. theses, E. H. Moore 31. Meanwhile, at Texas, starting in 1920, R. L. Moore eventually trained 50 Ph.D.s.

As Ph.D. production at Chicago increased, the quality decreased, at least according to some critics. Whatever the validity of that argument, it is true that Chicago Ph.D.s scattered far and wide, especially over the South where, or so it seemed, every ambitious mathematics program trumpeted its Chicago Ph.D.

Yet this new mathematical energy, first imported from Europe, and later generated in competition with Europe by an enormously talented young generation of American mathematicians, had yet to penetrate Kentucky. Lamentably, there was no one on the UK mathematics faculty who could bring the good news! One UK faculty member of the time commented: "Our work is hard and our compensation small." During the 1880s the UK mathematics department was never lucky enough to hire that one person who had actually experienced the new world of mathematics and understood its implications.[1]

Perhaps one of the restraining factors was the forty year reign of President James K. Patterson, who even after his retirement in 1909 continued living in the president's home until his death in 1922.

Finally, in 1912, UK hired its first Ph.D. mathematician, Paul Prentice Boyd, who arrived with a degree from Cornell under Virgil Snyder, with a specialty in algebraic geometry. At his arrival the math faculty consisted of Prof. White (A.M.), Prof. Boyd (M.A., Ph.D.), Prof. Davis (A.M.), Assistant Professors Elijah Latham Rees (C.E.), Harold Hardesdy Downing (B.C.E.) and one instructor. In short order the UK course catalog added two new year-long courses, one in Projective Geometry and a second in Geometric Transformations. The core program was reorganized into the more modern list consisting of algebra, analytic geometry, differential and integral calculus, differential equations, and advanced calculus. Professor Downing assumed responsibility for the Astronomy program, which had been a primary interest of Professor White.

It is worth noting here that for many decades Astronomy had been an integral part of the UK mathematics program; indeed the most advanced course offered by Professor White was in astronomy. Further, White—and Downing, who succeeded White as its steward—saw to it that the university observatory, housed in a sturdy brick building on Woodland Avenue, was an integral part of the mathematics program.

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1 Quote is by Jack Neville, professor of Greek and Latin, in response to criticism from the state legislature on the college's inadequacies, 1896, located in Carl B. Cone, *The University of Kentucky: A Pictorial History* (Lexington: University Press of Kentucky, 1989), 46.

Following White's death, Boyd was made head of the department, and in 1917 he became Dean of Arts and Sciences while continuing his role as head of mathematics. These added duties limited Boyd's impact on the graduate program. (Thirty years later, this early imposition of dual administrative duties would lead to a departmental train wreck.) Consequently, almost two decades more would pass before the UK Department of Mathematics granted its first Ph.D.—to Russell Smith Park, later mathematics chair at Eastern Kentucky University.

Meanwhile, the University was expanding its educational role. On Oct. 16, 1916, the State University of Kentucky celebrated its 50th anniversary and its assumption of a new name—The University of Kentucky.

Except for the coming and going of the occasional instructor, the faculty and its programs remained reasonably static until the arrival of Elizabeth LeStourgeon (1880-1971) in 1920. A native of Virginia, she had obtained a bachelors degree from Georgetown College (Kentucky) in 1909, then taught at a number of small colleges before matriculating at the University of Chicago, where she wrote her thesis under the direction of Gilbert A. Bliss. She enriched the graduate curriculum at UK by adding courses in complex variables, Fourier series, calculus of variations, and functions of a real variable. Her service to the department extended into the mid-1940s, when she retired with the rank of associate professor.

Another Chicago Ph.D., Claibourne G. Latimer, arrived in 1927. One of the many students of L. E. Dickson, Latimer also added to the program by introducing courses in algebraic invariants and number theory.

Clearly, the era from 1912 to 1927 was a major transition period for the UK math department. It functioned at the beginning predominately as an undergraduate department, where it was possible to become an instructor with only a B.A. in math or even a degree in engineering and gradually to work one's way through the ranks. This was the path followed by Joe Morton Davis (B.A.) and Elijah Lathan Rees (C.E.) both of whom joined the Department before 1913. As far as can be determined, neither pursued an advanced degree. Nonetheless, both taught rather broadly at the undergraduate level, and both retired at the rank of professor, Davis in 1934 and Rees in 1938.

Promotion without a Ph.D., already difficult, soon became impossible. But the hard economic times of the 1930s forced many aspiring math professors to take a slow path to the Ph.D., a path that required considerable determination. It began by using a bachelor's or master's degree to obtain an entry-level teaching position, followed by years of matriculating in a Ph.D. summer program at a major university, and often topped off by a semester's leave to write a thesis. This was the path followed by Harold Downing, who received his Ph.D. in 1929 from the University of Chicago under G. A. Bliss. His professorship followed quickly.

Douglas Eugene South followed a similar path. He joined the Department in 1923 as an instructor, became a professor and served continuously, except for leave during WWII, until his resignation in 1952. He received his Ph.D. in statistics in 1937 from the University of Michigan under the direction of C. C. Craig.

Sally Pence first appears as a graduate assistant in the 1927-28 academic year, then as an instructor for several years before receiving her Ph.D. in 1937 at the University of Illinois under Arnold Emch. She retired in 1963 as professor.

Toward the end of the 1920s the UK Mathematics department could look back on considerable progress since the death of James G. White in 1913. Although still thinly staffed, it could count three full professors in Boyd, Davis, and Latimer; three associate professors in Rees, Downing, and LeStourgeon; and two assistant professors in South and Brown. By this time, too, the White mathematics club was a well-established activity center for mathematics majors. At its weekly meetings, students presented solutions and discussed assigned topics. Attendance by graduate students was mandatory. The program, while not robust, was quite adequate for a solid master's program and, given strong supervision, could support study at the doctorate level. Clearly lacking, however, was any indication of a nascent faculty research program.

Sometime in the late 1920s, the Mathematics Department moved to the first floor of newly constructed McVey Hall, space it would occupy until 1969, when it moved to its current location in the Patterson Office Tower.

2. The Depression and an Unexpected Infusion of Talent

Leonard W. Cohen joined the Mathematics department in the fall term of 1931, fresh from two years at Princeton as a National Research Fellow. He was a 1928 graduate of Michigan, where he developed an interest in analysis from courses under T. H. Hildebrandt and wrote a thesis in topology directed by Raymond Wilder, a student of R. L. Moore at Texas. At Princeton, Cohen benefited from the influential topology group headed by J. W. Alexander and Oswald Veblen and also from association with Solomon Lefschetz.

According to Cohen, "J. W. Alexander got me a job at Kentucky and it took WWII to get (me) out." There are several implications here: First, Kentucky was still considered a "mathematical backwater," a place no well-trained and ambitious young mathematician would want to go. Second, the country was deep into the Great Depression and good positions were almost impossible to come by. And third, job mobility would return to mathematical employment only as a result of WWII. Leon Cohen may not have been the first Jewish mathematician to come to Kentucky, but he was certainly the first with important connections in the mathematical community.[2]

Considerably before Adolf Hitler became chancellor in the early days of 1933, many young German Jewish scientists, well aware of the growing personal danger, were

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2 The Princeton Mathematics Community in the 1930s: An Oral History Project, Transcription 06: Leonard W. Cohen, 13 April 1984. <http://www.princeton.edu/~mudd/finding_aids/mathoral/pmc06.htm>

trying to secure positions elsewhere. Meanwhile, an organization in New York, the Emergency Committee in Aid of Displaced Foreign Scholars, was providing assistance to these scientists by making their names known to prospective employers in America. One such list—of mathematicians—made its way to Princeton, and Princeton professor J. W. Alexander forwarded it to Leonard Cohen.

An algebraist on this list attracted the attention of Cohen and Latimer. But there was no money available for the hire. So following the advice of a savvy local, they decided to hit up Lexington merchants from one end of Main Street to the other and managed to raise a small amount, probably no more than $2,000. It was enough, and at the end of 1933 Dr. Richard Brauer (1901-1977) arrived at UK and began teaching in English. At the end of that academic year Brauer went to Princeton as an assistant to Hermann Weyl, and after teaching at several universities became a professor at Harvard, where he finished his career. That spring Brauer gave a talk in McVey Hall to the Kentucky MAA meeting, entitled “Mathematics in German Schools and Universities.” Even if it was only for a brief period, the Department did enjoy the presence of one of the world’s very best young algebraist and of a future recipient of the National Medal of Science.

Richard Brauer’s older brother Alfred, also an outstanding research mathematician (matrix theory), almost waited too long to leave. He tried and failed in 1938, and then finally left in 1939, working first as librarian at the Institute for Advanced Study in Princeton, and then for many years at the University of North Carolina at Chapel Hill. A sister of the Brauers died in the Holocaust.

One further benefit arose from Richard Brauer’s short tenure in Lexington. Richard Courant, himself a displaced German mathematician and professor at New York University, noting Brauer’s American trajectory, inquired whether there might be a position at Kentucky for one of his Ph.D. students, Fritz John (1910-1994).

John came to Lexington in 1935 and, except for war-time leaves, remained until 1946, when he left to join Courant at NYU. While here he published over a dozen papers, including two short notes in the *Bulletin of the Research Club, University of Kentucky*. At NYU he soon became a key member of the Courant Institute and a master mathematician in the general area of partial differential equations. Author of more than 90 publications, he made fundamental contributions in ill-posed problems, numerical solutions and non-linear wave propagation.

John made other contributions, as well. In a recent review in *Notices of the AMS* Marjorie Senechal, Professor Emerita in Mathematics at Smith College and native Kentuckian, closed with a personal comment, the outgrowth of an interview with Nobel Laureate William Lipscomb, a native Lexingtonian and graduate of the University of Kentucky.

> I grew up near Lexington and took piano lessons from a teacher in town named Helen Lipscomb. Helen was a polio victim, confined to a wheelchair; her brother, Bill, was a chemist at the University of Minnesota. I met Bill Lipscomb for the first time in 2009, two years before he died at the age of ninety-two. By then he’d taught at Harvard for forty years and earned a Nobel Prize (1976) for his work on boranes. Unlike me, Bill had attended the University of Kentucky after

> a Lexington public high school; he'd had a music scholarship and studied chemistry on the side. "Why did you decide to become a chemist instead of a musician?" I asked him. "What changed your mind?" "A math class," he told me. "A math class taught by a German named Fritz John."[3]

In his personal biography, William Lipscomb recalled that an interest in astronomy led him to visit nights at the observatory of the University of Kentucky where Prof. H. H. Downing gave him a copy of Baker's *Astronomy*. Lipscomb recalled gaining many intuitive physics concepts from the book and from his conversations with Downing, who became a lifelong friend.[4]

Throughout the 1920s and early 1930s, UK was the site of numerous MAA meetings. Finally, in the mid-1930s an increasingly ambitious faculty was successful in securing a meeting of the American Mathematical Society. The Three Hundred Twenty-Sixth Regular Meeting of the AMS was held in Lexington on November 29-30, 1935. All sessions were in McVey Hall. Professors Cohen and John read papers; Latimer gave a lecture. Other notable attendees included Leo Zippin of the Institute for Advance Study, C. C. MacDuffee from University of Wisconsin, and L. E. Dickson from University of Chicago.

The downtown provided single rooms without bath at $2.00, single rooms with bath at $2.50 and double rooms with bath at $4.00. Taxi fare to campus was $.25. An informal dinner for AMS members and guests was held Friday evening at the Lafayette at the price of $1.25 per plate.

3. The War Years and a Train Wreck Delayed

The first impact that WWII had on the UK mathematics program was to negate significantly the hard-won gains of the previous decade. By the summer of 1942 Cohen, John, and South were on leave, the first two headed for government jobs at the Army's Aberdeen Proving Ground (APG) in Maryland where mathematicians and scientist from many institutions would cooperate in the solution of the numerous technical problems then facing our military.

Soon key graduate mathematics courses disappeared from the University catalog, and similar devastation must have been occurring throughout the University for in

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3 Marjorie Senechal, review of *Transcending Tradition: Jewish Mathematicians in German-Speaking Academic Culture*, Birgit Bergmann, Moritz Epple, and Ruti Ungar, eds. (Berlin: Springer Verlag, 2012), in *Notices of the AMS* 60 (February 2013): 213. <http://www.ams.org/notices/201302/rnoti-p209.pdf> Much of the preceding information on German Jewish emigres can be found in *Transcending Tradition*.

4 William N. Lipscomb, "Process of Discovery (1977); An Autobiographical Sketch," in *Structures and Mechanisms: From Ashes to Enzymes*, Gareth R. Eaton, Don C. Wiley, Oleg Jardetzky, eds. (Washington, D.C.: American Chemical Society, 2002), xv. <http://pubs.acs.org/doi/pdf/10.1021/bk-2002-0827.pr001>

1943-44 more than 160 UK faculty and staff were listed as either resigned, died, transferred by the War Department, or on military leave.

The second and broader impact of WWII was to thrust mathematicians and scientists into close contact with the federal government at research and testing facilities such as APG. These activities generated a national discussion which, further energized by the Cold War, culminated in the creation of the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and other governmental organizations designed to support various areas of research deemed essential to the national interest.

By spring 1946, veterans eager to take advantage of benefits offered by the new GI Bill were arriving on campuses from coast to coast. Those choosing UK were advised to report to the personnel office with a copy of their discharge papers, all applicable transcripts, statements of specialized military training that might qualify for university credit, and all documents issued by the Veterans Administration.

This influx of returning veterans and the prospects of an economic upturn raised the expectation of a quick return to the pre-war research progress led by Cohen and John. Cohen and South returned to the Department in 1946 and for one short semester the promising research program initiated by Cohen and John seemed destined to continue and, perhaps, expand. But it was not to be. The first setback, however, was the departure of Fritz John to NYU. It was not realistic, of course, to expect John to refuse the opportunity to join Courant. His loss was partially mitigated in fall 1946 by the arrival of two new and promising assistant professors: Casper Goffman, an analyst with a Ph.D. from Ohio State, and Albert Grau, an algebraist with a Ph.D. from Michigan.

In the summer of 1947 LeStourgeon, Cohen, Latimer, Goffman, and Grau all submitted resignations. LeStourgeon retired, Latimer assumed the chairmanship at Emory University, Goffman and Grau initially went to the University of Oklahoma and later moved on to distinguished careers—Goffman at Purdue and Grau at Northwestern. Cohen spent the mid-fifties as Program Director for the Mathematical Sciences at the National Science Foundation and later as chairman at the University of Maryland, where he was instrumental in building a large and talented department.

The conditions leading to this mass exodus trace back to the appointment of Boyd as department chair in 1913, and as dean four years later. For thirty years he had held both titles, with Downing acting as a nominal co-chair within the Mathematics Department. At the time of Boyd’s retirement at the end of the 1946-47 academic year, apparently those faculty with research interests were opposed to the elevation of Downing, while Boyd and the incoming Dean Martin M. White viewed the departmental chair as a reasonable reward to Downing for decades of faithful service. Downing was appointed Head, effective summer 1947.

So, in the 1947-48 academic year the departmental ranks were reduced to Professors (all ranks) Harold Downing (Head), M. C. Brown, Sally Pence, Frances Pullian, and Eugene South, plus a gaggle of instructors.

It was now Downing's job to rebuild a decimated graduate program and to mollifying graduate students, some threatening to leave. And the challenge was enormous. Hundreds of thousands of returning service men and women, eager to take advantage of the new GI Bill, were flooding into the nation's colleges and universities, with resulting increased teaching responsibilities at all levels. Suddenly, the nation's rather small group of Ph.D. mathematicians found themselves in considerable demand. In the midst of this professional turmoil, the UK Mathematics Department began another long slog to respectability, a slog that would be eased somewhat by a timely growth in legislative funding for the University and long awaited salary growth.

4. A Decade and a Half of Rebuilding

One of the graduate students facing the decision whether to stay or to transfer was Wimberly C. Royster. He had been recruited by Dean Boyd the previous year from Murray State Teachers College, ostensibly to pursue a master's degree supplemented by a $90 per month teaching assistantship. He decided to stay and launch what would be over a half century of service to UK and the Commonwealth first as a professor, then as Dean of Arts and Sciences and, finally, as Dean of the Graduate School and
Vice President for Research.

During the next two years the Department was able to fill only two positions: Frances Pullian, a young Ph.D. from the University of Illinois and Thadeusz H. Leser, a Polish refugee with a Ph.D. from the University of London in 1947. Pullian left after two years, and Leser left in 1954 for a position at the Aberdeen Proving Grounds, where he later became head of their computing laboratory's analysis branch.

Three new faculty arrived fall 1949: Professor James H. Ward and Associate Professors Vincent Cowling and Adolf Goodman. Ward, who came from the University of Georgia, was a 1940 Ph.D. from Wisconsin, where he had studied with C. C. MacDuffee. Cowling (Ph.D. Rice University, 1945) had worked with the now famous Azolem Mandelbrojt and had taught at Lehigh and Ohio State universities. Goodman had received his Ph.D. in 1947 from Columbia University, where he had studied with Otto Szasz and E. R. Lorch. Ward provided support for the graduate program in algebra, while Cowling and Goodman guided complex variables and real analysis. These three deserve much credit for reenergizing the Department's graduate program.

In the academic years 1950-1951, 1951-1952, Morris S. Davis, fresh from a Ph.D. in astronomy at Yale, provided support for the Department's astronomy program. He then left for a position at the University of North Carolina, where after a long career he retired as Morehead Professor of Astronomy.

William H. Pell's academic career began as a UK student in the late 1930s. He went on to do graduate work at Wisconsin, where in 1943 he wrote his Ph.D. thesis under the direction of I. S. Sokolnikoff. In 1952, he interrupted his career in applied mathematics at Brown University to accept the leadership of UK's Math Department. At some point in the unfolding of an academic career, many

mathematicians feel the attraction of devoting time to the rebuilding or elevation of their alma mater. Perhaps that nostalgic impulse figured in Pell's return to UK. But after two years back in Kentucky, 1952-53 and 1953-54, he decided to return to his professorial work at Brown.

Standing in the wings was another Kentuckian and UK undergraduate, Dr. James C. Eaves, who earned his Ph.D. in matrix theory at UNC Chapel Hill in 1949 working with E. T. Browne, and who had been teaching at Auburn. Eaves was appointed Head in 1953, a position he would hold for almost a decade.

J. C. Eaves believed in spreading the news of great opportunities in mathematics and of the math department activities. Using his role as department head and M.A.A. lecturer he gave presentations statewide to high school students as well as to civic and luncheon clubs. These activities were covered locally and by the *Courier Journal*. In 1955 the *Herald Leader* announced the University of Kentucky Observatory would be open to the public each Wednesday evening: "The observatory, located on Woodland Avenue at Hilltop will be open at 6:30 P.M. each Wednesday if the weather is clear. Varied programs of observation using the University telescope have been planned. No charge will be made." The article then gave Dr. Eaves's description of the programs to be presented.[5]

A rather extensive article appeared in the *Herald Leader* on the occasion of the first N.S.F. research grant to a UK math faculty for a summer research project. Dr. Vincent Cowling was the recipient of a $6,600 grant to support research in "Summability and Analytic Functions." The article went on to review Cowling's resumé in some detail.

Also, in 1956 the University of Kentucky Department of Mathematics and Astronomy received a $12,000 grant from the Fund for the Advancement of Education to "determine if new methods of teaching large groups can be developed so that the students show an increase in learning over those instructed in small units." The experiments were to be carried out with class sizes of 100 to 150.

Faculty growth in the Mathematics faculty continued through the mid- and late-fifties and early sixties. The additions were:

- William Fawcett, Ph.D. 1955, Tulane. Advisor: A. D. Wallace

  Frank Levin, Ph.D. 1955, Univ of Cincinnati. Advisor: Arno Jäger

  James G. Horne, Ph.D. 1956, U.N.C. Advisor: Billy Pettis

  Tulio Pignani, Ph.D. 1955, U.N.C. Advisor: Wm. M. Whyburn

  Christopher Scriba, Ph.D. 1957, Universität Geissen. Advisor:

  Wasley Krogdahl, Ph.D. 1942, Univ. of Chicago. Advisor: Subramanyan Chandrasekhan

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5 Lexington *Herald-Leader*, 7 November 1955.

Wimberly Royster, Ph.D. 1952, Univ. of Kentucky. Advisor: Adolph W. Goodman

A. L. Duquette, Ph.D. 1960, Univ. of Illinois. Advisor: Paul T. Bateman

J. B. Wells, Ph.D. 1957, Univ. of Kentucky. Advisor: D. E. South

Thomas Lee Hayden, Ph.D. 1961, Univ. of Texas. Advisor: Hubert S. Wall

Rodney Jack Roth, Ph.D. 1962 Duke Univ. Advisor: Seth Warner

Frank L. Cleaver, Ph.D. 1960, Tulane Univ. Advisor: A. D. Wallace

Herold Robertson, Ph.D. 1962, Univ. of Illinois, Advisor: ?

James H. Wells, Ph.D. 1958, Univ. of Texas. Advisor: Hubert S. Wall

After gaining his Ph.D. in 1952, Dr. Royster taught the next four years at Auburn and returned to UK in 1956. The acquisition of Dr. Krogdahl in 1958 represented the department's continuing commitment to astronomy, a relationship that had endured for almost a century. However, the consensus was building that astronomy was better served in the physics department. At the time of the official transfer in 1966 Dr. Krogdahl became a professor of physics.

From this group, only Wimberly Royster, T. L. Hayden, and J. H. Wells served the Department through the following decades.

Clearly the decade of the 1950s witnessed a significant growth in research at UK. This evolution of faculty expectations for instructional and research support grew out of increased graduate enrollment following WWII. In the resulting efforts to improve graduate education and research, some faculty—especially the young—grew to believe that the existing administrative structure was not supportive of educational improvement consistent with the times. In the fall of 1960, UK president Dickey, in response to growing pressures for change, appointed the Committee of 15 to survey administrative structures at other institutions and make recommendations for change where needed.

One of the subcommittees was charged with conducting a study of UK's policies with respect to college and departmental administration, specifically the appointment and tenure of departmental heads and college deans. Following an extensive survey of both public and private institutions, the subcommittee recommended that departmental heads and college deans be appointed only after consultations with staff and that appointments should be for five years with a thorough performance review to precede an extension. Further, it was recommended that qualifications of departmental heads should include scholarly activity, leadership, and administrative abilities. Similar recommendations were made for college deans, with greater emphasis on organizational skills.

The report of the Committee of 15 defines a clear watershed, an organized call from the faculty for fundamental changes to an outdated and autocratic administrative structure. Usually such reports are long on proposals and short on implementation

—but not in this case. Within a year President Dickey was indicating his intention to step down and the search for a new president began.

5. The Oswald Years

The sprint for excellence that permeated UK and the Department of Mathematics throughout the 1960s could not have occurred without the leadership of two progressive governors, Bert T. Combs from 1959-1963 and Edward T. Breathitt from 1963 to 1967. Together they created the atmosphere that helped transition UK into a modern university, and they fought for the legislative budgets essential to successful implementation. Combs in particular deserves much credit for not interfering in the faculty process that culminated in the appointment of President John W. Oswald.

Oswald was a plant pathologist from the University of California system. Starting out on the Davis campus, he later served as departmental chairman at Berkeley, and came to UK from the position of vice president for administration of the statewide system. At that time the California system of higher education was touted as the national model, and it soon became clear that Oswald's goal was to transplant that organizational model to Kentucky. During his five year tenure at UK he achieved that goal.

One of his first innovations was to institute a limited program of university-sponsored summer research grants, given with the expectation of generating grant proposals to NSF and other granting agencies. The academic promotion process became much more rigorous, with greater emphasis on external review. As part of a completely new set of governing regulations, departmental heads with indefinite tenures of office were replaced by departmental chairs appointed for a fixed period, with renewal subject to review. As part of a new Honors Program, the Math department taught its first class of honors calculus. Somewhat later, Oswald implemented the Community College System.

For the first few semesters of his tenure Oswald operated with a free hand: he had a plan and he understood how to implement it; he had the full support of the Board of Trustees; and, as observed above, he enjoyed both the political and budgetary support of governors Combs and Breathitt. His initiatives also drew strong support among the younger faculty, and many of the senior faculty either supported his actions or took a wait-and-see attitude. But there was criticism from some older faculty and the community at large. Lexington was not used to sudden change.

Having expended his administrative capital, in 1968 Oswald returned to the California system for a short period and then spent his remaining career as president of Penn State University. At UK, he left behind a faculty animated by a commitment to research, teaching, and service, supported by a modernized set of governing regulations, and a half decade of increasing budgets.

In the first year of the Oswald presidency, 1963-64, the Department of Mathematics taught its program with a faculty of fourteen whose members only could support serious graduate work in analysis and complex variables. At his departure in 1968,

the faculty numbered thirty-two and could boast of research activities in complex variables (Wimberly Royster, S. M. Shah, Frank Keogh and J. D. Buckholtz), algebra (Edgar Enochs, Donald Coleman, James Beidleman), topology and semigroups (Brauch Fugate, John Selden, John Mack) and differential equations (Carl Lagenhop, Federick Atkinson, Henry Howard).

During this period Professors Eaves and Goodman left the Department, and in 1963 Professor Wimberly Royster was appointed Department Chairman. The ’68 faculty contained the research and administrative core that would drive the Department for the next decade and beyond. And thanks to timely leadership on the part of Dr. Royster, the growth and infusion of talent enjoyed by the Department during the Oswald era would be continued for an additional five years, buoyed by funds provided by the National Science Foundation.

6. The Science Development Grant

During the mid-sixties the National Science Foundation (NSF) invited proposals from academic institutions nationwide in competition for long-term funding targeted to individual departments for the improvement of scientific research, in particular to make significant investments in departments having a potential for excellence. Three UK departments elected to participate: Mathematics, Physics, and Chemistry. The UK administration chose to submit to NSF only two proposals, those from the departments of Mathematics and Physics.

In due course an NSF review team spent time on campus interviewing members of the involved departments and the UK administration. Based on the team’s recommendations, NSF rejected the proposal from the Physics Department and approved the Mathematics proposal for a total of $974,000 spread over three academic years 1968-1971. In its final form the NSF Science Development Grant (SDG) also required that some of its resources be expended in an effort to assist in the development of research activity in both statistics and computer science.

How the NSF team came to that decision, we cannot know, but some UK faculty who had contact with the review team point to the probable influence of one of its senior members, R. H. Bing. Bing, a Wisconsin topologist, member of the National Academy of Sciences and graduate of the University of Texas, was familiar with the recent improvements at UK. He knew professor S. M. Shah, a recent addition to the Department and a past visitor at Wisconsin. He was also aware that three of the younger additions to the UK math faculty had completed their graduate work at the University of Texas, doing their research under professors he knew and respected.

At about the same time, fall 1969, the Math Department moved from its cramped quarters in McVey Hall to the newly completed Patterson Office Tower, where it occupied most of the 7th and 8th floors and a portion of the 9th floor. These facilities, coupled with the adjacent White Hall classroom building, provided a much-needed platform to showcase departmental activities and enhance recruitment.

In addition to its primary goal of increasing the size and research quality of the math faculty, the NSF grant provided support for graduate students, post-doctoral

appointments, symposia, travel and support staff. Key to its long-term impact was a "pick-up" provision which obligated the University to assume a portion of the annual expenditures on both faculty salaries and current expenses.

The Science Development Grant (SDG) ran from fall 1968 to spring 1973, the last two years '71-'72 and '72-'73 tacked on as extensions when it became clear to all parties that the original spending projections simply could not be met. This meant that over a five year period, the Department absorbed around $200,000 of new money annually for new faculty, teaching assistants, visitors, post-docs, library acquisitions, honoraria, symposia, and travel. In tandem, annual University support for the Department rose from around $700,000 to $1,100,000 during the same period.

The SDG projected growth of the math faculty, starting in the high 30s in fall 1968, to reach 57 FTEs by the grant's end. That never happened, but it did reach the low 50s.

Like other SDG recipients—such as the mathematics departments at the University of Texas and the University of Utah—UK received the grant not for existing research excellence, but rather for recent improvement and potential. In UK's case that potential had been boosted by the recent arrival of a group of established faculty, including Frederick Atkinson, S. M. Shah, Frank Keogh, Carl Lagenhop, and Edgar Enochs. During the SDG funding period, the Department of Mathematics hired four dozen new faculty, brought in numerous visitors, and hosted ten post-doctoral appointments. In addition the grant supported four new faculty each in Statistics and Computer Science and organized numerous symposia, including major gatherings in topological dynamics and infinite-dimensional holomorphy, theproceedings of which were published in the Springer-Verlag Lecture Notes series. During the SDG the Mathematics Department granted 31 Ph.D.s and the areas of research competence spread from algebra, analysis, and topology to include partial differential equations, optimization, linear programming, and numerical analysis.

The department benefited immensely from a bevy of distinguished visitors, including French mathematician Jean-Pierre Rosay, who later became a distinguished professor at the University of Wisconsin; Hebert Amann from Germany, an expert in partial differential equation who taught much needed advanced courses; Matts Essen from University of Uppsala in Sweden, who reinforced and participated in joint research with our complex variable group; two outstanding algebraists, David Kent Harrison from the University of Oregon and William Heinzer from L.S.U.; John Neuberger from Emory University, an expert in partial differential equations and semi-group theory and the recent recipient of a Sloan Foundation fellowship; and Anders Lindquist from the Royal Institute of Technology in Sweden, an expert in stochastic control.

Certainly, the NSF Science Development Grant supported unprecedented growth, but the most beneficial impact came from the interaction with outstanding mathematicians who spent time here as visitors and who attended the numerous seminars and symposia made possible by SDG funding. Essentially, the SDG introduced UK math to the community at large, greatly improving our ability to compete for the best talent available. That competitive advantage soon bore fruit.

Since 1955 the Alfred P. Sloan Foundation has provided research fellowships in support of early-career scientists and scholars who show independent research accomplishments. Fellowships were initially awarded in physics, chemistry and mathematics. Later, awards were extended to neuroscience (1972), economics (1980), computer science (1993), and recently to molecular biology and ocean science. John Milnor, a Princeton topologist, was one of the first three mathematicians to receive a Sloan Research Fellowship in 1955.

In the period 1973-1982 seven members of the UK Department of Mathematics were chosen as Sloan Research Fellowships recipients. They were:

- Thomas A Chapman 1973

  Kenneth Kubota 1974

  Steve Ferry 1978

  Lawrence C. Evans 1979

  Avinash Sathaye 1980

  Craig T. Benham 1982

  Robert Jensen 1982

Through 2013, only five UK faculty outside the Mathematics Department have been so honored, two each in chemistry and physics and one in neuroscience.

Tom Chapman was one of the very few—perhaps the only UK faculty member of the modern era—promoted directly from assistant to full professor. His promotion was based on his solution of a fundamental topological problem of that period: a proof of the topological invariance of Whitehead torsion. A corollary of Chapman's main theorem is that any homeomorphism of finite connected simplical complexes is a simple homotopy equivalence.

Soon the research of these Sloan recipients and that of other of the young faculty began to attract very competitive offers. During the same period, however, steady increases in state budgets for higher education began to slow, to be followed by a period of stagnation and, ultimately, reductions. The halcyon days of vigorous competition for the most talented young mathematicians slowly eroded.

Three decades later, while Chapman, Kubota, and Sathaye continued their career paths at UK, others of the above group chose alternate paths: Robert Jensen became chair and professor at Loyola of Chicago; Craig Benham served as professor of Biomedical Engineering and head of the Genome Center at U.C. Davis; Lawrence C. Evans became professor of mathematics at U.C. Berkeley and winner of the prestigious Steele Prize in 2004; and Steve Ferry became professor at Rutgers University.

Only six Departmental Heads preceded Wimberly Royster's appointment as Chair in 1963. Twelve have followed him: James H. Wells (1969-1972; 1989-1992), Raymond

Cox (1972-1975); John Mack (1975-1978); Roger Wets (1978-1980); Paul Eakin (1980-1986); Ron Gariepy (1986-1989 with Brauch Fugate as acting chair for one year); Paul Eakin (Spring, 1992); Carl Lee (1992-1996); Peter Hislop (1996-2000); Peter Perry (2000-2004); Richard Carey (2004-2007); Zhongwei Shen (2007-2011); and David Leep (2011-present).

7. Teaching and Technology

In the early 1950s slate blackboards remained an integral component in the teaching of mathematics. Indeed, the classroom had changed little over the previous century. Lectures as well as examinations were chalked (sticks of calcium carbonate), students copied fiercely, and when called on "went to the blackboard" to present their solutions. Tests were taken in "bluebooks" purchased at the university bookstore. Students weren't allowed to smoke in class, but professors were, and frequently did. One distinguished professor of the period (not at UK) routinely gave lectures armed with sticks of white and colored chalk plus a cigar all tucked between the fingers of his right hand while his students waited, in vain, for him to puff on a piece of chalk and write with the cigar. In today's classroom the blackboard has been replaced by a whiteboard.

Most lower-division math courses featured routine homework assignments regularly submitted for grading. Before WWII the responsibility for grading fell to the professor, but for a time in the postwar years a period of robust budgets permitted the hiring of undergraduates to shoulder much of that onerous duty.

Computation problems were attacked with a Kueffel & Esser(K & E) slide rule. Serious students carried a K & E LogLog Decitrig neatly holstered in a black carrying case attached to their belt. For more detailed calculations students and professors alike relied on one of the then available electro-mechanical calculators, a Monroe, a Friden,or a Marchant. The Monroe was at the low end; Marchants were the Cadillacs of desktop computing. In operation each emitted a racket much like that obtained by stirring bolts in a tin bucket. The UK Math Dept. owned a couple of Fridens which, like all Fridens, had the habit of jamming, an irritation the secretaries relieved by randomly prodding its innards with a pair of scissors.

The approaching digital age coupled with rapid advances in new and exciting subject areas signaled wholesale changes in course offerings. During the next decade or so, long standing courses such as Theory of Equations, Projective Geometry, Curve Tracing, Analytic Mechanics, Solid Analytic Geometry, Operational Calculus and Calculus of Finite Differences would give way to a modern lineup including Linear Algebra, Probability Theory, Partial Differential equations, Approximation Theory, Advance Numerical Analysis, Algebraic Topology, Functional Analysis and Homological Algebra.

The 1950s also ushered in the electrified version of the old hand-cranked mimeograph machines, making it easy to distribute reams of "dittoed" or "mimeographed" material. This technology marked a tremendous advance in efficiency, or so it was perceived. However, if you wanted to produce a publishable

manuscript you had to depend on departmental staff or prepare it yourself with a modified personal typewriter.

More fundamental changes in efficiency arrived in the 1960s: the Xerox machine and the IBM Selectric typewriter. Then one could insert a “mathematical typeball” and in an instant be ready to prepare a math manuscript. Of course, the Xerox machine made it possible to quickly prepare a variety of materials for class distribution. Within a few semesters math chairs throughout the country were issuing memos urging their faculty to curtail Xeroxing expenses. The outdated mimeograph machines went into a closet.

Before its move to the Patterson Office Tower in 1969, the Math Department occupied the first floor of McVey Hall. The University’s Computing Center was in the basement. Its IBM 360 mainframe operated on the punched card system: you generated your program cards on an electro-mechanical keypunch machine, then submitted your stack to the programming queue and came back later to retrieve your finished product. This system persisted into the early 1970s.

Hewlett-Packard entered the hand-calculator market in 1972 with its HP-35, the first hand calculator to include the trigonometric and transcendental functions. Despite being a bit pricey at $395 it was well received and valued for being rugged and extremely accurate. However, its use of Reverse Polish notation-that is, “8”+”5” is entered “8’,”Enter”,”5”,”+” instead of the algebraic “8”,”+”,”5”,”=” – limited its appeal later, especially when one could purchase a TI-30 for less than $30.

The first programmable hand calculators , though short on storage, created quite a stir. Some faculty, especially J. D. Buckholtz, were geniuses at getting a lot done with small capacity.

In the decades 1970-1990 most university departments, especially those outside engineering and computer science, benefited from the digital revolution at a pace dictated by the central administration. But that trickle down process didn’t apply here because the UK Math Department became a participant in the revolution, making its own contributions to the digital age.

The opportunity arose at the end of the Math Department’s Center of Excellence Grant in 1973. It was discovered that around $20,000 was left in one of the accounts and permission was given to use the sum toward purchase of a Digital Equipment Corporation (DEC) PDP-8. Once installed on the 9th floor of Patterson Office Tower, computer scientist Tony Baxter and mathematicians Paul Eakin and Ken Kubota set about getting it up and running.

During this period the Department acquired five or so TRS-80s (Tandy-Radio-Shack) desktop microcomputers. The little lab they formed gave faculty and students the opportunity to learn Basic and to introduce a computational component into the calculus sequence. At the same time Don Coleman was introducing hand-held calculators into his summer courses for K-12 teachers.

In the late 1970s another DEC product, a PDP-10, appeared on the 9th floor, courtesy of Wimberly Royster who had acquired it to assist work of the graduate school and, of course, it also served as a platform for both math and computer science faculty

to extend their expertise. One major step, carried out by Eakin and Kubota, was the acquisition of the computer language C from a colleague at the Univ. of Cincinnati.

By now NSF and other funding agencies had decided to make substantial funds available in promotion of the digitalization of American universities. Under these favorable conditions it became possible to involve both undergraduate and graduate students in an investigation of how to best utilize the technology. Soon Patterson Tower's ninth floor offices fairly hummed, both day and night, with aspiring techies. It was almost as if students were competing for the opportunity to get involved.

In the early 1980s various grants supported the conversion of CB 339 (the classroom building adjacent to Patterson Tower) into a terminal equipped laboratory which, for years, served math, statistics and computer science as well other A&S departments. For the first time students could obtain immediate printouts of their work. A broadened research program and installation of office terminals followed the acquisition of a VAX 750.

In spring 1986 offices were finally equipped with computers that provided access to e-mail and computational software such as Maple. Equivalent service appeared on graduate student desks shortly thereafter.

Eakin and Kubota developed the idea of Web-based homework in 1997, tested it in MA 123 and gradually expanded it to most lower-division courses. A natural outgrowth of existing technology, it was implemented at a propitious time because repeated budget cuts over the previous two decades had effectively eliminated the paper-grading budget.

A further extension of the technology now supports a technical interface with the Kentucky Public School system. This means that for participating schools and for selected courses-for example advanced placement courses- high school students have access to essentially the same learning experience as their collegiate counterparts.

8. Women's Role

While the role of women in mathematics is currently well established and even rapidly expanding, over the period leading up to WWII and even later it was hampered by a repressive tradition that had its roots in Europe. The cruelty of that tradition is epitomized by the plight of the great German algebraist Emmy Noether, who, after obtaining her doctorate, taught for several years without pay and, when invited to Göttingen by David Hilbert, was forced to teach under his name. In U.S. mathematics departmental discrimination against women applicants often was of a more subtle nature: their files were simply placed at the bottom of the stack. Thus, even the most talented woman's opportunity for appointment to a major university was seriously limited. A major blow against that practice occurred in 1971, when topologist Mary Ellen Rudin was promoted from instructor to professor at the University of Wisconsin. That event, coupled with the quality of her research and her

ubiquity within the American mathematical community, provided a constant and positive reminder to all of women's capabilities.

When Elizabeth LeStourgeon joined the department in 1920, she was the only woman Ph.D. in the entire college faculty of around 160 (counting instructors), one of only nine women at the assistant professor level or higher, and the only woman at that level in the mathematical and physical sciences. At the time of her appointment LeStourgeon was already 40, having spent twenty years teaching at small colleges and taking graduate courses as time and resources permitted. Nonetheless, her thesis merited publication in the *Transactions of the American Mathematical Society.*[6] With the appointment of Sally Pence to an instructorship in 1929, the Department counted two women in a faculty of no more than a dozen. After receiving her doctorate, Pence was promoted to assistant professor in 1938 and to professor in 1956. Both women spent the rest of their careers at UK, LeStourgeon retiring in 1946 and Pence in 1963; and both would live into their 90s.

The first woman to earn a Ph.D. in mathematics from UK (in 1943) was Aughtum Smith Howard who served for many years as a professor at Eastern Kentucky University. Of the thirty-six Ph.D.s granted by the Department up to 1965, six were awarded to women. In the ensuing forty-seven years _____ women have earned Ph.D.s, and the Department has been cited nationally as having a high percentage of female doctoral students. We mention two who stand out:

Susanne Lenhart graduated in 1981 with a thesis supervised by Lawrence C. Evans. She is now professor at the University of Tennessee, past president of the Association of Women in Mathematics, and a member of the SIAM Board of Trustees. Her research area is partial differential equations and optimal control, and she has recently completed a joint-authored book entitled *Optimal Control Applied to Biological Models*. She has supervised nine doctoral students.

Elizabeth Yanik earned her Ph.D. in 1982 with a thesis in numerical analysis supervised by Graeme Fairweather, and is now professor at Emporia State University. Her energetic and successful development of programs promoting early research experiences has brought her national recognition including, the 2004 Presidential Award for excellence in science, mathematics and engineering mentoring.

9. MathExcel and the Math House

Uri Treisman is professor of mathematics and director of the Charles A. Dana Center for Mathematics and Science Education at the University of Texas. He is credited as being the creator of a pioneering program aimed at helping students, especially those from underprivileged backgrounds, improve their performance in calculus. But in the 1960s he was just a young assistant professor at Berkeley puzzling over

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6 Elizabeth LeStourgeon, "Minima of Functions of Lines," *Transactions of the American Mathematical Society* 21 (1920): 357-383. <http://www.ams.org/journals/tran/1920-021-04/S0002-9947-1920-1501150-2/>

why some student cohorts with relatively similar backgrounds seemed to perform radically better than others. The reason, he found, was study habits. Asian American students, without encouragement it seemed, naturally formed study groups, while African American students practically never studied together. Hence the idea of MathExcel: workshops in which students work together in small groups to solve challenging math problems.

Over the last few decades, many universities and college math departments have developed their own versions of MathExcel. The version developed at the University of Kentucky is different, however, in that the program utilizes the facilities of a Math House, a private residence dedicated to activities of the Department. We owe this unique combination to the efforts of Professors Michael Freeman and Paul Eakin.

In the 1980s it was possible for TAs as well as interested faculty to learn the ins-and-outs of running a MathExcel program by attending a summer workshop in Austin. Our program developed quickly after Mike returned from just such a conference and very soon he was lobbying for a special meeting place to accommodate our MathExcel students.

With luck and considerable lobbying, hard work, and amazing administrative support, Mike Freeman and Paul Eakin succeeded in having a University-owned house transferred to the Math Department's use. It served for twenty years or so as the MathHouse and though recently destroyed to make way for a sorority house, the University has generously replaced it with another house just off campus. Mike's personal story is available in…… .

The genius of MathExcel is that it creates a learning community, a sort of academic sanctuary. It goes a long way toward making hard work fun. By studying with others in a relaxed off-campus setting, students develop a comradery and commitment they might not otherwise acquire. MathExcel students feel supported and encouraged, and as a consequence even the weaker students do not give up as quickly.

After being in operation for almost 25 years, MathExcel at UK remains vibrant and popular. Indeed, the problem-solving tradition and joint effort atmosphere it promotes is beginning to appear in other recitation sessions.

10. Outreach

In the decades leading up to WWII mathematics teachers in American public and parochial schools faced extremely limited opportunities for professional development. The country was locked in a great depression, fundamental instructional deficiencies had yet to be identified, and elementary and secondary texts long in use were in great need of revision. But perhaps most important, the American mathematical community was still young and few of stature were willing to turn attention to the public arena.

There were exceptions in Europe and Russia. In the 1920s and 1930s the great Polish mathematician Stefan Banach wrote arithmetic, algebra and geometry texts

for high school plus a text in differential and integral calculus. Similarly, I. M. Gelfand, both in his long years in Russia and in the U.S., authored high school texts. Richard Courant's two volumes, translated from the German by E. J. McShane of the University of Virginia, was the first high quality calculus treatise available to the American reader.[7]

During a twenty year period following WWII, the Mathematical Association of America, through its Committee on the Undergraduate Program in Mathematics (CUPM) formed a number of separate panels charged with the responsibility of making recommendations in support of a new mathematics curriculum for colleges and universities. The final proposal, issued in 1965, recommended a general mathematics curriculum built around the following courses:

- Math 1. Introductory Calculus(4 semester hours)
- Math 2. Multivariate Calculus, Limits and Differential Equations
- Math2P. Introductory Probability
- Math 3. Linear Algebra
- Math 4. Advanced Multivariable Calculus
- Math 5. Algebaic Structures
- Math 6. Probability and Statistics
- Math 7. Numerical Analysis
- Math 8. Geometry
- Math 9. Applied Mathematics
- Math 10 . Introductory Real Variable Theory
- Math 11. Complex Analysis[8]

It was no accident that a course in Linear Algebra appeared in our math program at approximately the same time.

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7 See Roman Kaluza, *Through a Reporter's Eyes: The Life of Stefan Banach* (Birkhauser Boston, 1996); *Trigonometry*, I. M. Gelfand and M. Saul (Birkhauser Boston, 2001); and *Differential and Integral Calculus*, vols. I & II, Richard Courant (New York: Iterscience Publishers, Inc., 1934).

8 W. L. Duren, "A General Curriculum in Mathematics for Colleges," *American Mathematical Monthly* 72 (October 1965): 825-831. <http://www.maa.org/sites/default/files/pdf/CUPM/pdf/CUPM_Report_1965.pdf>

This was the time period at which the mathematical community began to understand that such ambitious collegiate programs could not prosper unless and until elementary, middle and high school teachers of mathematics were properly trained and provided with essential resources and technologies. In response, the national Science Foundation and other educational agencies began the expansion of grant opportunities to include summer teacher training programs.

In the late 1960s the UK Math Department offered only two courses for elementary and middle school teachers, Fundamentals of Elementary Math I & II. One of the faculty assigned to these courses, Don Coleman, began to make contacts within the College of Education and to build a network of local elementary and middle school teachers. In 1971 he taught the first NSF summer project: 25 teachers for six weeks, six hours per day. Several other NSF projects followed in which he involved Paul Eakin and others as co-PIs. In 1975 Coleman made a bold move: he requested and was granted leave for a semester to teach at Garden Springs Elementary here in Lexington.

Other members of the Department also were reaching out to the community. Michael Freeman, in his tireless efforts to grow the MathExcel program built a network of counselors in local and regional high schools in order to make contact with high performing students.

Beginning in the 1990s the UK Math Department provided key leadership for a succession of large NFS grants directed to the improvement of K-14 and K-16 math and science education in Kentucky and adjacent states. The first of these resulted from the use of external pressure successfully modifying a new NSF program.

After NSF turned its educational focus to troubled urban schools, Wimberly Royster sensed the opportunity to broaden that initiative to include rural schools and after persistent lobbying of Luther Hodges, then Assistant Director, NSF created the Rural Systemic Initiative in 1995. One of the regions covered was a group of sixty-six poverty-stricken counties spread across a six state consortium involving Kentucky, Ohio, West Virginia, Virginia, Tennessee, and North Carolina. With Dr. Royster as principal investigator, this $10 million grant, known as the Appalachian Rural Systemic Initiative (ARSI) began in 1995. It was organized around three fundamental goals: 1) to dramatically increase knowledge and skills among K-14 teachers; 2) to provide access to educational resources and build a sustainable system; and 3) to build leadership and regional partnerships.[9]

As ARSI came to an end several other Math faculty were involved in larger grants directed to K-14 students and educators. The first was ACCLAIM (Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics), another $10 million grant, beginning September 1, 2001. This grant set up an inter-institutional program involving faculty from UK, the University of Louisville, Ohio University, West Virginia University, Marshall University, and the University of Tennessee. The program component most involved with UK Math was that directed

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9 The Appalachian Rural Systemic Initiative (ARSI): An Evaluation Portfolio <http://www.inverness-research.org/arsi/3welcome.html>

to the training of good math teachers in Appalachia to the Ph.D. level in order that they themselves become good trainers of teachers.[10]

The program structure required a high, probably unprecedented, level of cooperation between the involved graduate programs. For example, students were to be admitted simultaneously as in-state students in all participating institutions and Ph.D. committee composition responsibility was also to be shared. As one of the co-PIs, Professor Carl Lee was asked to lead this effort.

The students were chosen from the ranks of in-service teachers who had to squeeze their course work into a series of three, five week summer programs plus two on-line courses each semester during each of the following academic years. Carl was the instructor for many of these courses both in lecture and on-line form. Summer programs rotated among consortium members, the first cohort meeting at the University of Tennessee in the summer of 2002. And after a decade of courses and research projects almost half of the forty-five participating teachers have finished their Ph.D.s in math education.

Operating essentially parallel to ACCLAIM was another product of Wimberly's vision for rural education. This grant, under the title "The Appalachian Mathematical and Science Partnership," (AMSP) was funded in October 2002 for $25 million. It involved fifty-one school districts and nine universities and colleges in Kentucky, Tennessee and Virginia. UK served as the fiscal agent and provided most of the project leaders: Paul Eakin, Lead PI; Carl Lee, Co. PI; Wimberly Royster, co-Pi/Project Director. They were joined by Steve Henderson, Project Director for ARSI and John Yopp, Assoc. Provost for Education Partnerships at UK.

The goals of the grant were enormously ambitious, both in scope and size.

- Close achievement gaps in math, science and technology in the involved school districts.

- Build a higher educational system to ensure the selection, development and career-long support of a high quality math and science teacher work force.

The grant also required UK to fill two tenured positions dedicated to math and science outreach. In the Math Department that position is now held by David Royster.

AMSP clearly had the potential of being unwieldy and without significant impact. But, according to those who evaluate such ventures, it was not. Its regional directors quickly embraced local leaders, many of whom had participated in earlier projects, and encouraged participation by teachers, counselors, K-12 administrators and higher education faculty and administrators. The end result was a palpable increase in local leadership capacity for math and science improvement.[11]

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10 Rural Mathematics Education and ACCLAIM <https://sites.google.com/site/acclaimruralmath/Home>

The sum total of all these grants, going back to those secured by Don Coleman in the early 1970s, must total between $50 and $60 million. Thus the UK Math Department has become a leader in improving math education and teacher training in Kentucky and Central Appalachia. In doing so it has gained modest prestige and considerable respect among those Kentucky educators it has served.

Finally, it is interesting to note that at least three UK math professors admit to having some experience as high school teachers: Carl Lee, Russell Brown and David Royster.

Conclusion: A Maturing Graduate Program

In 1930 the University of Kentucky granted its first Ph.D. degree in mathematics to Smith Park, later chair at Eastern Kentucky University. His thesis, entitled "On Certain Identities in Theta Functions," was directed by Claiborne Latimer. By 1940 four more UK students had earned their doctorates, and thirty more followed in the years from 1940 to 1965. The resignations of Latimer, LeStourgeon, and Cohen in 1947, followed by the arrival of A. W. Goodman and Vincent Cowling in 1949 signaled a dramatic shift in the Department's graduate program—away from algebra toward complex variables and classical analysis. Statistics was also eliminated with the retirement of Eugene South in the early 1950s. This group, Goodman and Cowling, reinforced by the return of Royster in 1956, was responsible for all fourteen of the last Ph.D.s leading up to 1965.

The appointment of W. C. Royster as chairman in 1963, coupled with an infusion of significant funds dedicated to new faculty positions, allowed the Department to engage in serious planning that would lead to dramatic broadening and growth of research.

The first returns from this investment appeared in the period 1966-1970, when forty students earned doctorates. Of the twelve faculty directing this research, all but two had joined the department after 1962. In the decade 1971-1980 the Department granted forty-three doctorates.

During this period, from the early 1960s to 1980, the Department's research areas, as indicated by thesis advisors, were:

- Algebra: Edgar Enochs, James Beidleman, Donald Coleman, Paul Eakin
- Topology: Tom Chapman, John Mack, Michael McCord, Carl Eberhart, Brauch Fugate, Wayne Goodman
- Differential equations: Carl Lagenhop, Henry Howard

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11 "The Appalachian Math Science Partnership: A Multi-State Umbrella Partnership Promoting Local Mathematics And Science Reform," Inverness Research Inc., January 2008. <http://www.inverness-research.org/abstracts/ab2008-01_Rpt_AMSP-umbrella_report.html>

- Complex variables: S. M. Shah, Wimberly Royster, Frank Keogh, J. D. Buckholtz, Michael Freeman, Ted Sufferidge
- Optimization and stochastic control: Anders Linquist, Roger Wets
- Numerical analysis: Graeme Fairweather
- Real analysis: T. L. Hayden, J. H. Wells

After 1980 the budgetary growth that had defined the previous two decades slowed and then became static, and this reversal of fortunes gradually pushed Kentucky higher education into a period of decline that would last for decades. With some difficulty, the university administration met its commitments made earlier to the Science Development Grant. Computer science had now become an attractive graduate major for some students who earlier, perhaps, might have chosen mathematics. The confluence of these factors had a negative impact on the Department's graduate program and figured in the reduction of the Ph.D. production to eighteen over the period 1981-1990. No Ph.D.s at all were produced in 1983-84 and 1986-87.

New Ph.D. advisors in this decade were:

- Analysis and partial differential equations: Lawrence Craig Evans, John Lewis, Ron Gariepy
- Stochastic control: Raymond Rishel
- Topology: Fred Cohen
- Algebra: David Leep

This lull in graduate production was short-lived, for in the following decade 1991-2000 the Department produced a total of 72 Ph.D.s and introduced several new thesis advisors:

- Applied and computational math: Zhaojun Bai, Lother Reichel, Bernard Bielecki.
- Analysis and partial differential equations: Peter Hislop, David Adams, Peter Perry, Russell Brown.

Much of the remarkable rebound in Ph.D. production at that crucial moment and the continuing vitality of the program were due to the work of Brauch Fugate, Director of Graduate Studies in the late 1980s and early 1990s. He made sure that the Department was a welcoming and stimulating place. He built a recruiting network of four-year colleges, organized annual events for graduate students at AMS meetings and truly believed that one's current team of graduate students is the best recruiting tool available.

The efforts of the 1990s carried over to the decade 2001-2010. A total of 55 Ph.D.s were produced with the following new names as thesis advisors:

- Algebra and number theory: Uwe Nagel
- Analysis and partial differential equations: James Brennan, Larry Harris, Changyou Wang, Zhongwei Shen
- Topology and geometry: Vassily Gobounov
- Applied and computational math: Craig Douglas, Chi-Sing Man, Su Ha Kang, Qiang Ye
- Discrete math: Margaret Readdy, Richard Ehrenborg

From 1930 to the summer of 2013 the UK Department of Mathematics granted 280 Ph.D.s. Some pursued careers in academic research at universities such as UNC at Chapel Hill, Vanderbilt University, University of Minnesota, Michigan State University, Florida State University, University of Tennessee, University of Louisville, and University of Cincinnati. Many more entered teaching careers at smaller universities and colleges. Others, both past and present, occupied positions in the federal government, in diverse industries, and as leaders of their own companies.

Despite decades of disappointing higher education budgets, the Department faculty continues to be animated by its strong commitment to research. Out of a full-time faculty now hovering in the mid-thirties, some seventeen currently hold research grants.

No mathematics professor and perhaps no professor in the University has made greater contributions to graduate education than Edgar Enochs. Since his arrival in 1969, he has maintained a vigorous research program while supervising over forty Ph.D.s here at UK, in addition to nine he has supervised at the University of South Carolina.

Any mathematician involved in academic hiring knows how difficult it is to attract talented young faculty, and once hired how very difficult it is to retain that talent. Like all departments successfully aspiring to excellence at the graduate level, the UK Department has been privileged to be the home of exceptionally talented individuals. While some have chosen to develop their careers here, others have followed attractive opportunities elsewhere. Many deserve to be mentioned; we list only three:

Anders Linquist received his Ph.D. from the Royal Institute of Technology (RIT) in Sweden. He came to UK in 1974 and worked with Roger Wets and Raymond Rishel in developing a program in operations research and stochastic control. He returned to Sweden in 1983 to become professor and chair of the Department of Optimization and System Theory at RIT and has since received many honors and awards for his contributions to the theory of stochastic systems, signals, and controls. He has served in numerous visiting positions and is one of the few academics to have held professorships on three continents.

Robert E. Bixby, Ph.D. Cornell, took a position at Rice after serving our Department from 1972-1977. He is now Professor Emeritus of applied mathematics and Research Professor of management at Rice University. He is a world leader in optimization and design programming. A recipient of many awards and visiting appointments, Dr. Bixby is former president of the Mathematical Programming Society and founder of the company CPLEX Optimization.

Lawrence Craig Evans, Ph.D. UCLA, was assistant and then associate professor at UK from 1975-1980. Now a professor at the University of California at Berkeley, he is author of a widely acclaimed graduate text in partial differential equations and the joint winner of the prestigious Steele Prize for outstanding contributions to mathematical research.

Each year the University designates a group (usually four) of its faculty as University Research Professors in recognition of outstanding research. This honor carries an award of $40,000 to enable the nominee to devote full time to research. Mathematics professors Peter Hislop, Chi-Sing Man, Peter Perry, and John Lewis have been recent recipients.

The College of Arts and Sciences also annually honors one of its faculties with the Distinguished Professor Award, which provides a research year at full salary. Three of our mathematics faculty, Professors S. M. Shah, Tom Chapman, and Peter Perry have been so recognized.