## History

of the

# Mathematics 

## Department

Second Edition

$\int_{1889}^{2009} E v e n t s d t$

Nicholas J. Rose

# HISTORY <br> of <br> THE MATHEMATICS DEPARTMENT <br> at <br> NORTH CAROLINA STATE UNIVERSITY 

Second Edition
by

Nicholas J. Rose


A self-similar fractal

Copyright © 2004 by Nicholas J. Rose
Copyright © 2009 by Nicholas J. Rose
All Rights Reserved
[092309][111109]

Mathematics Department
2311 Stinson Drive
North Carolina State University
Raleigh, NC 27695-8205

## Contents

Preface ..... v
1 The Founding of North Carolina State University ..... 1
2 Mathematics from 1889 to 1906 ..... 3
3 The Mathematics Department 1906 to 1932-The Yates Years ..... 7
4 The Mathematics Department 1932 to 1957—The Fisher Years ..... 13
5 The Mathematics Department 1957 to 1967-The Cell Years ..... 23
6 The Mathematics Department 1967 to 1977—The Park-Rose Years ..... 33
7 The Mathematics Department 1977 to 1980—The Ortega Years ..... 45
8 The Mathematics Department 1980 to 1989-The Burniston Years I ..... 49
9 The Mathematics Department 1989 to 1999—The Martin Years ..... 59
10 The Mathematics Department 1999 to 2002-The Burniston Years II ..... 69
11 The Mathematics Department 2002 to 2006-The Interim Years ..... 73
12 The Mathematics Department 2006 to 2009-The Helminck Years ..... 83
Bibliography ..... 96
Index ..... 97


Memorial Bell Tower
(Picture courtesy of Rome Press)
The North Carolina State University Memorial Bell Tower was built to honor the alumni who died in World War I ${ }_{\square}^{1}$ Construction on the 115 -foot monument started in 1920 but was not completed until 1937. However the clock had not yet been installed in the tower. The student honor societies and the Class of 1938 provided for the clock; the Class of 1939 gave the floodlights.

[^0]
## Preface

I retired in 1989 but continued to teach part time until 2001. One day in 2000 Ernie Burniston, who had just started his second term as head of the mathematics department, asked me if I would write a history of the department. I was rather non-committal at the time but said I would consider it. A year later when I gave up teaching for good, I made a deal with Ernie that I would write the history in return for keeping my office. I thought that the project would take a few months-I have worked on it on-and-off for almost three years.

Some of the material for this project was obtained from the North Carolina State University Archives. Many thanks to the staff of the Archives, particularly Herman J. Trojanowski and Reed Underhill for their generous help. They pointed out potential sources and made many copies of both printed material and photographs. A great deal of information was gleaned from university catalogs and the Harrelson v's, a departmental newsletter. Perhaps the majority of material was obtained from present and former faculty members and staff. I thank them all for their assistance.

Former department heads and acting heads Hubert Park, Ernest Burniston, Robert H. Martin, Jr., Jean-Pierre Fouque and Bernard Mair provided me with much useful material. Charlene Wallace, Departmental Secretary, and Frankie Stephenson, Administrative Assistant, dug out many resumes from old files. I owe them all my gratitude. Special thanks to John Bishir, Richard Chandler, Bethany Meyer, Carl Meyer, Hubert Park and Muriel Rose who read versions of the entire manuscript, corrected many errors, and made valuable suggestions. Undoubtedly, many errors of commission and omission remain; for these I am solely responsible.

Much of this History, together with additional information, is contained in a web-site that may be reached from the mathematics department web-site, [http://www.math.ncsu.edu](http://www.math.ncsu.edu), by clicking on the "History of the department" link.

Finally, I dedicate this work to an NC State graduate, an English Major-my wife, Muriel. She has stood by me through thick and thin, and she has given me her love, help, support and encouragement for almost 58 years.

Nicholas J. Rose

July, 2004

At Loek Helminck's request I have updated this History to 2009.

NJR, September 2009

The art of doing mathematics consists in finding that special case which contains all the germs of generality.
—David Hilbert
That this subject [of imaginary magnitudes] has hitherto been considered from the wrong point of view and surrounded by a mysterious obscurity, is to be attributed largely to an ill-adapted notation. If for instance, $+1,-1, \sqrt{-1}$ had been called direct, inverse, and lateral units, instead of positive, negative and imaginary (or even impossible) such an obscurity would have been out of the question.
-Carl Friedrich Gauss
At first it seems obvious, but the more you think about it the stranger the deductions from this axiom [the axiom of choice] seem to become; in the end you cease to understand what is meant by it.
-Bertrand Russell
Mathematics is the queen of the sciences and arithmetic is the queen of mathematics. She often condescends to render service to astronomy and other natural sciences but under all circumstances the first place is her due.
-Carl Friedrich Gauss

## Chapter 1

## The Founding of North Carolina State University

The pioneering Morrill Land-Grant Act was signed into law by President Lincoln in 1862. This legislation opened the doors of higher education to children of the working classes and added applied science and practical technology to curricula previously dominated by classical and theoretical studies.

Under the terms of the Morrill Act, the federal government provided to each state a grant of 30,000 acres of public land for each of that state's senators and representatives. The states would sell the land and invest the proceeds. The income derived from these investments, called the LandScrip Fund, would be used, according to the law, to establish and endow "at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts in such manner as the Legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

For about twenty years the University of North Carolina (at Chapel Hill) received the interest, amounting to about $\$ 7,500$ annually, from North Carolina's Land-Scrip Fund. In the 1880's many farmers questioned whether the programs at Chapel Hill really met their needs. Their cause was taken up by Leonidas Lafayette Polk, the state's first Commissioner of Agriculture (1877-1880), who called for the establishment of a land-grant college separate from the University at Chapel Hill. In his journal, The Progressive Farmer, Polk argued that the state had failed to fulfill its obligations under the conditions of the Morrill Act. He believed that a new land-grant college for agriculture and the mechanic arts should be established and that the interest from the Land-Scrip Fund should be transferred to the new college. Another voice calling for change was Walter Hines Page, youthful editor of a short-lived, militantly progressive Raleigh paper, The State Chronicle. Page helped to organize the Watauga Club which pushed for the establishment of a new industrial college to be located in Raleigh. In 1885 this group petitioned the General Assembly to authorize
a new college. They received the authorization but no funding. The next year the Watauga Club persuaded the City of Raleigh to provide money and land for a new college. The pressure from the farmers and the Watauga Club finally paid off. On March 7, 1887, the General Assembly authorized the establishment of the North Carolina College of Agriculture and Mechanic Arts (now North Carolina State University) in Raleigh on land donated by R. Stanhope Pullen, a leading Raleigh citizen and philanthropist. (According to legend, Mr. Pullen laid out the original boundaries of the campus with his plow and mule.) The Land-Scrip fund was transferred from Chapel Hill to the new college at Raleigh. The Board of Trustees of the new institution was apportioned under the law evenly between the two political parties, and provision was made for 120 students to be admitted free, with each county entitled to one student for each member sent to the General Assembly. The cornerstone of the main building (now Holliday Hall) was laid in August, 1888, and the College officially opened on October 3, 1889.

From this brief history it is evident that the rivalry and competition between the University of North Carolina at Chapel Hill and North Carolina State University at Raleigh began even before the latter institution was founded.

I know not what I appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell,whilest the great ocean of truth lay all undiscovered before me.
-Isaac Newton
When Newton was asked how he made his discoveries he replied "I keep the subject of my inquiry constantly before me, and wait till the first dawning opens gradually, by little and little, into a full and clear light."

## Chapter 2

## Mathematics from 1889 to 1906

In the fall of 1889 the North Carolina College of Agriculture and Mechanics Arts began its first academic session. Alexander Quarles Holladay was president and there was a faculty of five: D. H. Hill, professor of English; J. R. Chamberlain, professor of agriculture; W. F. Massey, professor of horticulture; A. Withers, professor of chemistry and J. H. Kinealy as professor of mathematics and practical mechanics.

There were two courses of instruction, one in Agriculture and one in Mechanics. Four years of mathematics were offered: for freshmen, arithmetic and algebra; for sophomores, algebra and plane geometry; for juniors, solid geometry, analytic geometry and for seniors, calculus. Trigonometry was taken as part of the surveying course. The Agriculture students took only the first two years of mathematics while the Mechanics students took all four years. Some idea of campus life can be gleaned from the following excerpts from the 1905 College Catalog. The emphasis on Agriculture and the importance of military training and religion is noteworthy.

## PRIZES

A first prize of ten dollars and a second prize of five dollars are awarded annually to the students in the Freshman Class who earn the largest and the next largest amount of money by labor on the College farm. The Zenner Disinfectant Company, Detroit, Mich., offers a silver medal to the student making the best report on the Live Stock Exhibit at the State Fair. The value of this medal is $\$ 25$.

The North Carolina State Fair Association offers a prize of $\$ 5$ to the student preparing the best essay on the Live Stock Exhibit at the State Fair.

## DISCIPLINE

The College is under military discipline and the students are regularly organized into a battalion. . . . The discipline is intended to secure studious and economical habits, with punctuality, system and order in the performance of all duties. A durable
uniform, which is required to be worn on all occasions, prevents extravagance and folly in dress; rooms plainly furnished and a mess-hall economically managed by the College prevent extravagance in living; regular study hours, day and night, with proper restrictions as to visiting Raleigh, check, or at least minimize, tendencies to idleness, vice, and rowdyism.

Every effort is made to develop strong, intelligent, high-toned men; and proper patience, forbearance and sympathy are used in this great work; but the College is in no sense a reform school, and its work must not be hindered by the presence of young men who are grossly vicious, idle or incompetent.

## RELIGIOUS INFLUENCES

All students are required to attend chapel exercises in Pullen Auditorium each morning. These services are conducted by the President, by some member of the Faculty, or by some visiting minister. Each student is required to attend religious service in Raleigh on Sunday morning at the church of his choice.

The Young Men's Christian Association, containing in its membership representatives of all the Christian denominations, meets regularly each Sunday afternoon at 2:30 o'clock for conference, Bible study and worship, and exerts a wholesome influence throughout the College.

Although military training was a required part of the curriculum from the inception of NC State, an ROTC ${ }^{1}$ program to train future officers of the Army (and later the Air Force) did not start until 1916. All male students were required to take at least two years of ROTC training until 1964 when the program became optiona ${ }^{2}$ Women students were not admitted into regular programs at State until 1921; they were excused from military training.

During the first two years of existence of the College, there was no separate Mathematics Department; mathematics was part of the Department of Practical Mechanics and Mathematics. Robert E. Lee Yates was hired as an Adjunct Professor of Mathematics in 1891. He played a major role in mathematics at the College until 1932. By 1892 J. H. Kinealy, the first professor of mathematics and practical mechanics, had left and mathematics became a sub-department of the Department of Mechanics and Applied Mathematics headed by Wallace Riddick. Surprisingly, in 1895-1896, there appears to be a separate "department" called "Pure Mathematics" as indicated in the report by Yates to President Holladay shown on the next page.

[^1]
# REPORT OF ADJUNCT PROFESSOR OF PURE MATHEMATICS 

Col. A. Q. Holladay, President College Agriculture and Mechanic Arts.
Dear Sir:
I have the honor to submit herewith the following biennial report of the work done by me in the Department of Pure Mathematics:

It has been the aim of this department to give the young men a thorough and practical knowledge of this subject. The course begins with the Freshman year, and is completed by the students in the Mechanical engineering course at the close of the Winter term of the senior year. Agricultural and Scientific students drop the study of mathematics with the completion of Trigonometry. The Freshman classes have, during each year, finished Arithmetic with the close of the Fall term. The remainder of the session has been devoted to the study of Algebra, about two-thirds of the subject being completed. The present class has, however, during this term, in addition to Arithmetic, recited Algebra twice a week.
The Sophomores, reciting five times a week, usually complete Algebra a little before Christmas. They then take up Geometry, completing Plane, Solid and Spherical by the end of the session. This class, during the Spring term, takes two recitations a week in Trigonometry additionally. It has been my pleasure to give the present class more in the theory of Equations than any preceding one. This, doubtless, will be of considerable advantage to them in their applied Mathematics.
The Juniors finish Trigonometry during the latter part of the Fall term, and spend the remainder of the session on Analytical Geometry. The present class will very nearly complete this subject by the end of the Junior year, which is very desirable.
The Seniors are under the charge of Professor Riddick [for Calculus].
Respectively submitted
R.E.L. Yates

Adj. Professor of Pure Mathematics
(From Chancellor's Office, 1895-96 Folder,UA \# 2.21, NC State University Archives)
In 1895 the program in Mechanics was dropped in favor of a program in Engineering. Mathematics was placed in the new Civil Engineering Department with Wallace Riddick as head. In 1896 the Populist-Republican party won control of the North Carolina Legislature and appointed a new Board of Trustees for the College. Several professors were fired including Yates ${ }^{3}$ However Yates was a

[^2]popular instructor and the Board soon reinstated him. This was one of several times when the North Carolina Legislature exercised its power over Public Higher Education. By 1906, the enrollment of the College had increased to almost 500, and the powers that be decided to make mathematics into a separate Department ${ }^{4}$

Pure mathematics consists of such association as, if such and such a proposition is true of anything, then such and such another proposition is true of that thing. It is essential not to discuss whether the first proposition is really true, and not to mention what the anything is of which it is supposed to be true.... . If our hypothesis is about anything and not about some one or more particular things, then our deductions constitute mathematics. Thus mathematics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true.
-Bertrand Russell

Everyone knows what a curve is, until he has studied enough mathematics to become confused through the countless number of possible exceptions.
-Felix Klein

The shortest path between two truths in the real domain passes through the complex domain.
—Jacques Hadamard

Mathematics is a game played according to certain simple rules with meaningless marks on paper.
—attributed to David Hilbert

[^3]
## Chapter 3

## The Mathematics Department 1906 to 1932—The Yates Years

Robert E. Lee Yates became the first head of the Mathematics Department at North Carolina A\&M in 1906. The department consisted of Yates and three instructors-Carroll L. Mann, John A. Park and Michael R. Richardson.
R. E. L. Yates was born on his father's farm on December 19, 1866. He attended the Raleigh Male Academy where he obtained an excellent preparation for college from the founder of the academy, Capt. T. J. Fray, and Professor Hugh Morson.

Football fans may get a kick out of this: On March 12, 1892, the North Carolina A\&M Aggies (now N C State) played their first and only football game that year at the Raleigh Athletic Park (now Pullen Park). Their opponent was the aforementioned Raleigh Male Academy. The Aggies won 12-6 ${ }^{1}$

Yates went to Wake Forest University in 1888, received his Master's Degree in four years, and was salutatorian of his class. He spent several years on his father's farm before becoming an adjunct Professor of Mathematics at NC A \&

R. E. L. Yates
(From 1909 Agromeck) M in 1891. The next year he married Miss Minnie Elizabeth Johns of Auburn (Wake County, North Carolina). Yates served on the faculty at State College until 1905 when he left for graduate study at the University of Chicago. In 1906 he returned as Professor and Head of the Mathematics Department ${ }^{2}$

[^4]Following is an excerpt from the 1906 Catalog indicating the general philosophy of the mathematics department and the courses taught:

## MATHEMATICS

While the subject of Mathematics is presented in such a manner that the student obtains a thorough working knowledge of those principles which he needs in his Engineering Courses, yet, at the same time, it is not the purpose to subordinate the general theory of Mathematics to the practical side. The work consists of recitations, written exercises and lectures, the scope being quite sufficient for the needs of the institution.
261. Arithmetic.-Milne's Standard Arithmetic. Begin with decimal fractions and complete the subject. Five periods, first term. Required of first year students in Mechanic Arts. Mr. Holmes and Mr. Mann.
262. Algebra.-Well's Higher Algebra. Up to quadratic equations. Five periods, second and third terms. Required of first year students in Mechanic Arts. Mr. Holmes and Mr. Mann.
263. Algebra.-Well's Higher Algebra. Begin at quadratic equations and complete logarithms, embracing ratio and proportion, variation, the progressions, the binomial theorem, series and partial fractions. Five periods, first term; two periods, second term. Required of all Freshmen and of second year students in Mechanic Arts. Mr. Richardson and Mr. J. A. Park.
264. Geometry.-Plane and Solid. Wentworth's Plane geometry. Three periods second term; five periods, third term. Required of all Freshmen and of second year students in Mechanic Arts. Four periods, third term. Required of all Freshmen and second year students in Mechanic Arts.
265. Solid Geometry. Required of Sophomores, Five periods, first term. Professor Yates, Mr. J. A. Park and Mr. Richardson.
266. Advanced Algebra.-Well's Higher Algebra. Compound interest and annuities, permutations, combinations, continued fractions, general theory of equations and the solution of higher equations, etc. Required of Sophomores, Three periods, second term. Professor Yates and Mr. J. A. Park.
267. Trigonometry.-Phillips \& Strong's Plane and Spherical Trigonometry. Plane Trigonometry. Solution of plane triangles, triangulation, etc. Spherical Trigonometry. Solution of spherical triangles. Required of Sophomores. Two periods, second term; five periods, third term. Professor Yates and Mr. J. A. Park.
268. Analytic Geometry.-Nichols's Analytic Geometry. Conic Sections, higher plane curves, Geometry of three dimensions. Four periods, first and second terms. Required of Juniors. Professor Yates.
269. Differential and Integral Calculus.-Osborne's Elements of Calculus. A thorough treatment of the fundamental principles and derivation of formulae; application to various problems, such as expansion into series, evaluation of indeterminate forms, maxima and minima, radius of curvature, lengths of curves, areas, volumes, etc, Four periods, third term. Required of Seniors. Professor Yates.

In the catalogs around 1920, two courses were offered which seem strange to us today, namely, Agricultural Mathematics and Farm Mathematics.

Agricultural Mathematics.-Kenyon and Lovitt's Mathematics for Agriculture and General Science. This course consists of elementary Geometry, Trigonometry, and Conic Sections, with their practical applications to Agricultural Science.

Farm Mathematics. In teaching this course, problems for solution will be of the nature of those coming up daily on the average farm, such as calculating the plant food contained in and removed by different crops when fed and when sold directly from the farm; fertilizer formulas for different crops using different classes of materials; rations with different kinds of feed and for different kinds of animals, engaged in different kinds of work; capacity of different classes of farm buildings; speed of pulleys; draft of farm implements of different kinds; size of drainage tile for different conditions; capacity of cisterns and silos; quantity of different materials needed for preserving different kinds and amounts of meats; measure of hay in the barn or stack; amounts of concrete, sand and gravel needed to construct walls or floors of different kinds; number of feet of lumber woodlands of different kinds will yield; and thousands of other practical farm problems the thoughtful farmer has to work out.

In 1917 the growing importance of engineering precipitated a change in the name of the College from the North Carolina College of Agriculture and Mechanic Arts to the North Carolina State College of Agriculture and Engineering. This also brought the College more in line with other land-grant colleges ${ }^{3}$

The mathematics department in 1921 is depicted on p. 10. Besides Yates, several of those shown played significant roles in the development of the mathematics department. John Harrelson was head of the mathematics department in 1933-1934 and then became Dean of Administration of the College. Hilbert Fisher was head of the mathematics department from 1934 to 1957. Page Williams and Harry Mock served on the faculty for many years.

[^5]

## Department of Mathematics

Robert E. Lee Yates Professor
John W. Harreison
Associate Professor
Harry L. Mock
Assistant Professor

Hilbert A. Fisher
Instructor
Harvey P. Williams Instructor
John H. LeRoy Instructor

By far too many students look upon Mathematics as a monstrosity. They have never fully realized its importance and its practical application. Life is fascinating, and whatever is close to life and its activities should have a charm and an interest for the average student.

It makes no difference what vocation a student may choose to follow, he needs the training in precise and accurate thinking that is characteristic of the student of Mathematics, to say nothing of the utilitarian side. The ideals of neatness, accuracy, and systematic arrangement will influence all other work. All thought expression will be more direct, clear and concise.

The teaching of Mathematics should also be vitalized. It should be brought close to life, for it is the fundamental basis of all our great enterprises. Facts and formulx that have been centuries in making are being used to accomplish many remarkable things-so, while the subject is old with the ages, it is new with life.

In the North Carolina College of Agriculture and Engineering. Mathematics holds a very important place. It is the foundation of all engineering courses. Every engineering student is required to take all courses offered.


The Mathematics Department in 1921
(From the 1921 Agromeck Yearbook)

In 1923 the College was reorganized into three schools: Agriculture, Engineering, and Business and Science. The department of mathematics was placed in the School of Business and Science under Dean B. F. Browne. At that time there were 6 faculty in the mathematics department: Professors R. Yates (Head) and J. Harrelson; Assistant Professors H. Fisher, H. L. Mock and P. Williams; and Instructor F. A. Lee. The courses offered were: Algebra, Solid Geometry, Trigonometry, Analytic Geometry, Differential Calculus, Integral Calculus, Advanced Calculus, Theory of Equations, Differential Equations and Advanced Analytic Geometry.

There were few changes in the course offerings until 1929 when three new courses were introduced: Vector Analysis, History of Mathematics and Theory of Equations. These were offered as courses for advanced undergraduates and graduate students. Of course there were no undergraduate or graduate math majors at this time. The courses were taken by graduate students in other disciplines or as preparation for graduate degrees in mathematics at other colleges.

In 1928 the Mathematics Department moved to the Engineering School because of difficulties between Dean Browne and Mathematics faculty ${ }^{4}$ The department remained in the School of Engineering until 1960 when the School of Physical Sciences and Applied Mathematics (PSAM) (now College of Physical and Mathematical Sciences (PAMS)) was founded. Professor Yates served as Head of the Mathematics Department until 1932. The department increased from four in 1906 to nine in 1932. The department in 1932 consisted of Professors H. A. Fisher, R. E. L. Yates; Assistant Professors H. L. Mock, H. P. Williams, F. A. Lee, Jr., C. G. Mumford and J. Fontaine; Instructor W. H. Jurney and Teaching Fellow D. B. Thomas (a graduate student in Physics). There were no Ph.D.'s on the mathematics faculty. The student body had increased from just under 500 in 1906 to 1697 in 1932.

A mathematician of the first rank, Laplace quickly revealed himself as only a mediocre administrator; from his first work we saw that we had been deceived. Laplace saw no question from its true point of view; he sought subtleties everywhere; had only doubtful ideas, and finally carried the spirit of the infinitely small into administration.
—Napoleon

[^6]The mathematical facts worthy of being studied are those which, by their analogy with other facts, are capable of leading us to the knowledge of a physical law. They reveal the kinship between other facts, long known, but wrongly believed to be strangers to one another.
-Henri Poincaré

Riemann consulted a doctor about his diet. He was told to reduce the amount of food he ate at each meal but to increase the number of meals. He proceeded to do so and ultimately ate infinitesimal amounts infinitely often. He found that his weight did not change. Shortly after this he gave a precise definition of a definite integral.
—Anonymous

The analytical geometry of Descartes and the calculus of Newton and Leibniz have expanded into the marvelous mathematical method-more daring than anything that the history of philosophy records-of Lobachevsky and Riemann, Gauss and Sylvester. Indeed, mathematics, the indispensable tool of the sciences, defying the senses to follow its splendid flights, is demonstrating today, as it never has been demonstrated before, the supremacy of the pure reason.
—Nicholas Murray Butler

Of all things, good sense is the most fairly distributed: everyone thinks he is so well supplied with it that even those who are the hardest to satisfy in every other respect never desire more of it than they already have.

## Chapter 4

## The Mathematics Department 1932 to 1957-The Fisher Years

Professor Yates retired as head of the mathematics department in 1932. Hilbert Fisher served as acting head for one year until John Harrelson, who was on leave at the time, could assume the headship in 1933. However, after just one year, Harrelson was summoned to be the chief administrator officer of the College. Fisher then took over as head and served from 1934 to 1957.

Hilbert Fisher was born on Jan. 14, 1892, in Salisbury, North Carolina. He graduated from Mount Pleasant Collegiate Institute (junior college) in June, 1911, and entered the U. S. Naval Academy at Annapolis. He made his letter in athletics for four years, and for three years he was the leading batter on the baseball team. Prof. Fisher graduated from the Naval Academy in June, 1915. During World War I he was in transport service and made 10 round trips to Europe convoying troops. He served on the dreadnought (a battleship armed with six or more guns having calibers of 12 inches or more) U. S. S. New Hampshire for two years and was Executive Engineering Officer for one year. In 1919 Prof. Fisher graduated from the U. S. Submarine School and for the next year was assigned to sea duty on a submarine. He resigned

H. A. Fisher from the navy in 1920 and came to State College as an instructor in the Department of Mathematics. In 1921 Prof. Fisher accepted an offer to be co-principal of the Mount Amoena Seminary at Mount Pleasant; he returned to State College in 1924. In 1927 Fisher received a Master of Science in Physics from State College. He received an honorary doctorate from Lenoir-Rhyne College. Fisher is the author of textbooks in solid geometry and algebra.

John William Harrelson was born in Cleveland County, North Carolina, the son of a tenant farmer. He entered NC A \& M (NC State) in 1905 and graduated with a bachelor's degree in Mechanical Engineering. He was president of the senior class, president of the Mechanical Society, captain of the student military unit, business manager of the Agromeck, and valedictorian of the class of 1909. After graduation he stayed on at the College as an instructor in the Mathematics Department. By 1921 he had become a full professor. He was granted a leave of absence in 1929 to be Director of the State Department of Conservation and returned to North Carolina State in 1933 as Head of the Mathematics Department. After one year as Head he was selected to be Dean of Administration of the College (title changed to Chancellor in 1945). He took a leave of absence to serve as a Colonel in WWI. Harrelson, known as "Colonel" by students and faculty, became college archivist when he retired in 1953. He left a $\$ 100,000$ donation to NC State for art purchases and a lecture series. Harrelson Hall is named in his honor.


Graham


John Harrelson

By 1931 there were three major public institutions of higher learning in North Carolina: the University of North Carolina in Chapel Hill, the North Carolina College for Women in Greensboro and the North Carolina College of Agriculture and Engineering in Raleigh. To effect greater efficiency and to avoid duplication of programs, the State Legislature voted to consolidate these three institutions under one central administration. The college in Raleigh was given the long and awkward name: North Carolina State College of Agriculture and Engineering of the University of North Carolina ${ }^{1}$ The trustees of the consolidated university recommended that the School of Business and Science at State be phased out. Both State and Chapel Hill had engineering programs and the issue of where the engineering instruction was to be centered was left to President Graham, the first president of the consolidated system. Graham was a UNC graduate and the NC State supporters feared that Graham would favor UNC in his decision. However in 1936, President Graham made the crucial decision to close the engineering program at Chapel Hill and consolidate all engineering

[^7]instruction at State. This decision was an enormous boost to NC State and its engineering school. The Mathematics Department also benefited greatly from this decision for it meant an increased demand for mathematics courses. The price paid for getting exclusive control of engineering was the prohibition of granting degrees in the humanities and sciences, including mathematics. This ban on a degree in mathematics was not lifted until 1956.

According to Hubert Park, who became one of the department's prominent professors, Fisher had a vision for State College. He anticipated that the Engineering School at State would grow in size, quality and prestige and wanted the mathematics department to participate in this growth. He decided it was time to upgrade the faculty in the department. In 1934 Fisher hired the first two Ph.D.'s in the department: J. G. Estes (MIT) and J. M. Clarkson (Cornell). Hubert Park, who received his Ph.D. from UNC in 1939, also joined the faculty that year. In 1935 three additional Ph.D.'s were appointed: J. W. Cell (Illinois), J. Levine (Princeton), and R. C. Bullock (Chicago). In addition L. S. Winton and H. Nahikian joined the department; they received their doctorates in 1939, Winton from Duke and Nahikian from UNC. In addition C. Mumford who joined the department in 1928 received his doctorate from Duke in 1941. Estes died in an airplane accident in 1935 but the rest of these men were the core of the Mathematics Department for several decades.
J. G. Estes had a Ph.D. in Aeronautical Engineering and was also a pilot. One spring day in 1935 Hubert Park and his wife Mary Alice were watching Estes fly at the old Raleigh airport near Garner. Estes asked Hubert if he wanted to fly with him. Before Hubert could say anything, Mary Alice replied, "No, he doesn't." Hubert and his wife left the airport and returned home. Shortly thereafter they received a call from the airport informing them that Estes had died in a crash. Ever since, Hubert had the good sense to listen to the good sense of his wife.
John Clarkson published a series of papers in Algebraic Geometry. In 1952, he was chairman of the committee for the first meeting of a national mathematics organization on the State campus. Clarkson was a Fulbright Lecturer in Turkey in 1958-59.

Roberts Bullock was active in rocket research during and after World War II and produced ten technical reports in this area. He contributed greatly to the graduate program in its early days. He supervised 21 Master's students, most with theses. Bullock was also an excellent and popular instructor; he received an Outstanding Teacher award in 1965. When he retired Bullock set up two scholarships in honor of his wife, Pauline, and his daughter Rebecca who predeceased him. They are given to outstanding mathematics majors who have also demonstrated an ability in the use of the English language.
John Cell was head of the department from 1957 until 1967. Cell established a Ph.D. program in mathematics and guided the department during its transition from a strictly teaching department to a teaching and research department. He supervised two large sponsored research projects, one in rocket science, the other in fracture mechanics. He published several books and many papers and had two Ph.D. students. Cell received an Outstanding Teacher Award in 1967. After his death in 1967, the Cell family, and others, established the J. W. Cell Scholarships which are awarded to outstanding junior or senior mathematics majors. (See also p. 23)

Jack Levine was the first in the department to do significant research in mathematics, and he was one of the most prolific. Throughout his career he published well over 100 papers in Tensor Analysis, Mathematical Physics and Cryptography. He produced a dozen Ph.D. students. Levine received an Outstanding Teacher Award in 1969. In 1982 Levine established an annual award to the student who had the best performance on the nationwide Putnam Examination. The award was originally known as the "Jack Levine Award". However, in 1983, the family and friends of Professor Charles Anderson contributed to the fund and its name was changed to the "Levine-Anderson Award."

Carey Mumford supervised undergraduate courses for the department from 1957 to 1960. He was Assistant Dean for the School of Physical and Mathematical Sciences from 1960 to 1966 and served for ten years as the chairman of both the University Scheduling Committee and the Traffic Committee. Mumford retired in 1968. The Mumford Scholarship was established in 1970 by the Mumford family and others. It is awarded to an outstanding mathematics student in the sophomore, junior or senior year.
Howard Nahikian was the first Graduate Administrator in the department, serving from from 1957 to 1973. He was Assistant Department Head from 1973 until he retired in 1977. During this same period he was editor of the Harrelson v's. Nahikian wrote two undergraduate textbooks and developed an undergraduate course using modern mathematics in biology. He and Park developed a popular graduate course in Matrices and Linear Transformations using the classic treatise of Gantmacher.

Hubert Park served as Assistant Department Head from 1962 to 1972 and Associate Department Head from 1973 to 1978; after John Cell's death in 1967 Park served as Acting Department Head for one year. He received Outstanding Teacher Awards in 1965 and 1968, the Alumni Distinguished Professor Award in 1975 and the Wautauga Medal in 1986. The Mary Alice and Hubert V. Park Scholarships were established in 1977 by Hubert Park and his wife Mary Alice. These awards are made to rising juniors or seniors in mathematics who have demonstrated high academic ability. (See also p. 33

Lowell (Bob) Winton served the department in many capacities from 1935 until his retirement in 1976. Although he didn't have a special title he served as what is now called the Director of Undergraduate Studies. He acted as chief advisor for math majors and coordinator of curricular matters for undergraduates. He was recognized in 1971 by his former students as being in the top five percent of the faculty "who contributed most to my education at NCSU." To all who knew him, Dr. Winton was a gentleman and a scholar. In 1987 Winton and his wife Cornelia set up the Winton Graduate Scholarship to aid doctorate students.

Fisher was very diplomatic, and he knew how to get things done. He was a close friend of Harrelson, the Dean of Administration, and had cordial relations with other members of the administration of the College. He used these friendships to good advantage in getting the approval to hire

Ph.D.'s in the department. According to Hubert Park, some members of the engineering department thought that it was foolish to hire Ph.D.'s to teach engineers. However, most eventually came to the conclusion that it was not only good for the mathematics department but also for the engineering school. The following excerpt from the 1936-37 annual report by Fisher to Dean Riddick shows that research was starting to play a role in the department.
"... there is a weekly seminar conducted for discussing the work in the major field of research of the leader, who is scheduled for a series of six successive lectures. To date, the fields discussed have been Tensor Analysis, Projective Differential Geometry, Cremona Plane Transformations, and Functions of a Complex Variable. $\cdot \square^{2}$

In 1936 an undergraduate course in Mathematics of Finance was introduced. It has remained a popular course over the years. The course became identified with C. F. Lewis who taught it from about 1950 to 1992. Marilyn McCollum took over and has guided the course since then. Three new courses for advanced undergraduates were added in 1936: Series, Approximate Methods and Advanced Analytic Geometry.

In 1947, after several years effort, the degree of Master of Engineering Mathematics was approved. It is interesting that the graduate degree program was started before the undergraduate degree program. The prerequisite undergraduate courses for entrance into the Master's program in Engineering Mathematics were Drawing, Mechanics, Fluid Mechanics, Strength of materials, Physics and Differential Equations. This essentially ruled out anyone who did not have an undergraduate degree in engineering. The required courses for the degree were Theory of Equations, Advanced Calculus for Engineers, Series for Engineers, Vector Analysis, Ordinary and Partial Differential equations, Complex Variables and Operational Mathematics. Seven additional courses were required with at least five being chosen in one or two fields of engineering. According to the 1947 catalog:
"The curriculum is designed for several purposes-to remedy an alarming deficiency in trained teachers in Engineering Mathematics, to provide supplementary courses of a distinguished quality for other engineering curricula, to foster mutual scholarly attainments with members of other departments, and to provide men for industry with the necessary training to apply mathematics to engineering problems"

During World War II there was a drop of enrollment from 2426 in the fall of 1942 to a low of 822 in the fall of 1944. By 1946 the number had jumped to 4902, mainly because of the G.I. bill which gave generous education benefits to returning veterans. During the war, Fisher was named Armed Services Coordinator for the war programs at State College. Although the regular student enrollment decreased, there were special programs for the military to aid in the war effort. Six members of the department taught in the Pre-Radar program and five members were transferred to part-time teaching in Electrical Engineering, Mechanics and Physics. John Cell was on leave for a year doing research on artillery rockets at the Aberdeen Proving Ground. Jack Levine worked as a

[^8]civilian in the Signal Intelligence Service at the beginning of the war but then he joined the Army doing the exact same job, for less pay. The Army awarded Levine the Legion of Merit for his work.

## Gutericau filatijematical fociety

PROGRAMS OF MEETINGS

Nevember 28-29, 1952


Preliminary Announcoment
59th Annas Meeting, Deomber 27-29, 1552, St Louls, Nisomil 18 *

Announcements of Publications


Colloquium Publinatoas, valuares 9 and $24 \ldots 24^{*}$

## 1952 AMS Meeting Announcement

The increased stature of the faculty undoubtedly contributed to the holding of a meeting of the American Mathematical Society at NC State on November 28-29, 1952. This was the first meeting of a national mathematics organization to be held at the College. The local Committee on Arrangements consisted of Clarkson (Chairman), Bullock, Levine and Mumford. As seen in the announcement above, two other meetings of the Society were held at the same dates in other parts of the country. This was an unusual occurrence. There were two principal speakers, Dr. H. H. Goldstine
of the Institute for Advanced Study who spoke on Some Remarks on Numerical Analysis, and Professor Wallace Givens of the University of Tennessee, who spoke on Polarities and their signature in von Neumann's continuous geometry. Other speakers included L. F. McAuley, J. S. MacNerney, A. T. Brauer, L. Carlitz, Jack Levine and Olga Taussky. One of the speakers (W. V. Parker) was listed to be from Alabama Polytechnic Institute; it is now Auburn University.

The department had long wanted an undergraduate degree program in mathematics. This had been prohibited by President Graham when NC State received the engineering school. However, in 1956, NC State finally obtained permission to offer a Bachelor's degree in Engineering Mathematics. This was certainly a natural name for the program since the Mathematics Department was then in the School of Engineering. Moreover, any attempt to call the program "Mathematics" was objected to by the University at Chapel Hill, who didn't want a program that would compete with their own program in mathematics. Students in this program typically took seven semester courses in mathematics beyond calculus, two semesters of statistics, all of the usual engineering science courses, one year of French or German, and the required courses in humanities. Most of the students were planning for graduate study in preparation for teaching or for work as mathematicians in industry. The freshman class in the fall of 1956 contained five men listed as majors in the Engineering Mathematics Program. In the spring of 1957 the first two undergraduates received the degree of "Bachelor of Engineering Mathematics."

As mentioned above, Fisher brought in a group of Ph.D. faculty in the 1930's; he also hired the following:

Charles N. Anderson came to NC State in 1953. He obtained both an undergraduate degree and a master's degree from State. His teaching effectiveness was recognized in 1970 by a letter from Provost Kelly who congratulated him for being in the top $25 \%$ of the faculty as rated by the students. He was also very active as a student advisor and served on many departmental committees and the Faculty Senate. Anderson was the Scheduling Officer of the department from 1973 until his retirement in 1983. After his death in 1984, the family, friends and colleagues of Anderson increased the funding for the "Jack Levine Award." This award is given to the student with the best performance in the Putnam competition. Later, the name of this award was changed to the "LevineAnderson Award."
Dorothy Brant obtained her Bachelor's and Master's degrees from the University of Wisconsin. She joined the department in 1956. Her main interest was teaching mathematics to liberal arts students. Brant retired in 1975.
Henry C. Cooke earned his Bachelor's and Master's degrees at NC State and joined the faculty in 1949. Cooke was an enthusiastic instructor during his 30 year teaching career and won an Outstanding Teacher Award in 1973 and was also recognized by the alumni as a person who contributed most to their education. He was one of the first to teach courses on Educational Television. Cooke also served on the Faculty Senate and was the first chairman of the Faculty Assembly of the UNC system. He retired in 1979.
Ruth B. Honeycutt received a BA from Wellsley College in 1932 and a MA from Duke University in 1934. She joined the department in 1946. Honeycutt helped develop the
courses taken by liberal arts students. She was a dedicated teacher until her retirement in 1975.
Charles F. Lewis obtained his bachelor's degree from Middle Tennessee State University in 1932. He taught at various secondary schools before coming to State in 1946. In 1969 his former students ranked him in the top five percent of the faculty as an instructor "who contributed most to my education at NCSU." Lewis took over the undergraduate Financial Mathematics course and developed it into a popular course for non-math majors. He retired in 1975 but continued to teach part-time for another 16 years-the last 9 years without compensation. When Lewis retired he endowed a scholarship to be given to an outstanding student who is pursuing a double major in Mathematics and Mathematics Education.
Paul E. Lewis got his Ph.D. from the University of Illinois before joining the mathematics department in 1947. In 1955 he left State to work in industry. He returned to the department in 1965 as Professor of Mathematics and Director of the Computer Center. In 1967 Computer Science became a separate department and Lewis became Head of the new department.
Charles H. Little graduated from from Davidson College in 1933 and obtained a M.S. from UNC in 1936. He came to State in 1946 after serving in the Navy in WWII. Little was a popular and dedicated teacher until his retirement in 1979. He was recognized by vote of the alumni as one who contributed most to their education at State. He served in the Naval Reserve for 30 years, reaching the rank of Captain.
Armstrong Maltbie was educated at the University of Vermont and spent five years teaching High School Mathematics before coming to NC State in 1946. Except for the period 1951-1956, when he was head of the Math Department at Broughton High School in Raleigh, Maltbie remained at State until his retirement in 1979. Maltbie received Outstanding Teaching Awards in 1967 and 1970. He served as supervisor of the teaching assistants for over twenty-two years. When he retired Professor and Mrs. Maltbie established the "Armstrong Maltbie Awards" to be given to graduate Teaching Assistants who have excelled in teaching.
Arnold R. Nolstad came to State in 1946 and received a Ed.D. from the University of Pittsburgh in 1948. Nolstad, together with Cooke and Petrea, pioneered in teaching courses on TV. The course in History of Mathematics was taught by Nolstad for many years. He retired in 1974.
Carlotta P. Patton obtained her undergraduate degree at the College of Charleston in 1928. She taught at State from 1943 to 1945 and rejoined the department in 1956. Patton was the one who suggested that the department put out an annual newsletter. The Harrelson v's was published annually from 1972 until 1986 and then again in 2000. She retired in 1973.

Howard A. Petrea joined the faculty in 1946 and obtained an M.S. in 1951 from UNC. Petrea was one of the most demanding, yet popular, undergraduate instructors. He taught large lecture sections in calculus and differential equations for over thirty years
and probably reached more students than any other mathematics instructor. Petrea received Outstanding Teacher Awards in 1966, 1971 and again in 1983. He was also awarded an Alumni Distinguished Professorship in 1976. E. E. Burniston, head of the department for many years, noted that whenever he ran across graduates of NC State in his travels, they would almost always inquire about two people-Professor Park and Professor Petrea. Upon his retirement in 1995, Petrea's friends, family and colleagues set up the Howard A. Petrea Scholarship awarded to an outstanding senior in mathematics.

Jason L. Sox obtained his Bachelor's and Master's Degrees from State. He was an instructor at Elon before joining the faculty at State in 1956. He finished his Ph.D under Harrington in 1969 on complete orthogonal sequences and wrote several papers in this area. Sox was listed in the top $25 \%$ of the faculty in student polls for five consecutive years, 1966-1970. He retired in 1986.

Herbert E. Speece came to NC State as an instructor in the Mathematics Department in 1947. He was the first Ph.D. graduate of Jack Levine in 1956; however, the degree was from UNC Chapel Hill, since State did not yet have a Ph.D. program. He obtained a joint appointment with the School of Education in 1949 and administered the mathematics and science teaching programs. He became the first head of the Mathematics and Science Education Department and held that position until he retired in 1980. Speece retained his joint appointment in the Math Department and was the main reason for the close working relations between the Math and the Math Education Departments.

Charles F. Strobel got a Ph.D. from the University of Illinois in 1941 and came to NC State the same year. At the time he was one of only a handful of Ph.D.'s in the department and was deeply involved in the Master's degree program. Strobel died in 1956, one day before his 45th birthday.

George C. Watson received an M.A. from the University of Virginia in 1934 and joined the Mathematics Department in 1945. He served as Scheduling Officer for the department until he retired in 1973. Watson was a Civil War buff and published several papers on Slavery in the Old South.

During the Fisher years, 1932-1957, the department changed considerably. The course offerings increased from 10 to 39 , and the number of faculty rose from 9 to 31 . The number of Ph.D.'s on the faculty jumped from 0 to 11. Degree programs in engineering mathematics were started at both the Master's and Bachelor's level. During this time research started to become recognized as an important part of the work of a faculty member. There were two sponsored research programs started after World War II-one on Combinatorics supervised by Jack Levine, and one on Rocket Science directed by John Cell. The university enrollment rose from 1633 in 1932 to 5766 in 1957, although, as mentioned above, there was some shrinkage during World War II.

In 1956, the last year of the Fisher administration, the faculty consisted of:
Professors: H. A. Fisher (Head), R. C. Bullock, J. W. Cell, J. M. Clarkson, Jack Levine, C. G. Mumford, H. M. Nahikian, H. V. Park, H. Page Williams, L. S. Winton.

Associate Professors: P. E. Lewis, C. F. Strobel, G. C. Watson. Assistant Professors: E. J. Canady, H. C. Cooke, Anna Mae Harris, C. F. Lewis, D. M. Peterson, V. R. Brantley, C. H. Little, A. Maltbie, A. R. Nolstad, H. A. Petrea.

Instructors: H. E. Speece, R. B. Honeycutt, C. N. Anderson, G. C. Caldwell, M. J. Garren, A. R. Marshall, C. P. Patton, W. C. Turner, D. P. Wylie.

The faculty included four women. Of the 23 professorial faculty, 11 held the Ph.D. Degree.

Everything should be made as simple as possible, but not simpler.
—Albert Einstein
Hilbert in his researches on integral equations, considered infinite sequences that were square summable. Eventually such sequences came to be regarded as "points" in an infinite dimensional space, and an appropriate "geometry" was developed. Although Hilbert did not take this point of view, such spaces and analogous spaces of square integrable functions became known as "Hilbert Spaces." One day Hilbert was attending a mathematical meeting with his colleague Courant. At this meeting it seemed that every other paper referred to this or that Hilbert Space, or this or that property of Hilbert Space. After one of these papers, Hilbert is reported to have turned to Courant and said "Richard, exactly what is a Hilbert Space?"

## Chapter 5

## The Mathematics Department 1957 to 1967—The Cell Years

John Wesley Cell was selected to head the Department of Mathematics when Hilbert Fisher retired in 1957.

John Cell attended Kansas City Junior College and earned his B.A., M.A. and Ph.D. degrees from the University of Illinois. Before coming to N. C. State in 1935, Cell taught at the University of Illinois, Southern Methodist University and the University of Texas.

Cell played a significant role in getting approval for the Master's program in Engineering Mathematics in 1947 and the Bachelor of Engineering Mathematics program in 1956. He was active in research and had an ongoing sponsored research program in rocket science.

In 1943, Cell was honored as the first recipient of the Faculty Award by the NC State chapter of Tau Beta Pi. In 1967 he received


John Cell
(Photo from Archives, UA \#23.5) an Outstanding Teacher Award. During his tenure as department head he helped steer the department from a strictly service department to a more research-oriented department.
The increased number of students registered for mathematics courses led Cell to get help in the administration of the department. Howard Nahikian was appointed as graduate administrator, Carey Mumford was put in charge of the undergraduate courses for engineers, Hubert Park looked after the undergraduate courses for non-engineers and Bob Winton took on the task of supervising
the Engineering Mathematics undergraduate program. Armstrong Maltbie, recognized by all as an excellent teacher, got the responsibility of supervising the teaching assistants.


Cell teaching the slide rule
(Photo from University Archives, UA \#23.5)

In the fall of 1957 a superior student program was inaugurated for engineering students with marked ability in mathematics. Students in this two year program were taught in special sections which went more deeply into the subject matter than was possible in the regular sections. In Cell's words "Those schools and colleges with sufficient vision to rescue the able students from boredom and stagnation and to provide a realistic and challenging program for them must be followed by all the rest." John Cell did not attempt to run the department as a democracy. He was clearly the one in charge. He was full of energy and enthusiasm. Yet he was a gentle man (and a gentleman) who gave encouragement and help to the faculty, particularly the younger faculty.

Cell carried his enthusiasm into the classroom. When he taught, chalk dust would fly everywhere. John Bishir, who observed some of Cell's lectures, used to worry that he would get so much chalk on his glasses that he wouldn't be able to see anything.

In 1960 the School of Physical Sciences and Applied Mathematics (now College of Physical and Mathematical Sciences) was formed, consisting of departments of mathematics, chemistry, physics and experimental statistics. The first Dean was Arthur Clayton Menius. Finally the Mathematics Department had found a true home. One might have expected that there would be some opposition to the formation of this school from the University at Chapel Hill, but this did not occur. However, there was some controversy concerning the new school of Humanities which also started in 1960. A chapter of Pi Mu Epsilon, the Honorary National Mathematics Society, was installed at State the same year.

Pi Mu Epsilon was founded in 1914 at Syracuse University and currently has over 300 chapters at colleges and universities throughout the United States. The purpose of Pi Mu Epsilon is the promotion of scholarly activity in mathematics among the students in academic institutions. Membership is not restricted to math majors. Jim Wilson was faculty advisor for the NC State Chapter from 1960 to 1980, Bob Silber took over until he retired in 2002. Hien Tran has looked after the program since then.

The Undergraduate degree program was changed from Engineering Mathematics to Applied Mathematics in 1961. One of Cell's principal goals was to establish a Ph.D. program in Applied Mathematics. Approval for the program was obtained in 1962. The first Ph.D.s graduated in 1964; there were a total of six awarded: Jack Levine had two students (Joel Brawley and Robert Dalton), Rai Struble had two (John Heinbockel and Thomas Proctor) and John Cell had two (Jerry Roberts and John Welch).

Cell made many important additions to the faculty to support the Ph.D. program and the undergraduate teaching responsibilities of the faculty.

Cell met Walter Harrington (Ph.D., Cornell University, 1941) while working on Rocket Science during WWII. In 1957 he convinced Walter to join the faculty at State. Walter said "Cell made me an offer (a full professorship) I couldn't refuse." Harrington was active in research in orthogonal functions, rocket science and fracture mechanics. He published over two dozen research papers and had 4 Ph .D. students. He served as Acting Department Head in 1979-80 and Assistant Department head from 1976 until he retired in 1982. (See also p. 46)

Raimond Struble got his Ph.D. from the University of Notre Dame in 1951 and came to NCSU in 1958. Struble was instrumental in establishing the Ph.D. program in Applied Mathematics. He published more than 70 research articles and the influential graduate text Nonlinear Differential Equations. He produced 12 Ph.D. students. His research was funded by the U. S. Army for 14 years. In 1970 Struble was appointed to the prestigious position of University Professor. He retired in 1987.

James Wilson was the recipient of a Ph.D. from the University of Florida in 1957 and joined the department the same year. He contributed greatly to the department and the university at large. Wilson was chairman of the Faculty Senate in 1974-75 and served as Assistant Head and then Associate Head of the Department from 1978 until 1986. In the words of E. E. Burniston "While any administrator has to frequently say 'no' to a student's request, Jim Wilson is one of the very few who has the ability to do so in such a way that the student feels good about it." He received an Outstanding Teacher Award in 1968. Wilson served as faculty advisor for Pi Mu Epsilon from 1960 until 1980. He retired in 1987.

Thelma J. Caraway earned a bachelor's degree at Alabama College and a Masters from the University of Arkansas. She joined the mathematics department in 1959. Caraway
received an Outstanding Teacher Award in 1970. She died prematurely in 1974.
Leroy B. Martin, Jr., a Raleigh native, obtained a Ph.D. from Harvard University in 1958. He worked at IBM before joining the Mathematics Department in 1961. He served as Director of the Computing Center (later Assistant Provost for University Computing) from 1968 until 1983. During this time Martin continued to teach one mathematics course each Spring. He returned to full time teaching in the mathematics department in 1983. Even after his retirement in 1996, Martin continued to teach parttime. In 1999 Dr. Martin and his wife Charlotte M. Martin endowed two scholarships and a teaching effectiveness program. In 2008 Martin was honored with the Distinguished Alumnus Award by the college of PAMS. In addition, Jim Goodnight from SAS, in recognition of Dr. Martin's contributions to mathematics at NC State, endowed the "LeRoy Martin Distinguished Professorship." This is the first privately endowed chair in the department.

Hans Sagan earned his Ph.D. from the University of Vienna in 1950.He was on the faculty of the University of Idaho and Montana State University before coming to NC State as a full professor in 1963. He had a sponsored research project on Optimal Control from NASA from 1965 to 1974 and had six Ph.D. students. Sagan produced nine books and numerous research and expository articles. His latest book was a treatise on Space Filling Curves. From 1963 to 1973 he was Associate Editor of the Mathematics Magazine. Sagan was a member and secretary of the MAA Committee on the National Mathematics Contest. He also was a popular lecturer for MAA. In 1994 he was elected to the scientific advisory board of the Manatshefte für Mathematik. Sagan was editor of the Harrelson v's from 1978 until 1986. He retired in January 1994.

Kwangil Koh came to State in 1964 after getting his Ph.D. from UNC at Chapel Hill. His research is in ring theory, number theory, group theory and topological algebra. During his career Koh wrote one book, more than 70 research papers and supervised 11 Ph.D. theses. Koh was a leading force in establishing algebra as a research area in the department. In 2002 an Algebra Conference was held in honor of the retirement of Koh and his colleague Jiang Luh. Koh was on phased retirement at the time and retired fully in 2004.

John Bishir received a Ph.D. in Statistics from NC State in 1961. He has been on the faculty of the mathematics department since 1957 except for one year at Florida State in 1961-62. Bishir has helped develop many courses for the biological and social sciences. He has written one textbook, over 30 research papers, and supervised 5 doctoral students. Since 1989 his research has been sponsored by the U.S. Forest Service. Bishir received an Outstanding Teacher Award in 1968. He retired in 2003 but continued teaching and research.

Robert Savage obtained his undergraduate and Master's degrees in mathematics from NC State. He became a member of the faculty in 1964. Savage and Maltbie ran the
"proctorial system" of instruction for many years. This led Savage to start an AudioVisual Tutorial Center with the help of an NSF grant. This Center has been very successful (it has been renamed the Multi-Media Center). Savage served as Assistant Dean of PAMS from 1987 to 1997 where he helped to establish "summer camps" for mathematics and science students. He received an Outstanding Teacher Award in 1987. Savage retired in 2000.

Richard Chandler got his doctorate from Florida State University in 1963 and came to State in 1965. He was the department's first topologist. He wrote several books and many research papers in topology and computer graphics and supervised 4 Ph.D. students. Chandler served as Graduate Administrator from 1973 until 1985. He received an Outstanding Teacher Award in 1993. Chandler took over the "Mathematics Magic Show" from Robert Silber and gave a large number of performances throughout the State. He retired in 2002. Since his retirement Chandler has collaborated on two booklets on North Carolina Fossils.
H. Robert van der Vaart (Ph.D., Leiden University) joined NC State in 1962 with a joint appointment with Statistics. He published over fifty papers in statistics and theoretical biology. He was named Drexel Professor of Biomathematics in 1974 and received an Outstanding Teacher Award in 1975.

Donald Hansen received his Ph.D. from the University of Texas at Austin in 1962 and came to NC State the same year. His research interest was algebra; he published ten papers on partially-ordered algebraic systems. Hansen introduced the first undergraduate course in number theory in 1969 and taught it almost every year until he retired in 1996. In 1984 E. E. Burniston, the head of the department, asked Hansen to be Building Liaison for Harrelson Hall. He did a superb job watching over Harrelson Hall and making sure everything was in working order. Whenever a conference or special meeting was held in Harrelson, Hansen was there to see that everything was going smoothly. He handled this task until his retirement. However in 1997, after being retired for only one year, Hansen agreed to return as Building Liaison and handled this responsibility until the department moved into SAS Hall in 2009.

Oscar Wesler (Ph.D., Stanford University) came to NC State in 1964 with a joint appointment in the Mathematics and Statistics Departments. His specialty was probability. He received an Outstanding Teacher Award in 1967.

Ernest Burniston is a native of England. He earned his Ph.D. from the University of London in 1962 and came to NC State in 1965. His research was in fracture mechanics and transport theory; he wrote over 30 research papers and supervised $3 \mathrm{Ph} . \mathrm{D}$. students. Burniston served as Head of the Mathematics Department from 1980 to 1989 and, above and beyond the call of duty, served another term as Department Head from 1999 until he retired in 2002. (See also p. 49 and p. 69) Joe Marlin left Bell Labs and came to State in

1964 as an instructor in the department while he worked on his Ph.D. under Struble. He finished his Ph.D. in 1965. Marlin's research was in non-linear differential equations. He wrote 10 papers and supervised 12 M.S. students and 2 Ph.D. Students. He served as Associate Head of the Department from 1987 to 1994. His main responsibilities were scheduling and advising the department head on computing. In his own words "I am the primary person to blame for the introduction of MAPLE usage in the calculus courses." Marlin retired in 2000.

Dennis Garoutte came to NC State in 1966 and finished his Ph.D. from Montana State University in 1967. He was Assistant Department Head from 1987 until 1989 and Associate Department Head from 1989 to 1996. He served as coordinator of instruction and was responsible for organization and scheduling of courses. He handled student and faculty problems fairly and always 'kept his cool'. Garoutte received an Outstanding Teacher Award in 1986. He retired in 2001.

John Kolb joined the faculty in 1966 after getting his Ph.D from the University of Maryland. He had a joint appointment with the Mathematics and Science Education Department. Kolb has written several texts for high school and junior high school teachers in addition to his numerous research publications. He has supervised 18 doctoral students in Mathematics Education. Kolb won an Outstanding Teacher Award in 1968 and an Alumni Distinguished Professor Award in 1978. He retired in 2003.

Cell met Ian Sneddon, a distinguished Professor of Mathematics at Glasgow University, on one of his trips to England in connection with rocket science. In 1960, Cell invited Sneddon to come to N.C. State as a distinguished lecturer and later Sneddon was appointed an Adjunct Professor. Each spring, for about ten years, Sneddon traveled to N.C. State to lecture on fracture mechanics and consult with the Applied Mathematics Research Group. There were also many exchanges of students and faculty between Glasgow and NC State during this period.
J. M. A. Danby (Ph.D., Manchester University) was for a time a professional musician, the first chair oboist in the London Philharmonic Orchestra. Danby arrived on the NC State campus in 1965. The minor planet Danby was named after him by the International Astronomical Union in recognition of his contributions to the study of Celestial Mechanics. He authored books on Celestial Mechanics and the use of computers in the study of Differential Equations. Danby received an Outstanding Teacher Award in 1979 and an Alumni Distinguished Professorship in 1987. He retired in 1999.

Paul Nickel (Ph.D., UCLA, 1959) joined the faculty in 1965. His research was in function theory. He supervised two Ph.D. students at State and in addition, was Dennis Garoutte's Ph.D. adviser (Garoutte got his degree from Montana State University while an instructor at NC State). Nickel retired in 1989.

William G. Dotson graduated from our sister institution in Chapel Hill with a Ph.D. in 1968. He actually came to State in 1965 as an instructor while he completed his
doctoral work. His research area was functional analysis. Dotson published over 25 research papers and supervised $3 \mathrm{Ph} . \mathrm{D}$. students before his promising career was cut short by illness. He died in 1988.

Harvey Charlton (Ph.D., Virginia Polytechnic Institute, 1966) was hired by John Cell in 1966. Since 1994 Charlton has been performing a variety of administrative duties. He is Scheduling Officer, Transfer Officer, in charge of homework graders and Director of the Summer School. Since 2000 Charlton has organized weekly Departmental Teas for faculty and graduate students. He has also developed an on-line course-MA 501-502 (Advanced Mathematics for Engineers and Scientists).

David Ullrich came to NC State after getting his Ph.D. from Carnegie-Mellon University in 1966. Ullrich concentrated on undergraduate instruction and was known as a demanding, but effective teacher. Ullrich made several tapes on differential equations for the audio-visual tutorial center. He retired in 1996.

Robert Ramsay (Ph.D., University of Miami, 1967) joined the department in 1967. He helped to coach students for the Putnam Competition from the early 1980's until his retirement in 2004. Ramsay served as Director of the Undergraduate Program and Coordinator of Advising for Mathematics from 1989 until 1999. He started the Undergraduate Math Newsletter which has been published twice each year since 1995. The same year Ramsay took the lead in getting a separate Bachelor of Science Degree Program in Applied Mathematics. He promoted the opportunities for mathematics majors in Actuary Science and developed new courses that would facilitate entry to this field. Ramsay retired in 2004.

During the 1960's there was a shortage of mathematics instructors. The government sponsored Master of Teaching programs for retired military officers at several universities including Duke University and State. Four of the graduates of these programsGeneral George Speidel, Colonel Henry L. Crouch, Colonel Thomas F. Gordon and Commander Harold L. Davison-joined the faculty at NC State and gave many years of faithful service.

In 1960 Cell obtained support from the Air Force Office of Scientific Research for an Applied Math Group working in fracture mechanics. The Air Force became interested in the problem when cracks were discovered in USAF planes, and the research was expanded to the whole area of fracture mechanics. Besides Cell, Harrington, Burniston, T. W. Ting and Adjunct Professor Sneddon worked on this project which continued until 1973.

In 1962 the department moved from its quarters in Tompkins Hall into Harrelson Hall a large cylindrical building surrounded by a large "brickyard" (technically the "University Plaza"). While the brickyard was being constructed students, viewing the work from a Harrelson window, noted that the workmen made a mistake in laying out the pattern of white and red bricks. After the foreman was informed, the mistake was corrected. Harrelson Hall looks terrific from the outside and it has many features that should appeal to mathematicians. The horizontal cross-section of the


## Harrelson Hall

(Photo by Richard Chandler)
building is a circle, the solution of the isoperimetric problem. The hallways are annular in shape and, surrounding the center of the building, there is a helical ramp from the bottom to the top. The space occupied by a classroom or an office in Harrelson Hall has the shape of an element of volume in cylindrical coordinates. A horizontal cross-section has the shape of an element of area in polar coordinates. Thus, two sides of every office and classroom are straight and two sides are circular arcs. The interesting geometry of the building has some negative consequences. In the offices, rectangular desks do not fit neatly on the curved walls. Amazingly, the classrooms originally had curved blackboards so that a student at point $\mathbf{A}$ could not see past point $\mathbf{B}$ on the blackboard as shown on p . 31 Eventually all the blackboards were replaced by straight blackboards.

In 1965 Cell negotiated a cooperative program with the Air Force Academy which brought Air Force officers to the campus for graduate work. A similar program was worked out with NASA at Langley in conjunction with Hans Sagan's research grant from NASA. These two programs provided many excellent Master's and Ph.D. candidates for about 10 years.

During the Cell administration both the university and the mathematics department grew in size and prestige. The university enrollment rose from 5766 in 1957 to 10,203 in 1967. The mathematics department increased from 31 faculty members with $11 \mathrm{Ph} . \mathrm{D}$ 's in 1957 to 66 faculty with 32 Ph.D's in 1966. The faculty had a sprinkling of "pure mathematicians" in algebra and topology. A doctoral program in mathematics was established, a superior student program was started and sponsored research became a significant part of the research done in the department. The number of courses grew from 39 in 1957 to 83 in 1967.


## Harrelson Hall Classroom

The following two paragraphs deal with matters that occurred during the Cell tenure that are important in the history of the university although not of direct relevance to the mathematics department.

During the 1960 's as State College grew in size and prestige, the faculty, students and alumni sought to change the name to "North Carolina State University." The Consolidated University was in favor of "the University of North Carolina at Raleigh." Students, faculty and alumni of State protested that this would make State look like a mere branch of the institution at Chapel Hill. In 1963, the state legislative officially decreed that State College be called "North Carolina State of the University of North Carolina at Raleigh," clearly a name made up by a committee. Friends of State were not happy. They kept pressure on the legislature until finally, in 1965, the name was changed again to "North Carolina State University at Raleigh.' ${ }^{1}$

In contrast to many southern colleges, integration of African-American students into NC State proceeded peacefully. The first black graduate students were admitted in 1953 and the first black undergraduates in 1956. The student body, faculty and administration were strong advocates of civil rights. In particular Chancellor John Caldwell who served from 1959 to 1975 not only supported admission of African-American students but strongly advocated the racial integration of Raleigh's public facilities. There were many protests to racial discrimination, some involving faculty at NC State and Chapel Hill. In 1963, some members of the North Carolina Legislature were disturbed at seeing professors of the Consolidated University participating in public demonstrations in downtown Raleigh. To punish the university, these legislators hurriedly passed the infamous "Speaker Ban Law." This law prohibited the consolidated university from permitting any known communist, or anyone advocating violent overthrow of the government or any Fifth Amendment pleaders from speaking on campus. The Speaker Ban Law was

[^9]universally condemned throughout the academic community as an affront to academic freedom. The noted British scientist J. B. S. Haldane refused to lecture on campus after he was questioned about his previous editorship of the British Daily Worker. The "Ban" remained a stain on the reputation of the Consolidated University until the law was declared unconstitutional by a Federal Court in 1968 ${ }^{2}$

By 1966 the department had grown to a total of 66. They were:
Professors: R. C. Bullock, J. W. Cell (Head), J. M. Clarkson, W. J. Harrington, J. Levine, P. E. Lewis, C. G. Mumford, H. M. Nahikian (Graduate Administrator), H. V. Park (Assistant Head), H. Sagan, H. E. Speece, R. A. Struble, T. W. Ting, H. R. van der Vaart, O. Wesler, L. S. Winton.

Visiting Professor: M. Itoh.
Adjunct Professors: A. S. Galbraith, L. Roberts, I. N. Sneddon;
Associate Professors: J. W. Bishir, H. C. Cooke, K. Koh, C.H. Little, Jr., L. B. Martin, Jr., P. A. Nickel, A. Nolstad, D. M. Peterson, H. A. Petrea, J. W. Querry, G. C. Watson, J. B. Wilson.

Assistant Professors: V. R. Brantley, E. E. Burniston, T. J. Caraway, R. E. Chandler, H. J. Charlton, R. B. Honeycutt, J. R. Kolb, C. F. Lewis, A. Maltbie, J. A. Marlin, P. Shahdan, G. S. Speidel, Jr., D. F. Ullrich, J. D. Zund.

Instructors: C. N. Anderson, D. L. Brant, H. L. Crouch, C. A. Davis , H. L. Davison, W. G. Dotson, G. M. Eargle, M. J. Garren, P. M. Gibson, T. F. Gordon, T. C. H. Harris, J. Hoomani, G. F. Knight, J. G. McVay, C. P. Patton, D. W. Reid, R. G. Savage, J. L. Sox, G. K. Warmbrod.

The faculty included four women. Of the 47 professorial faculty, 33 had Ph.D. degrees.

Mathematics is like checkers in being suitable for the young, not too difficult, amusing, and without peril to the state.
-Plato
Angling may be said to be so like mathematics that it can never be fully learned.
—Izaak Walton
Transcendental numbers occupy a position in the field of real or complex numbers much like that of insects in the kingdom of animals. Everybody knows they are, by a large margin, the most abundant class, but few know more than one or two of them by name.
-Anonymous

[^10]
## Chapter 6

## The Mathematics Department 1967 to 1977—The Park-Rose Years

In the spring of 1967 Professor Cell resigned as Head because of ill health and H. V. Park was appointed as Acting Head.

Hubert Vern Park was born in Salisbury, North Carolina, and raised on a farm there. He received his undergraduate degree from Lenoir-Rhyne College and did his graduate work at the University of North Carolina at Chapel Hill. In 1986, Hubert Park was awarded the Watauga Medal, the highest non-academic honor that the university bestows. Park's career was aptly summarized by Chancellor Poulton when he presented the Medal:
"In honoring Dr. Park, it has been necessary to create exclusively for him, a new academic title-'Professor Extraordinaire.' The reason is simple: he has earned or been awarded every other title of distinction as a teacher available at the University. He was selected as an Alumni Distin-


Hubert Park guished Professor in 1975 and returned the monetary award to the Alumni Association to establish a scholarship. He was cited four times by alumni as the teacher who had contributed the most to their education. He won the University's Outstanding Teacher Award twice and was the first chairman of the Academy of Outstanding Teachers. He has served in administrative capacities in mathematics, directed special training for mathematics teachers, and been president of the NCSU Scientific Society of Sigma Xi. His dedication for some 50 years, since his appointment here in 1934, is summed up in a tribute of colleagues and his former students: 'His door was always open, students were always welcome.' He has taught without compensation since he turned 72 -and he's still at it. A professor who really loves to teach."

Park made some significant additions to the faculty during the 1967-68 academic year. Of the seven appointments, four remained in the Department and made notable contributions to research and teaching.

Robert Hartwig received a Ph.D. from Adelaide University in Australia in 1966. He works in matrix theory and cryptography. Hartwig has written over 100 research papers and produced $4 \mathrm{Ph} . \mathrm{D}$. students. He served on the editorial board of Linear Algebra and Its Applications for 20 years.
Carl Meyer got his doctorate from Colorado State University in 1968. He does research in computational linear algebra. Meyer has written four books, over 60 research papers and supervised 8 Ph.D. students. He was managing editor of the SIAM Journal of Algebraic and Discrete Methods and has served on the editorial boards of two other journals. Meyer has received support for his research since 1978 from NSF, NASA and Boeing. He was the first director of the Center for Research in Scientific Computation from 1986-1988. He also served as Associate Director of the Operations Research Program from 1997 to 2000 and Acting Director in 1998. In 2003 Meyer was honored with a a conference, Matrix Analysis and Applied Linear Algebra on the occasion of his 60-th birthday. Meyer received the 2007 Mathematics Department Alumni Award from Colorado State University.
Jiang Luh obtained a Ph.D. from the University of Michigan in 1963. He is an algebraist who worked on prime rings and semisimple rings. He wrote a large number of research papers and supervised $7 \mathrm{Ph} . \mathrm{D}$. students. In 2002 a Mid Atlantic Algebra Conference was held in honor of the retirement of Luh and K. Koh.
Robert Silber earned a Ph.D. from Clemson University in 1968. He introduced and taught MA 127, a popular course in Recreational Mathematics ${ }^{1}$ He provided "Brain Twisters" for all the issues of the Harrelson v's'. He developed a Mathematical Magic Show which he performed in High Schools throughout the state. Silber was faculty advisor for Pi Mu Epsilon from 1980 until he retired in 2002.

In 1963 John Cell started a small departmental library for the convenience of faculty and students. In 1968, through the generosity of the Cell family and friends, the "John W. Cell Library" was expanded and formally recognized as part the the NC State Library System. The library was dedicated on May 20, 1968 in a ceremony in Harrelson Hall. I. T. Littleton, the Director of the University Library, stated:
"First, I would like to bring greetings and congratulations to the Mathematics Department from the staff of the D. H. Hill Library. We congratulate you, and Dr. Cell, posthumously, on the establishment and growth of the John W. Cell Library. Dr. Cell devoted much time and energy to building the Mathematics collection both in the D. H. Hill Library and in his own department. In his death, the Library Staff feels a tremendous loss. His enthusiasm for Library development on this campus was an inspiration to us.

[^11]He believed, as any outstanding educator must, that a strong library is an indispensable requisite of a great university. $2^{2}$

Nicholas J. Rose was selected to head the Department of Mathematics in 1968. Rose was previously head of the Mathematics Department at Stevens Institute of Technology in Hoboken, New Jersey. He was the first department head to be chosen from 'the outside'.

Nicholas J. (Nick) Rose was born just five blocks from greater downtown Ossining, New York (population 15,000, mainly known as the home of Sing-Sing Prison). He was raised in Yonkers, New York (Rose used to say it was "next to the largest city in the world."). In 1941 he went to Stevens Institute of Technology and graduated in 1944. He was an ensign in the Navy during WW II. In 1946, after the war, he became an instructor in mathematics at Stevens. Rose obtained his Master's and Ph.D. degrees from the Courant Institute at New York University. He became head of the mathematics department at Stevens in 1960.

At Stevens, Rose helped establish the Ph.D. program in mathematics and managed a large M.S. program for Bell Labs. He had 7 Ph.D. students at Stevens and one more at


Nick Rose NC State. Rose worked in control theory, differential equations and matrix theory.

When Rose arrived on campus he was shocked to find that there were only 5 telephones in a department consisting of 67 faculty and 50 graduate students. It took Rose several years of negotiating and pleading with Dean Menius to finally get a phone in every office. It had been the custom in the department that 4 -credit Calculus courses would meet 5 times a week, and the 4-credit Algebra and Trigonometry course would meet 5 times a week with quizzes on Saturday morning. The Saturday classes were eliminated and the students in the four credit calculus courses were required to meet only 4 times a week, with a fifth meeting optional (for extra help). It was also decided to stop teaching the slide rule in math courses, leaving whatever instruction was needed to the engineering and science departments.

At a social affair hosted by Chancellor John Caldwell, Rose casually suggested that a better name for the school of "Physical Sciences and Applied Mathematics" (PSAM) would be "Physical and Mathematical Sciences." (PAMS), and to Rose's surprise, his suggestion became a reality in 1969.

The same year student protests of the Vietnam War were heating up nationwide. The Board of Trustees of N.C. State wanted to keep disruptions to a minimum and passed a resolution requiring that all future faculty appointees answer the following question satisfactorily:
"Have you ever been subjected to an inquiry, hearing, or proceeding relating to the violation of (1) any federal or state statute or local ordinance (other than traffic violation)

[^12]or (2) any college or university rule or regulation while an undergraduate, graduate, or professional student or faculty member? if so, explain fully."

The administration even required that those who had accepted positions for the fall of 1969 be contacted by phone and asked to respond to the same questions. Rose had one such appointment but did not feel he could, in good conscience, ask these questions of a faculty member who had already accepted a position. He told that to Dean Menius and offered to resign. The Dean said that wouldn't be necessary and he would take care of it. Rose doesn't know how the Dean finessed the situation with the administration but everything went smoothly after that.

In the spring of 1970 the Kent State Massacre pushed student protests to a fever pitch throughout the nation. At NC State many classes were disrupted and the university faculty, responding to strong student pressure, voted to give individual faculty members wide discretion in grading for the spring semester.

One of the instructional innovations tried during the Rose years was the Proctorial system of instruction introduced in 1971. In this system students are allowed to advance at their own pace through the course material. The instructor and undergraduate proctors provide assistance. Students take tests whenever they are ready, and even retake tests as often as desired until a respectable grade is obtained. Several sections of beginning courses were taught under this system. TV tapes and interactive computer lessons were developed in an Audio-Visual Tutorial Center run by Bob Savage. Like almost all innovative systems of instruction, the Proctorial system soon ran its course (pun intended). However the Audio-Visual Center remained a permanent fixture in the department. It later morphed into the Multimedia Center under the direction of Lavon Page.

Some anonymous wit once quipped "Although Mathematics and Applied Mathematics do not exist as separate entities, the tensions between them do exist." This was certainly the case when Rose took over as head in 1968. The department offered undergraduate and graduate degrees in "applied mathematics" yet there were substantial numbers who were interested in "pure mathematics"; many faculty felt the applied mathematics degree was not suitable for such students. To take care of this situation the department obtained administrative approval to change all degrees to just Mathematics. Applied Mathematics became an option under the Mathematics umbrella.

In 1973 Carlotta Patton suggested that the department start an annual newsletter to help keep the alumni and other friends of the department in touch with the affairs of the department. Thus started the Harrelson v's which was published "almost periodically" from 1973 until 1985 and then again in 2000. Nahikian was the first editor of the Harrelson v's. Sagan took over as editor in 1977 upon Nahikian's retirement. Many items in this History are based on information from issues of the Harrelson v's.

In 1973 Rose reorganized the department. Park was promoted to Associate Head, Nahikian became Assistant Head, Chandler signed on as Graduate Administrator. Winton continued as Director of the Undergraduate Program. In 1974 Linda Maddry retired after serving as department secretary since 1937. Dianne Joyner took on this position and held it until her retirement in 2002.


The Kitchen Kabinet
Back to front: Rose, Head; Chandler, Grad. Admin.; Park, Assoc. Head; Winton, Undergrad. Admin.; Nahikian, Ass't Head (Photo taken from 1974-75 Harrelson News)

Everyone addressed Linda Maddry as "Miss Maddry." She was an unusually well qualified departmental secretary. Besides her secretarial training she obtained a Bachelor's degree in Mathematics from Meredith College. She was efficient, well organized and ran the departmental office with an iron hand. She protected the secretaries who typed papers for the faculty.

Miss Maddry had a rule that each paper typed could be submitted only once for corrections. Early in his career Professor Meyer pleaded with her to have corrections made a second time. Miss Maddry said, "Professor Meyer, you don't seem to realize that assistant professors are a dime a dozen but good secretaries are hard to find."

A review of all courses and curricula in the mathematics department was undertaken during the Rose regime. Several new undergraduate courses were added: MA 410 (Theory of Numbers), MA 412 (Introduction to Combinatorics), MA 414 (Introduction to Differential Geometry), MA 425-426 (Mathematical Analysis I and II), MA 427-428 (Introduction to Numerical Analysis I \& II), MA 530 (Introduction to Applied Mathematics) and a new course mainly for Industrial Engineers, MA 303 (Introduction to Linear Analysis). The undergraduate program was revised. As mentioned above, the name of the degree was changed from Applied Mathematics to Mathematics with Applied Mathematics as an option. The required hours for graduation were reduced from 131 to 126 ; however the new program contained a more demanding group of core courses. On the grad-

uate side there were several courses introduced for math majors: MA 520 (Linear Algebra), MA 534 (Introductory to Partial Differential Equations) and MA 601-602 (Advanced Ordinary Differential Equations I and II). For non-math majors courses introduced were a one-year survey course MA 501-

502 (Advanced Mathematics for Engineers and Scientists) and a sequence of four courses designed to strengthen the mathematical background of high school teachers: MA 507 (Analysis), MA 508 ( Geometry), MA 509 (Abstract Algebra) and MA 510 (Selected Topics). Most of these courses have stood the test of time and are still being given in 2009. The courses for high school teachers came about because of the very close working relations between the mathematics department and the mathematics education department.


Emeritus Faculty
Back to front:Daniel. M. Peterson, George C. Watson, Howard M. Nahikian Charles F. Lewis, Lowell S. Winton, Roberts C. Bullock Carlotta Patton, George S. Speidel, John W. Querry Dorothy Brant, John M. Clarkson, H. Page Williams

Ruth Honeycutt, Jack Levine
(Photo taken from 1974-75 Harrelson News)

The number of women students at State increased dramatically in the 1960's and 1970's. In 1959 there were 164 women students representing about $3 \%$ of the student population. By 1975 there were 4853 women, about $30 \%$ of the enrollment. In mathematics, Nancy E. Mumford was the first woman to received a B.S. degree in 1959. The first woman valedictorian at the university was
a math major, Jane Carroll Pickard, who earned a B.S. in Applied Mathematics in 19713 Also in 1971 the first woman to receive a Ph.D. in mathematics was Jo Ellen Perry, an advisee of Kwangil Koh.

The first African-American Ph.D. in mathematics at State was Hampton Wright who received his degree in 1973. He was a student of Jack Levine. He stayed at State in 1973 and was the first African-American to serve on the professorial faculty. Wright left in 1974 to go to Johnson C. Smith University in Charlotte, North Carolina, where he rose to be head of the mathematics department. The first African-American to be hired from the outside was James Nelson, Jr. who joined the department in 1975. In the 1980's Nelson left for Saint Augustine's College in Raleigh.

In 1976-77 the Audio-Visual Tutorial Center, under the direction of Professor Savage, completed its second full year of operation. The center was fortunate to hire Marilyn McCollum, a State graduate in Math Ed as Educational Media Technician to assist in the operation of the center. In addition to individual tutoring, seven beginning courses were put on TV tapes. During the academic year students viewed about 50 tapes per day. Later McCollum became an instructor, and besides teaching courses herself, took on the task of teaching Teaching Assistants to teach in 1985.

In 1976-77 there were 265 undergraduate math majors and 42 graduate students. The teaching assistants numbered 52, 10 of whom had majors in other departments. Bachelor's degrees were awarded to 37 students and 11 earned Master's degrees. No Ph.D.'s were awarded in 1976-77. Regarding the absence of Ph.D. graduates, we quote from the "Report on the Graduate Program" by R. E. Chandler which appeared in the 1976-77 Harrelson News.
"We had no Ph.D. graduates this year for the first time to my recollection. I believe this is a result of two things. First we had an abnormally large number of Ph.D. graduates last year [7]. Second, the tight job market continues to discourage qualified students from continuing beyond the Master's degree. According to statistics from the American Mathematical Society, unemployment for new Ph.D.'s in the mathematical sciences was up about $10 \%$ last year. This figure does not show 'underemployment' and it does not show the number of unemployed 'old' Ph.D.'s. It seems to me that the job situation can stand a lot of improvement, but there is still a place (and a prospect of reasonable employment) for capable dedicated people, particularly in the applicable areas of mathematics.
"The total number of graduate students in the department has been declining somewhat for the past several years, but has reached a plateau, at least for the time being. This decline is almost entirely among out-of-state students and seems to be caused by the limited number of tuition remissions we can make. We have not lowered our standards of admission, however, and if there has been any change in the quality of incoming students it has been for the better."

Perhaps the most important accomplishment during the Park and Rose administrations was the hiring of a large number of excellent faculty members. As mentioned above, Park added 7

[^13]new faculty in 1967. Rose added 27 more from 1968 to 1977 . This provided a substantial boost to the number of research-oriented faculty. Fortunately, there were many excellent candidates to choose from. The launching of the Russian satellite Sputnik in 1957 and the nation's commitment to be the first on the moon had greatly increased the production of new Ph.D.'s in the mathematical sciences-the number of doctorates in mathematics conferred annually nationwide increased from 332 in 1960-61 to 1070 in 1968-69.

Of the 27 new faculty hired during the Rose administration 21 were brave enough to spend the rest of their careers at State.

Stephen Campbell came directly to NC State after getting his Ph.D. from Northwestern University in 1972. His research interests are differential equations, control theory and numerical methods. He has written 7 research books, 4 undergraduate text books and 200 research papers. Campbell has supervised 13 Ph.D. students. His research has been funded by the NSF, the Army, and the Air Force. Campbell is on the editorial board of two SIAM journals. He served as Director of the Graduate Program from 1997 to 1999 and from 2002 to the present. He was elected a Fellow of IEEE in 2001.

Lung O. Chung obtained a Ph.D. from UCLA in 1974. He started in the math department in 1975. Chung works in function theory and ring theory. He has written one book, 35 research papers and supervised 3 Ph.D. students. Chung retired in 2007.
Jo-Ann Cohen came to State after getting her Ph.D. from Duke University in 1976. Her research is in compact rings and evaluation theory. She has written 25 research papers and supervised 1 Ph. D. student. Cohen received an Outstanding Teacher Award in 1992, the Alumni Distinguished Professor Award in 1995 and the Board of Governors Award for Teaching Excellence in 2001. Cohen served as Co-Director of the Graduate Program from 1993 to 1995. She has run a Math Summer Camp for young women in high school since 1995. Cohen was appointed Associate Dean of PAMS in 2001. She helped establish the Women in Science and Engineering Program in 2003 to encourage women to go into science and engineering curricula and to continue on to graduate work.
Joe Dunn got his doctorate from Adelphi University in 1967 and began at NC State in 1976. His main interests are optimization and control theory. Dunn has written 59 research papers and supervised 6 Ph.D. students (2 in math, 2 in Operations Research and 2 at other institutions). He has been a member of the editorial board of Computational Optimization and Applications since 1992 and served as editor for Fuzzy Sets and Systems Journal. His research was funded by the NSF for 23 years. Dunn served as Director of the Graduate Program from 1999 to 2002. He retired in 2002.
Gary Faulkner joined the department in 1976 with a Ph.D. from Georgia Tech. He works in set theory, topology and foundations of mathematics. Faulkner has written over 35 papers and has had $5 \mathrm{Ph} . \mathrm{D}$. students. His was supported by the National Research Council of Italy for 12 years. Faulkner retired in 2005.

John Franke received a Ph.D. from Northwestern University in 1973 and came to State the same year. He is interested in discrete dynamical systems with applications to population dynamics. Franke has written 54 papers and has had $3 \mathrm{Ph} . \mathrm{D}$. students. Franke served as Graduate Administrator from 1984 to 1993. He was Interim Associate Department head in spring of 2003 and Associate Department Head in 2003-2004.
Ronald Fulp graduated from Auburn University with a Ph.D. in 1965. He joined the NCSU faculty in 1969. Fulp works in geometrical and algebraic aspects of mathematical physics. Fulp has written 39 research papers and has supervised 6 Ph.D. theses. He received an Outstanding Teacher Award in 1997.
Carl T. Kelley obtained a Ph.D. from Purdue University in 1976. He specializes in non-linear equations and optimization. Since he came to State in 1978, Kelley has written 3 books, over 100 papers and has had $18 \mathrm{Ph} . \mathrm{D}$. students. His research has been supported by NSF and the Army for 25 years. He is editor in chief of SIAM Journal on Optimization and a member of the SIAM Council. He is on the editorial board of several journals including Optimization and Engineering, Advances in Water Resources and Pacific Journal of Optimization. Kelley was named a Drexel Professor of Mathematics in 2002. He was elected a Fellow of SIAM in 2009.
Thomas Lada arrived on campus in 1973 and finished his doctorate from the University of Notre Dame in 1974. He works in algebraic topology and homological algebra. Lada has written one book, 17 research papers and has had 3 Ph.D. students. Lada has received research support from NSF.
Dana Latch earned her doctorate at CCNY in 1971 and joined the department in 1976. Her interests were in algebraic topology and theoretical computer science. She published many research papers and had one Ph.D. student. Latch served as Program Director for the NSF Computer Science Division. She retired early in 2000 because of health problems.
Robert H. Martin, Jr. came to NCSU immediately after obtaining his Ph.D. from Georgia Tech in 1970. His area of research is non-linear differential equations and functional analysis. Martin has written 2 books, over 50 research papers and has supervised 6 Ph.D. students. His research has been partially supported by NSF, Army, NATO, and the Humboldt Foundation for 15 years. Martin served as Department Head from 1989 to 1999. He received an Outstanding Teacher Award in 1989. The NC State Alumni Association named Martin an Alumni Distinguished Undergraduate Professor for 2008-2010. (See also p. 59)
Lavon Page got a Ph.D. from the University of Virginia in 1968 and joined NC State in 1969. From 1969 until 1982 Page did research in operator theory and wrote 10 papers. From 1982 until 1996 he worked in algorithms for reliability of complex systems and wrote 20 papers in this area. He became Director of the Multi-media Center in 1994 and held that position until 2003. He helped implement the use of MAPLE in undergraduate courses and the use of Web-Assign, a web-based homework delivery, collection, grading and recording system. Page was a pioneer in the development of on-line courses and developed three such courses. He twice won Honorable Mention in the Gertrude Cox

Awards for distinguished performance in the use of technology in teaching. In 2004 Page was appointed by the Provost to "head the implementation effort" of NC State's LITRE (Learning in a Technology Rich Environment) program. Page retired in 2006.
Chen Ven Pao came to State in 1969, one year after receiving his Ph.D. from the University of Pittsburgh. He works in non-linear parabolic and elliptic equations and the reaction-diffusion equation. He has published one book, over 150 research papers and supervised $8 \mathrm{Ph} . \mathrm{D}$. students. Pao is on the editorial board of five mathematical journals. He retired in 2002 but continued his research work.
Sandra Paur obtained her doctorate from Indiana University in 1973 and joined the NCSU faculty the same year. Paur wrote several papers in geometric measure theory, but her major efforts have been in undergraduate instruction and as Director of the Honors Program in Mathematics. The Honors Program had just a handful of students in 1980 when Paur was put in charge. Under her guidance the program has grown to 35 to 40 students with 10 to 12 graduating each year. (See p. 46.47) Paur received an Outstanding Teacher Award in 2001 and the NCSU Faculty Adviser Award in 2007.
Mohan Putcha came directly to State after earning a Ph.D. from the University of California at Santa Barbara in 1973. He works in algebraic monoids, groups and representation theory. He has written one book, 136 research papers, and has supervised 8 Ph.D. students. Putcha is on the editorial board of two journals. His has received research sponsorship from the NSF.
Stephen Schecter received his Ph.D. from the University of California at Berkeley in 1975 and joined State the same year. He is interested in traveling waves and their stability, geometric singular perturbation theory and systems of conservation laws. He has written 40 research papers and has supervised one Ph.D. student. His research has been supported by the NSF. Schecter was Graduate Program Administrator from 1993 to 1995. In 2008 a conference was held at NC State to celebrate the contributions of Steve Schecter and Xiao-Biao Lin to Dynamical Systems.
James Selgrade became a member of the NCSU faculty after obtaining his doctorate from the University of Wisconsin at Madison in 1973. He does research in dynamical systems and biomathematics. Selgrade has written 48 research papers and has had 3 Ph.D. students. His research has been supported by the US Forest Service and other agencies. Selgrade was interim director of the Biomathematics Graduate Program in 2002-2003.
Michael Singer got his Ph.D. from the University of California at Berkeley in 1974. He joined the department in 1976 and does research in differential algebra and symbolic computations. He has written 2 books and 64 research publications and has supervised 7 Ph.D. students. Singer's research has been supported by the NSF. He is editor of two journals. Singer was on leave from 2000 to 2003 at the Mathematical Sciences Research Institute in Berkeley first as Deputy Director and then as Acting Director.
Ernest Stitzinger arrived on campus in 1969 after getting his Ph.D. from the University of Pittsburgh. He has written one book, 47 research papers and has supervised 16 Ph.D. students. Stitzinger received an Outstanding Teacher Award in 1988, an Alumni

Distinguished Professorship in 1991 and the Board of Governors Award for Teaching Excellence in 2002. He has been serving as Graduate Administrator since 1995.
William M. Waters, Jr. finished his Ph.D. from Florida State University in 1971. He came to State in 1970 with appointments in both the Math and the Math and Science Education Departments. His research is in mathematics education especially the teaching and learning of geometry. Waters has written 25 papers and has had 10 Ph.D. students. He received Outstanding Teacher Awards in 1972 and 1976. In 2006 Waters was awarded the W. W. Rankin Award by the NC Council of Teachers of Mathematics. Waters spent 3 years as Chinese interpreter for military intelligence while he served in the army prior to obtaining his Ph.D.
Robert White came to NCSU immediately after getting his Ph.D. from the University of Massachusetts in 1973. He is interested in partial differential equations and numerical methods in multiprocessing computation. He has developed undergraduate courses in numerical methods and computation. White has written two books and 27 research papers and has supervised $3 \mathrm{Ph} . \mathrm{D}$. students.

The members of the department in 1976-77 were:
Department administration: N. J. Rose, Department Head; H. V. Park, Associate Department Head; W. Harrington, Assistant Department Head and Coordinator of Advising; R. E. Chandler, Graduate Administrator; C. N Anderson, Scheduling Officer.

Professors: J. S. Bishir, E. E. Burniston, R. E. Chandler, J. M. A. Danby, R. O. Fulp, W. J. Harrington, K. Koh, J. R. Kolb, J. Levine, P. E. Lewis, J. Luh, R. M. Martin, Jr., P. A. Nickel, H. V. Park, N. J. Rose, H. Sagan, H. E. Speece, R. A. Struble, H. R. van der Vaart, O. Wesler.

Associate Professors: S. L. Campbell, H. C. Cooke, W. G. Dotson, J. C. Dunn, R. Gellar, R. E. Hartwig, J. E. Huneycutt, Jr., D. M. Latch, C. H. Little, Jr., A. Maltbie, J. Marlin, C. D. Meyer, Jr., A. R. Nolstad, L. B. Page, C. V. Pao, D. M. Peterson, H. A. Petrea, J. A. Roulier, E. L. Stitzinger, W. M. Waters, Jr., J. B. Wilson.

Assistant Professors: C. N. Anderson H. J. Charlton, L. O. Chung, J. E. Franke, M. L. Gardner, D. E. Garoutte, D. J. Hansen, T. Lada, C. F. Lewis, J. Nelson, S. O. Paur, M. S. Putcha, R. T. Ramsay, R. G. Savage, S. Schecter, J. F. Selgrade, R. Silber, J. L. Sox, Jr., D. F. Ullrich, R. E. White.

Instructors, D. L. Brant, H. L. Crouch, Jr., H. L. Davison, T. F. Gordon.
Of the 61 professorial faculty, 55 had Ph.D. degrees. The faculty produced 68 research papers and presented 60 papers at professional meetings.

## Chapter 7

## The Mathematics Department 1977 to 1980—The Ortega Years

Nick Rose stepped down as department head in 1977 and the headship was turned over to Dr. James M. Ortega. Hubert Park, Associate Head of the Department, delayed his retirement for one year to assist Ortega in the administration of the department.

James M. Ortega was born in Madison, Wisconsin. He graduated from High School in Albuquerque, New Mexico and received a B.S. degree in Mathematics from the University of New Mexico in 1954. He received his Ph.D. from Stanford in 1962. Dr. Ortega worked as a mathematician for the Sandia Laboratories in Albuquerque and for Belcomm in Washington, D.C. In 1961 he took a leave and served as visiting professor at the University of California in San Diego. In 1964 he joined the mathematics faculty at the University of Maryland and became professor of Computer Science, Mathematics, and Applied Mathematics in 1969.

In 1972 he was appointed director of ICASE (Insti-


James M. Ortega tute for Computer Applications in Science and Engineering) at the NASA research center at Langley, Virginia, and in 1973 he became an adjunct professor at the College of William and Mary and at the University of Virginia. Ortega has written two books and published extensively in numerical analysis. He also directed a number of Ph.D. dissertations at Maryland and Virginia.

Because of his academic and industrial background, the department had great expectations for Ortega's tenure as department head. Ortega and the department shared the aspiration to become a nationally recognized department, particularly in applied mathematics. Somehow, in the view of
some faculty, Ortega pushed too hard to have some pure mathematicians change to applied fields. There was also some disagreement between Ortega and the administration over promotions and appointments. To make a long story short, Ortega felt he did not receive sufficient backing from either the faculty or administration, and he resigned in 1979. He went on to a successful career at the University of Virginia.

Though Ortega's stay at State was brief, there were several accomplishments during his tenure. He appointed James B. Wilson as Assistant Department Head to take over Hubert Park's duties when Park retired in 1978. The Ph.D. program was made more flexible by having the written portion of a student's preliminary examination prepared and administered by the student's advisory committee (instead of a departmental committee). Ortega started a Distinguished Lecturer Series, which formalized the long-standing tradition of bringing outstanding mathematicians to the campus. In the period 1977-1979, the lecturers were Felix Browder, Peter Lax, Saunders MacLane, Roger Penrose, John Milnor, Raoul Bott and Garrett Birkhoff (a very distinguished group indeed!).

When Ortega resigned in 1979, Walter Harrington was appointed Acting Head. Harrington was well respected and kept the department on an even keel while a search committee looked for a new department head.

Walter Harrington was born in 1916 in Salamanda, New York (population about 10,000 ) near Buffalo. He did his undergraduate and graduate work at Cornell University, getting his his Ph.D. in number theory in 1941. From Cornell he went to Penn State and got involved in Ordinance Work for the War effort. Harrington met Cell while they were both doing work at the Aberdeen Proving Grounds. In 1957 John Cell lured him away from Penn State with an offer of a full Professorship.

Harrington played a significant role in getting the Ph.D. program approved. He participated actively in research and supervision


Walter Harrington of Ph.D. students. Besides serving as acting head in 1979-80, Harrington served as Assistant Head of the Department from 1976 to 1982 in overall charge of the undergraduate program and student advising.

In April of 1980, Harrington organized a ceremony to honor the winners of the Maltbie Awards. These awards are given to the six top graduate teaching assistants, based on their teaching performance. The awards were funded by a generous gift from Professor and Mrs. Maltbie. Professor Maltbie had supervised the graduate teaching assistants from 1957 until his retirement in 1979.

The Honors Program was started about 1965. Bob Winton was the first Honors Advisor, followed by John Bishir and then Lavon Page, each of them serving 5 years. Harrington appointed

Sandy Paur to take over the task in 1980. In her own words, Paur said
"Soon after I was appointed to the job, I started seeing things that needed changing, particularly in the ways students were identified and recruited for the program, and there wasn't anybody I needed to clear things with so I just did it. Then I found other things to change. At the end of 5 years, there were still a lot of things that I thought needed to be done. I was having a good time so I just didn't tell anybody that usually the Honors Advisor stepped down after 5 years. I kept finding things to fix and/or add to the program so here [ I am ] after 29 years."

When Paur took over the program in 1980 there were about 6-7 students with one or two graduating each year. Under Paur's leadership the program prospered. By the mid 1990's membership in the program was 20-25 students and is now between 35 and 40 students with 10-12 students graduating each year.

145 students have graduated from the Honors Program since 1992. Of these 110 students went on to graduate school. 38 studied abroad, including 29 at the Budapest Semesters in Mathematics. 27 students received prestigious scholarships and fellowships including Gates, Fulbright, Ford, Goldwater and NSF awards. It is clear that, because of Sandy Paur's hard work and dedication, the Honors Program is a big success and an asset to the department. In fact, in 2008, the External Review Committee specifically cited the department "for the size and quality of the undergraduate honors program".

During the 1977-1980 period there were four additions to the facutly. Two appointments were made while Ortega was head:

Jack Silverstein got his Ph.D. from Brown University in 1975 and began his stay at State in 1978. His specialty is probability and mathematical statistics with a special interest in random matrices. He has published 45 papers and has had two $\mathrm{Ph} . D$. students. Silverstein's research has been supported by the NSF. In 2007 Silverstein was elected Fellow of the Institute of Mathematical Statistics.

Elmor Peterson has a Ph.D. from Carnegie Mellon University in 1964. He works in convex analysis and optimization. He supervised $12 \mathrm{Ph} . \mathrm{D}$. students at other institutions before joining NC Sate in 1979. Since then he has been advisor or co-advisor of three more Ph.D.s. Peterson has written 1 book and over 50 research publications and has served on the editorial board of SIAM 's Journal on Discrete Methods. Peterson retired in 2005.

During his caretaker year, Harrington also made two additions to the faculty:
Charles Siewert was awarded a Ph.D. from the University of Michigan in 1965 and joined the faculty of the Nuclear Engineering Department at State the same year. In 1980 he was given a joint appointment with the Mathematics Department, and, in 1983, he became a full time member of the department. Siewert's research is in analytical and
computational methods in particle transport theory. He has written over 250 papers and has supervised 11 students in Nuclear Engineering. His research has been supported by the NSF since 1980. He serves on the editorial board of Transport Theory and Statistical Mechanics and the Journal of Qualitative Spectroscopy and Radiative Transfer. He received the Sigma Xi Research Award in 1970, the Alumni Association Research Award in 1985 and the Outstanding Alumnus Award from the University of Michigan in 1990. Siewert retired in 2008.

Jesus Rodriguez obtained a faculty appointment at NCSU after getting his Ph.D. from the University of Maryland in 1980. His research is in existence and qualitative properties of solutions to boundary value problems in differential and difference equations. Rodriquez has published over 20 papers and has supervised two Ph.D. students. He has had research support from NSF.
...the source of all great mathematics is the special case, the concrete example. It is frequent in mathematics that every instance of a concept of seemingly great generality is in essence the same as a small and concrete special case.
-Paul Halmos
Concern for man himself and his fate must always form the chief interest of all technical endeavors . . . in order that the creations of our mind shall be a blessing and not a curse to mankind. Never forget this in the midst of your diagrams and equations.
—Albert Einstein
The mathematician does not study pure mathematics because it is useful; he studies it because he delights in it and he delights in it because it is beautiful.

- Henri Poincaré

Taking mathematics from the beginning of the world to the time of Newton, what he has done is much the better half.

## Chapter 8

## The Mathematics Department 1980 to 1989—The Burniston Years I

After an extensive search of many outside candidates, Ernest Burniston was selected from the inside to become head of the department in the fall of 1980.

Ernest E. Burniston was born in 1937 in Sheffield, England. He earned a B.Sc. in Mathematics from the University of London in 1960 and a Ph.D. from the same university in 1962. He was a lecturer at Sir John Cass College at the University of London from 1962 to 1965. In 1964 Burniston applied for a position at NC State. In the spring of 1965 John Cell, the head of the mathematics department at NCSU, was on vacation in London and interviewed Burniston at an ideal location for an Englishman-in a tea shop. Burniston joined the mathematics department later that year.

Burniston did his research in elasticity, mechanics and fracture mechanics. He was part of the "Applied


Ernest Burniston Math Group" working on fracture mechanics which was funded by the Air Force from 1965 to 1973. In 1972 his research interest turned to transport theory, and he wrote several papers in this area, mostly with C. E. Siewert. He and Siewert also wrote several papers on solution of transcendental equations. All told, Burniston wrote over 30 research papers, supervised eight master's students and three Ph.D. students.

Burniston is an accomplished classical clarinet player who has participated in many musical performances in the Raleigh area.

In 1981 Burniston continued the program, started by Harrington, to recognize the winners of the Maltbie Awards for Outstanding Teaching Assistants in Mathematics. Moreover, in the spring
of 1982, Burniston extended the program to include all students receiving awards and scholarships. Students successfully completing the Honors Program were also recognized. This was the start of the tradition of having an annual "Awards Day" near the end of the spring semester.

In the late 1970's and early 1980's the enrollment of undergraduate majors declined somewhat. When Walter Harrington retired in 1982, Burniston went outside the department to find Michael J. Evans to be the Director of the Undergraduate Program. Evans was a solid mathematician, an excellent teacher, and had a fine rapport with students. Evans put new life into the undergraduate program. He recruited extensively throughout North Carolina, rejuvenated an undergraduate mathematics club, and raised the admissions standards. Bob Ramsay took over as Director of the Undergraduate Program in 1993 when Evans left State for a named professorship at Washington and Lee.

In 1983 Frank F. McKee, a Raleigh businessman concerned about mathematics education in Wake County, proposed an annual contest to recognize outstanding mathematics students. Burniston and Evans cooperated with Mr. McKee and the Wake County School System in setting up the contest. "The McKee Excellence in Mathematics Competition" was funded by Mr. McKee from 1983 to 1994. Burniston, Evans, Wilson and Petrea made up the problems for the contest. From 1994 until 2002, the math department sponsored the contest. Since 2002 the competition has been funded by Todd Fuller, and is now known as the the "Todd Fuller Competition".

Todd Fuller graduated Summa Cum Laude from NC State in 1996 with a major in mathematics. He also was a star on the State basketball team-one of the few math majors to participate in a major college sports program. Fuller was an Academic AllAmerican and declined a Rhodes Scholarship to play professional basketball. He played for several years both in the US and abroad.

From 1989-99 the exam committee was headed by Bob Ramsay and since then by Jeff Scroggs.
An external committee reviewed the state of the mathematics department in December of 1983. The committee consisted of Professor George J. Fix (Mathematics Department, CarnegieMellon University), Professor Jack K. Hale (Division of Applied Math, Brown University) and Professor Richard S. Pierce (Dept. of Math, Arizona University). The summary of their report appears below.

## Department of Mathematics

## North Carolina State University


#### Abstract

Summary The review committee feels that the Mathematics Department is essentially in good shape and serves the University well. It is in a state of transition with many new opportunities that will require some adjustment on the part of its faculty. However, with


careful planning, it can look forward to progress throughout this decade. Our review of the Department's undergraduate and master's programs is given in the second section [not included here]. These are traditional strengths of the Department, and they have produced a number of excellent students. The Department is involved in aggressive recruiting of students, which augurs well for continuing progress in the future.
The Ph.D. program and the Department's role in research has a shorter tradition, greater problems, as well as greater opportunities. The Committee feels that it would be a mistake to attempt to replicate large and broadly based programs such as for example exist at the University of California at Berkeley. A better strategy would be to concentrate on key areas in applied mathematics and analysis where there is a reasonable chance of achieving national prominence. However, this must be done in such a way as to preserve strength in pure mathematics. Care must always be exercised in developing the program toward more applied subjects, it is very easy to become concerned only with relevance and funding, forgetting about the academic side. This would be a mistake and detrimental to the morale of the Department.
The development of a critical mass in numerical analysis is an excellent step in that direction. In addition to adding to the department's overall strength, this group could be a university-wide resource in the stimulation of badly needed $\mathrm{Ph} . \mathrm{D}$. training and research in the computational sciences. Moreover, given current national trends it is not unreasonable for the Department to expect this group to attract rather generous amounts of outside funding.
The Department also has a budding research group in dynamical systems and differential equations. Current problems include a low level of faculty interaction as well as a substandard record of outside funding. Nevertheless, there is an abundance of talent in this area. This is a place where the right type of outside appointment could make a major difference.
The algebra group at North Carolina State University is fairly large and reasonably active, but the Committee feels that this group could be more effective if it had greater cohesion and a broader range of interest. An aggressive leader among the algebraists would be a real asset. With proper encouragement, such a person might emerge from the existing group, but it is more likely that an outsider could be found to fill this need.
The Committee has also looked at the organizational structure of the Department, and found it to be both rational and efficient. One area that can be improved is continual long term planning. There should be a better understanding of the criteria for promotion to tenure and it certainly should rely more on the national reputation of the candidates. Hiring procedures should become more aggressive and more formalized to avoid confrontation at the time candidates are being interviewed.
The space problems that confront the Mathematics department are very serious and affect the quality of the Department's efforts both in research and education. Fortunately, these problems are widely recognized, and it seems likely that they will be dealt with as soon as possible.

In general, members of the Department should be encouraged to obtain more external funding. Since the preparation of proposals is very time consuming, the Dean's office should take all responsibility for the routine aspects of this effort.


Meyer, IBM rep., Kelley, Plemmons with the IBM 4361

Burniston had anticipated the committee's recommendation to build strength in numerical analysis. He hired Bob Plemmons in 1981 and Moody Chu in 1982 to add to the faculty already here: Tim Kelley, Carl Meyer and Bob White. Later three more were added: Ralph Byers (now at the University of Kansas), Steve Wright (now at the University of Wisconsin) and Nancy Nichols (now at the University of Reading, England). The increased research in this area led to the consideration of establishing a Center for Research in Scientific Computing (CRSC). In 1985 IBM donated a mainframe computer, an IBM 4361, to the department (see photo above). This was used for research by the faculty and was also a factor in getting approval for the CRSC. The Center was approved by the UNC Board of Governors in 1986, based on a proposal written by Associate Dean Les Sims and Bob Plemmons with input from Ernie Burniston, Carl Meyer and Bob White.

The purpose of the CRSC was to foster research in scientific computing and provide a focal point for research in computational science, engineering and applied mathematics. Carl Meyer was Director of the CRSC from 1986 to 1988. Bob Plemmons took over from 1988 to 1990. There were several accomplishments of the CRSC during these first four years: an increase in interactions between faculty in several departments in PAMS and in Engineering on scientific computing activities, new courses in Mathematics related to scientific computing and parallel processing were developed, and a grant was obtained from the Air Force for a small supercomputer (Alliant FX4) which was located in the Mathematics Department. After Plemmons left for Wake Forest in 1990, the Center was inactive until Tom Banks was hired as director in 1992 during the Martin administration; it has since grown to a position of national and international renown.

Like the undergraduate program, the graduate program enrollment decreased in the late 1970's and early 1980's, following a national trend. The graduate administrator Richard Chandler,
with considerable assistance from Gary Faulkner, increased recruiting efforts which eventually led to increased enrollments in the graduate program. John Franke continued to recruit aggressively when he became Graduate Administrator in 1984.

The Audio-Visual Tutorial Center, directed by Bob Savage, continued to provide valuable assistance to students. In 1988-89 TV tapes, made by interested faculty members, were available for eleven different courses in precalculus, calculus courses, differential equations and advanced math for engineers and scientists. Students used these tapes extensively; about 5 tapes were viewed for each hour the center was in operation. In 1980 Savage pioneered in making a computer-assisted instruction video for a precalculus course using the North Star Computer, and in 1985, he made a similar video for Ma 111, Algebra and Trigonometry. These efforts were specifically cited in Part II of the 1983 External Review Committee where the committee commented: "Probably no department in this country has a better effort in the use of state-of-the-art audio-visual materials." Bob Savage left for the Dean's office in 1987, and the direction of the center was taken over by Lavon Page.

After Armstrong Maltbie retired in 1979, the supervision of the graduate teaching assistants was taken over by Tom Gordon and then by Mary Marsha Cupitt. In 1985 Marilyn McCollum agreed to take on this responsibility and has handled the task ever since. Under McCollum's leadership the program has grown into a four-day workshop for new graduate teaching assistants plus an additional workshop before the assistants teach their first course. In addition TA's are carefully monitored by the faculty while they are teaching. This program has been praised by many other universities and was specifically pointed out as a program that "could be a model for many other departments" in the report of an External Review Committee in 1997.

C. Lewis, H. Park, Chancellor Poulton, H. Cooke, H. Nahikian
(Photo from the September 22, 1986 edition of the Technician)

The picture on p .53 shows Chancellor Poulton commending four retired faculty who were teaching without pay (a State law at the time prohibited any salary for people over the age of 72). Besides those in the photo, H. Speece and J. Levine also contributed their time. The only "compensation" they received was free parking and tickets to State football games. This is just one of several manifestations of the unusual loyalty of the faculty to the department and the university. Although the department has had many prominent mathematicians, only a few left the department for positions at other institutions. In addition, fourteen awards and scholarships have been established by faculty of the department, often with the help of family and friends. They are C. Anderson, H. T. Banks, R. Bullock, J. Cell, J. Cohen, C. Lewis, J. Levine, A. Maltbie, L. Martin, C. Mumford, H. Park, H. Petrea, N. Rose and L. Winton.

Since World War II, electronic, and later transistorized, digital main frame computers became increasingly available on college campuses. Many faculty used these computers for numerical calculations related to their research, and a few used them in conjunction with their courses. In the 1980's symbolic computational programs, sometimes called computer algebra programs, became available on main frame computers, and later on personal computers. These programs could perform algebraic manipulations and symbolic computations such as differentiation, integration, summation of series, etc. A number of faculty members experimented with the use of these programs in their classes. MACSYMA, developed at MIT, was used in 1985 by Singer and Rose on a VAX computer. However, the computer was not powerful enough to handle the load for a class of students. In 1986, Ramsay had better luck using MAPLE, developed at Waterloo University in Canada, in his calculus classes. Ramsay concluded that MAPLE would be a useful addition to undergraduate calculus classes and even more useful in advanced courses where long or tedious calculations are encountered. In the late 1980's a number of faculty including Page, Evans, Singer, Evans and Burniston started using MAPLE in undergraduate courses. Some faculty used MUMATH, a program that could run on personal computers.

Since the 1960 's, all additions to the professorial ranks had Ph.D. degrees. Research was an important criterion (some complained it was the only criterion) for advancement. During the 1980's most of the faculty were doing some research. In 1987-88 the faculty produced 59 research publications and 60 papers were presented at professional meetings. The department had developed areas of strength in applied mathematics, mathematical physics, numerical analysis, differential equations and dynamical systems, algebra and topology. Sponsored research was starting to become more significant in the 1980's. The new annual research grants during the 1980's varied from a low of $\$ 80,000$ to a high of $\$ 700,000$ with average of $\$ 379,000{ }^{1}$

Burniston made many additions to the faculty during his tenure as department head. In addition to building up the numerical analysis group, he hired staff in differential equations, applied mathematics, mathematical physics and algebra. Brief notes on some of these faculty are given below:

Moody Chu received his Ph.D. from Michigan State University in 1982 and came to NC State the same year. He is interested in numerical linear algebra, numerical

[^14]solution of differential equations, nonlinear algebraic equations and dynamical systems on manifolds. Chu has written one book and 85 publications. His research has been supported since 1985 by NSF, DOE, and the Army Research Office. He was editor of the SIAM Journal on Matrix Analysis and Applications from 1995 to 2000. Chu won an Outstanding Teacher Award in 1996 and an Alumni Distinguished Undergraduate Professor Award in 2006.

Ethelbert N. Chukwu got his doctorate at Case Western Reserve University in 1972. He joined the department in 1987. Chukwu works in the application of ordinary differential equations, functional equations and integral equations to control theory and large scale economic systems. He has written 5 books and 86 research publications. He is on the editorial board of the Journal of Nonlinear Analysis. Chukwu is a member of the New York Academy of Sciences. Chukwu retired in 2006.
Michael J. Evans obtained his Ph.D. from Michigan State University in 1970 and came to NC State in 1982. His area of research is real analysis. He has written 65 research papers and supervised 3 Ph. D. students at State. He has been editor of the journal Real Analysis Exchange. Evans was the Director of Undergraduate Programs from 1982 to 1989. He won an Outstanding Teaching Award in 1993. Evans left NC State for a named professorship at Washington and Lee in 1993.
Amassa Fauntleroy graduated from from Northwestern University with a Ph.D. in 1970. He joined the math department in 1986. Fauntleroy does research in the classification of algebraic varieties and has written 30 research articles in this area. Fauntleroy has served on the editorial board of the Notices of the AMS and the Journal of Pure and Applied Algebra. He has served on several committees of the AMS including the committee to select hour speakers for AMS meetings.
Aloysius G. Helminck came from the Netherlands and got his Ph.D. from the University of Utrecht in 1985. He works in algebraic groups, representation theory, p-adic groups, symmetric spaces and symbolic computation. Helminck joined the faculty in 1987. He has written over 40 papers and has supervised 6 Ph.D. students. He has 3 books in preparation. His research has been supported in part by NSF, NSA, and a Dutch Corporation for 10 years. Helminck chaired the departmental computing committee for many years. He served as interim associate department head in 2004-2005 as interim department head in 2005-2006 and as department head since July 1, 2006. (See also p. 83.
Arkady Kheyfets received a Ph.D. from the University of Texas at Austin in 1986 and joined the Mathematics Department in 1987. His research area is mathematical physics. Kheyfets has written 57 research articles and supervised $7 \mathrm{Ph} . D$. students.

Xiao-Biao Lin works in differential equations, applied mathematics, dynamical systems, bifurcations and singular perturbations. He earned his doctorate from Brown University in 1985 and joined the NCSU faculty in 1988. Lin has written 40 research papers and has supervised 2 Ph. D. students. Lin is on the editorial board of the Far East Journal of Dynamical Systems and the journal Partial Differential Equations and

Dynamical Systems. His research has been supported by the NSF since 1989. Lin has served on the department's Putnam Examination Committee and is currently chairman. In 2008 a conference was held at NC State to celebrate the mathematical contributions of Lin and Steve Schecter on the occasion of their 60th birthdays.
Marilyn McCollum received her M.S. from NCSU in 1977. She joined the faculty in 1981. McCollum has been Supervisor of Graduate Teaching Assistants since 1985. She has proven a worthy successor to Armstrong Maltbie. McCollum has developed two workshops for graduate assistants. One workshop when the students arrive on campus and one workshop before they teach their first course. McCollum received a 2005 Award for Outstanding Service in Support for Teaching and Learning from the Faculty Center for Teaching and Learning at NC State. She was honored with an NC State Outstanding Teacher Award for 2007-2008. McCollum retired in 2009.
Kailash C. Misra was awarded a Ph.D. from Rutgers University in 1982. He works in infinite dimensional lie algebras and quantum groups. He arrived at NC State in 1986. Misra has written over 50 research papers and has supervised $5 \mathrm{Ph} . \mathrm{D}$. students. He has a book in preparation. Misra's research has been supported by NSA or NSF since 1988. Misra served on the Faculty Senate. Misra has been on the Editorial Board of Communications in Algebra since 1995. He was honored with an Outstanding Teaching Award in 2004.
Larry Norris came to the Mathematics Department in 1980 after receiving his Ph.D. in Physics from N. C. State. He works in symplectic geometry and its generalizations, gauge theory and relativity. Norris has published 35 papers and has had 4 Ph.D. students (2 in math and 2 in physics). He has served as MAPLE Program Director in the department since 1999. MAPLE is a powerful symbolical computational program that is used in many mathematics courses. He his currently working on a DELTA ${ }^{2}$ grant from N.C. State to produce distance education versions of the Calculus Sequence. In this connection Norris is developing a program to automatically generate versions of MAPLE worksheets with randomized data for calculus and differential equations. Norris received the Elva and LeRoy Martin Teaching Effectiveness Award in 2004.
Robert J. Plemmons got his Ph.D. at Auburn University in 1965. His research is in matrix theory and computational linear algebra. He is author of more than 150 papers and three books on computational mathematics and is on the editorial boards of six journals. Plemmons joined the department in 1981 and left for Wake Forest University in 1990. He was one of the founders of the Center for Research in Scientific Computing and served as its director from 1988 to 1990. During his time at State he supervised 5 PhD students. He played professional baseball in the Baltimore Orioles System for four years in the 1960's after graduating from Wake Forest on a baseball scholarship.
Michael Shearer received his doctorate from Oxford University in 1976. He came to State in 1985. Shearer works in partial differential equations, granular flow and thin liquid films. He has written over 85 papers and has supervised $4 \mathrm{Ph} . \mathrm{D}$. students. His

[^15]research has been supported by NSF, Army and Air Force since 1985. He is on the editorial board of a SIAM journal and is Vice President of the SIAG ${ }^{3}$ Analysis of Partial Differential Equations. Shearer was Co-Director of the Graduate Program from 1993 to 1995.
Hien T. Tran has a Ph.D. from Rensselaer Polytechnic Institute in 1986. He spent three years as a post doctorate fellow at Brown University before joining the department in 1989. Tran's research is in modeling and control of physical and biological processes. He has written 65 papers and supervised 8 Ph.D. students. His research has been supported by a variety of sources including NASA, NSF, NSA, IBM, NIH in the government and MedAoustics, Aerospace Corporation and Calabaza Creek Research Inc. in the private sector. He received two awards from the Aerospace Corporation for his work: a Team Achievement Award in 2001 and an Inventor's Award in 2002. Tran is teaching the course Mathematical and Experimental Modeling of Physical Processes both to local students and by means of a high speed video hookup (NC-REV), to students at other universities. Tran has been faculty advisor for Pi Mu Epsilon since 2002. He has served as Associate Head of the Math Department since 2005.

In 1989, the last year of the (first) Burniston administration, the faculty consisted of:
Professors: J. W. Bishir, E. E. Burniston, S. L. Campbell, R. E. Chandler, E. N. Chukwu, L. O. Chung, J. M. A. Danby, J. C. Dunn, A. Fauntleroy, R. O. Fulp, R. E. Hartwig, C. T. Kelley, K. Koh, J. R. Kolb, J. Luh, J. A. Marlin, L. B. Martin, R. H. Martin, Jr., C. D. Meyer, N. Nichols, P. A. Nickel, C. V. Pao, E. L. Peterson, R. J. Plemmons, M. Putcha, N. J. Rose, H. Sagan, J. F. Selgrade, M. Shearer, C. E. Siewert, M. F. Singer, E. L. Stitzinger, H. van der Vaart, O. Wesler.

Associate Professors: M. Chu, J. D. Cohen, G. D. Faulkner, J. E. Franke, T. Lada, D. M. Latch, L. K, Norris, L. B. Page, H. A. Petrea, R. T. Ramsay, J. Rodriguez, R. G. Savage, S. Schecter, R. Silber, J. W. Silverstein, D. F. Ullrich, W. M. Waters, R. E. White.

Assistant Professors: H. J. Charlton, R. Haas, D. J. Hansen, A. Helminck, A. Kheyfets, K. C. Misra, S. O. Paur, J. L. Rulla, S. J. Wright.

Lecturers: E. L. Barnhardt, M. McCollum, J. E. Rohrbach, M. Schiermeier.
Teaching emeritus faculty: H. C. Cooke, J. Levine, C. F. Lewis, H. M. Nahikian, H. V. Park, H. E. Speece, J. B. Wilson.

[^16]Many who have had an opportunity of knowing any more about mathematics confuse it with arithmetic, and consider it an arid science. In reality, however, it is a science which requires a great amount of imagination.

> —Sofia Kovalevskaya

A topologist is one who doesn't know the difference between a doughnut and a coffee cup.
—John Kelley
It is India that gave us the ingenious method of expressing all numbers by means of ten symbols, each symbol receiving a value of position as well as an absolute value; a profound and important idea which appears so simple to us now that we ignore its true merit. But its very simplicity and the great ease which it has lent to computations put our arithmetic in the first rank of useful inventions; and we shall appreciate the grandeur of the achievement the more when we remember that it escaped the genius of Archimedes and Apollonius, two of the greatest men produced by antiquity.

- Pierre-Simon de Laplace

As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.
-Albert Einstein
Nothing has afforded me so convincing a proof of the unity of the Deity as these purely mental conceptions of numerical and mathematical science which have been by slow degrees vouchsafed to man, and are still granted in these latter times by the Differential Calculus, now superseded by the Higher Algebra, all of which must have existed in that sublimely omniscient Mind from eternity.
—Mary Somerville

## Chapter 9

## The Mathematics Department 1989 to 1999—The Martin Years

Burniston retired as department head in 1989. After a nationwide search, the search committee and the Dean of PAMS, Jerry Whitten, decided that the best candidate was already a member of the department, Robert H. Martin, Jr.. He was appointed the new head of the mathematics department in the fall of 1989.

Robert H. Martin, Jr. was born in Columbia, South Carolina and was raised there and in Greenville, S.C. His underaafa education was at the University of South Carolina. While he was an undergraduate he worked for three years as a Page in the South Carolina House of Representatives. He received his Ph.D. from Georgia Institute of Technology in 1970 and joined the faculty at NC State the same year.

Martin divides his career into three parts. For the first twenty years he concentrated on research in nonlinear differential equations and functional analysis. The next 10 years, 1989-1999, while he was head of the department, his efforts were mainly on administration.


Robert H. Martin, Jr. Since 1999, Martin has put his major emphasis on teaching, and has taken on a larger teaching load.

Martin was concerned about the high teaching loads for graduate assistants. He felt that these teaching loads distracted students from their studies and, in addition, made State less competitive in recruiting new students. Martin arranged it so that graduate assistants did not teach the first year unless they had a Master's Degree or previous experience. Furthermore they would teach no more than one course a semester after that. He encouraged faculty to get Research Assistants on
their research grants so that more students could concentrate on their studies and research. Martin also instituted the use of departmental funds together with scholarship funds so that more graduate assistants could work on their dissertation full time.

When Bob Plemmons, the director of the Center for Research in Scientific Computing, left for a named professorship at Wake Forest, the CRSC was left without a leader. Martin had met Tom Banks at a meeting in Austria in 1989 and thought he would be the ideal person to head the center. Besides an impressive academic record, Banks was an alumnus of NC State. Martin joined forces with Dean Jerry Whitten to try to convince Banks to come to NC State. Their joint efforts met with success in 1992 when Banks joined State as University Professor and Director of the CRSC.

H. T. Banks


Jerry Whitten

Whitten, working closely with Martin and Banks, put considerable resources into the Center and the Mathematics Department. First, at Banks' suggestion, Dr. Kazufumi Ito, a colleague of Banks at Brown and USC, was hired as a tenured Associate Professor of Mathematics; this was rarely done (normally only full Professors are hired with tenure). Second, he allotted considerable space on the third floor of Harrelson for the use of Post Docs for the center. This was the cause of some temporary resentment by the faculty and graduate students who were displaced. Third, he assigned four new faculty positions to the Mathematics Department.

The Center grew rapidly in activity and prestige. Most of the credit for its success was due to the leadership of Banks. However, the excellent working relationships among Banks, Whitten and Martin helped pave the way for this success. In 2009 the Center had 59 associated faculty and industrial partners in research and 24 associated graduate students. The Center produces about 30 technical reports each year.

In 1994 the CRSC started the Industrial Applied Mathematics Program (IAMP), which is now co-sponsored by the Mathematics Department. The main goal of the program is to provide substantive non-academic research-related experiences for graduate students, postdoctoral and faculty participants while contributing to the research efforts of industrial participants. The IAMP is open to graduate students, postdocs and faculty who commit to appropriate projects. The projects
need not be related to a student's Ph.D. thesis. Student participants normally are enrolled in one of the mathematics Ph.D. programs or are associated with faculty members of the CRSC. In the 20002001 academic year the program involved approximately 23 projects, 14 faculty, 4 postdocs and 25 graduate students. Its governmental and industrial collaborators include: The Lord Corporation, United States Air Force Research Laboratory, United States Army Waterways Experiment Station, NASA Langley Research Center, Chemical Industry Institute of Toxicology, Aerospace Corporation, Environmental Protection Agency, ETREMA Products Inc, The Boeing Company, Lockheed Martin, MedAcoustics and Jenike \& Johanson Inc.

In 1999 the Lord Corporation of Cary contributed \$200,000 to endow the Lord Corporation Fellowships. These awards support graduate and post-doctoral students in applied mathematics and scientific computation.

Franke stepped down as Graduate Administrator in 1993. Many faculty were reluctant to take on the job of Graduate Administrator because it would take too much time away from their research. A bifurcation was called for. There would be a Director of the Graduate Program and a Graduate Administrator. The Director would look after program requirements, new programs and recruiting and the Administrator would advise and look after the students. Michael Shearer and Jo-Ann Cohen agreed to take on the job for two years, Shearer as Director and Cohen as Administrator. Cohen and Shearer increased the options in the Graduate Program so that the requirements for a Ph.D. were flexible enough to accommodate the interests of both pure and applied students. Steve Schecter served as Director and Ernest Stitzinger as Administrator from 1995 to 1997. Steve Campbell took over as Director from 1997 to 1999 and Joe Dunn served from 1999 to 2002. Campbell returned as Director in 2002 and has held the position since then. Stitzinger has been Graduate Administrator since 1995, providing an important continuity in the administration of the graduate program.

To help in recruiting new graduate students, Tom Banks suggested having a recruiting weekend where prospective graduate students could visit the campus and talk to faculty and graduate students. This program was very well received and is now standard procedure. The efforts of Martin, Banks, the various graduate administrators, and the entire graduate faculty, resulted in an increase in the number of graduate students from 86 in 1992 to 117 in 1999. The number of Ph.D.'s increased from 29 in the 1980-89 period to 78 in the 1990-1999 period.

Garoutte stepped down as Associate Department Head in 1996. Garoutte's main duty was to oversee undergraduate instruction-assigning instructors and course coordinators, handling student complaints, etc. It had been customary to pick someone on the professorial faculty to handle these duties. However Martin appointed John R. Griggs, an Instructor, to take Garoutte's duties with the title of Coordinator of Undergraduate Instruction. Griggs had a somewhat different background. He had been a high school math teacher and coach of football and basketball teams at Apex High School before coming to State in 1990 as an Instructor. He was originally hired to help Burniston in the Turbo-Calculus Program. This program, modeled after a program at Berkeley, was a supplement to the beginning calculus courses specifically designed to give a boost to students from small towns or from impoverished backgrounds. Griggs also taught other pre-calculus and calculus courses. Martin felt that Griggs's background in teaching and coaching and his rapport with students made him an excellent person for this position. In 2000 Griggs earned his Ph.D. in Mathematics Education.

In the 1980's the mathematics department experimented with the use of symbolic computation programs in undergraduate calculus courses. A lot of time in undergraduate courses is spent in having students become proficient at differentiation and anti-differentiation, evaluation of definite integrals, solving differential equations and similar tasks. Symbolic computation programs such as MAPLE and MATHEMATICA perform these operations much faster and more accurately than students (or faculty) can. The challenge was to incorporate the use of such a program into the undergraduate curriculum. There was mixed feeling in the faculty about the use of such a program. Some were enthusiastic and others felt that students would rely too heavily on the computer and would lessen their understanding of the fundamentals of calculus. This debate was similar to that concerning the use of calculators in the classroom that raged a decade or so earlier.

In 1990 the department decided the time had arrived to start using MAPLE in the calculus sequence. MAPLE was chosen over MATHEMATICA because the site licenses for the program were more reasonable. Martin put Joe Marlin in overall charge of the project. There was much to be done. Computer Labs for the students had to be set up or modernized. The faculty had to have high speed access to the NCSU network; this involved a lot of wiring to be done in Harrelson Hall. Marlin arranged to give introductions to MAPLE for both faculty and students. Course materials were developed using MAPLE. In the beginning the MAPLE exercises were separate from the course work and run like a laboratory. Marlin was able to get an NSF grant to help in this project. Many faculty helped in this effort particularly Burniston and Evans. Gradually MAPLE started to be integrated into the course work. As of 2004, MAPLE is a standard part of the undergraduate calculus and differential equation sequence. In addition it has significantly improved many advanced courses such as Fourier series and boundary value problems and the study of the integral theorems of Gauss, Green and Stokes. MAPLE has excellent graphing capabilities, including the ability to make animations; these often helped put new life into course content.

Many important additions to the faculty were made during the Martin administration. He built on the traditional strengths of the department: numerical analysis, algebra, differential equations, applied mathematics and biomathematics. In addition symbolic computation was becoming an important new area of research and Martin added faculty in this area. Following is some information about those faculty who remained at State for a significant time:
H. T. Banks (Ph.D., Purdue University, 1967) was appointed University Professor and Director of the Center for Research in Scientific Computing in 1992. Banks's research interests are control and parameter estimation in partial differential equations, computational methods, biological modeling, flexible structures and structural acoustics. Banks has published 4 books, and over 400 papers. He has supervised $37 \mathrm{Ph} . D$. students and more than 30 postdocs. He has served as Editor for the Journal of Mathematical Biology and Managing Editor of the SIAM Journal on Control and Optimization. Banks served two terms (1982-1985) as SIAM Vice President-Publications and two terms (1997-2002) on the SIAM Board of Trustees, and four years as Chair of that Board. From 1980 to 2002, he served as Scientific Consultant to the Institute of Computer Applications in Science and Engineering (ICASE) and, in 1985 was named Associate Member. During the past 20 years, he has received funding from ARO, AFOSR and

NSF. Banks is a Fellow of the IEEE, a Fellow of the Institute of Physics, and a Fellow of SIAM. Banks was the recipient of the IEEE Control Systems Technology Award in 1996 and the W. T. and Idalia Reid Prize in Mathematics in 2002. Banks received the Alumni Association Outstanding Research Award in 1996 and again in 2008. He also received an Alumni Distinguished Graduate Professor Award in 2002.

Jean-Pierre Fouque came to the department from France in 1998. He earned his Ph.D. from the University Pierre et Marie Curie in Paris in 1979. His research interests are in probability, stochastic processes, waves in random media and financial mathematics. Fouque has written one book, over 50 research publications. and has supervised 6 Ph.D. students ( 2 at NCSU). His research has been supported by NSF, ONR and DARPA since 1999. In 2002 Fouque was a major factor in getting approval for a new graduate program in financial mathematics and served as the program's first director. In the spring of 2003 when Bernard Mair took a leave of absence, Fouque was appointed Interim Department Head. Upon Mair's resignation in 2004, Fouque was again appointed Interim Department Head. Fouque left state in 2005. (See also p. 74)

Pierre A. Gremaud obtained his Ph.D. from the Ecole Polytechnique in Lausanne, Switzerland in 1991. He had a postdoctorate fellowship at the University of Minnesota before coming to State in 1994. His research is in numerical methods for partial differential equations with applications to solid mechanics and hyperbolic problems. Gremaud has published 40 papers and has supervised four Ph.D. students. He became Associate Director of SAMSI in 2009.

John W. Griggs has taught at State since 1990 and received his Ph.D. from NC State in 2000. His specialty is Mathematics Education. Since 1996 he has been Coordinator of Instruction in the mathematics department. Griggs heads the statistical team that provides statistics for the home football and basketball games at NC State and serves on the Athletic Council. He is currently developing on-line courses for the main calculus sequence. Griggs is coordinator of the Todd Fuller High School Competition. He received an NC State Outstanding Teacher Award in 2005.

Ben Fitzpatrick received his Ph.D. from Brown University in 1988. He was a member of the department from 1992 until 1997. Fitzpatrick works in applied mathematics and had two Ph.D. students during his stay at State.

Hoon Hong obtained his Ph.D. from Ohio State University in 1990. He spent 7 years at the Research Institute for Symbolic Logic in Austria before joining the NCSU faculty in 1997. Hong does research in symbolic computation and has published over 50 papers. He has had $8 \mathrm{Ph} . \mathrm{D}$. students ( 6 in Austria and 2 in NCSU). He is editor in chief of the Journal of Symbolic Computation (whose editorial board also includes Singer and Kaltofen). Hong has had research support from the NSF and also from the Department of Commerce, the latter being joint work with a member of the Textile's school. He received an Outstanding Teaching Award in 2004. Hoon was elected Faculty Chair of College of Physical and Mathematical Sciences in 2004-2005.

Ilse Ipsen got her doctorate from Pennsylvania State University in 1983 and came to the department in 1993. Ipsen works in numerical linear algebra, matrix theory and scientific computing. She has written 74papers and has had 3 Ph.D. students. She has had research support from NSF, ARO, DARPA, Army and ONR. Ipsen is on the editorial board of SIAM Review and SIAM Journal on Matrix Analysis and Applications. She is the SIAM Vice-President for Programs and Chair of the SIAM Activity Group on Linear Algebra. Ipsen was on the Scientific Program Committee for the 6th International Congress on Industrial and Applied Mathematics Zürich, Switzerland in 2007 and on the Organizing Committee for the 2007 Meeting of the International Linear Algebra Society in Shanghai.
Kazufumi Ito earned his Ph.D. at Washington University in 1982 and joined State in 1992. He works in applied mathematics, control theory and partial differential equations. He has published one book, over 120 research papers and has supervised 4 Ph.D. students. Ito's research has been sponsored by NSF and the Air Force, Navy and Army research offices.
Naihuan Jing has a Ph.D. from Yale University in 1989. He started in the Mathematics Department in 1994. Jing works in symmetry and representation theory of lie algebras and quantum groups. He has published 55 papers and has had 4 Ph. . students. His research has been supported by NSF and NSA. Jing was awarded a Fullbright Fellowship for 2004, working out of the Max Planck Institute. He also received a Humboldt Fellowship for 2003-2005.
Erich Kaltofen is the recipient of a Ph.D. from Rensselaer Polytechnic Institute in 1982. He joined NCSU in 1996. His current interests are in computational algebra and number theory, design and analysis of sequential and parallel algorithms, and symbolic computation systems and languages. He has edited 4 books, including the new Computer Algebra Handbook, published 140 research articles and has supervised 9 Ph.D. students (4 at NC State). Kalfofen has contributed to the Waterloo Maple system and has developed symbolic computation software in Lisp and $\mathrm{C}++$. His research has been supported since 1983 mainly by NSF. He is on the editorial boards of two journals. Kaltofen was the Chair of ACM's Special Interest Group on Symbolic \& Algebraic Manipulation (1993-95), and is currently on its Advisory Committee. From 1985-1987 he held an IBM Faculty Development Award, and in 1990-91 he was an ACM National Lecturer.
Zhilin Li got a Ph.D. from the University of Washington in 1994 and started at State in 1997. He received a Junior Faculty Enhancement Award from the Oak Ridge Associate Universities in 1996. Li is interested in applied mathematics, numerical analysis and scientific computing, numerical methods for PDE'S, free boundary/moving interface problems and mathematical biology. He has written 62 papers and has gotten research support from NSF and ARO. Li has mentored 7 Ph.D. students. He has been Editor of Numerical Mathematics: Theory, Methods and Applications, since 2006.
Sharon R. Lubkin is a Ph.D. graduate in Applied Math from Cornell University in 1992. She joined the department in 1997. From 1997 to 2004 she held a joint appoint-
ment in Statistics. Her research interests are in mechanistic models of physical forces and transport phenomena interacting with cellular behavior in dynamic tissue remodeling and growth. Lubkin has written 42 papers and has supervised $3 \mathrm{Ph} . \mathrm{D}$. students. She has received sponsorship for her research from NSF and NIH. Lubkin served on the Board of Trustees for the Society for Mathematical Biology for two years.
Jeffry S. Scroggs got a Ph.D. from the University of Illinois in 1988 and worked at NASA (Langley) before coming to State in 1991. He is interested in numerical analysis for partial differential equations. He has written 33 papers and his research has been funded by NSF. Scroggs has been Associate Department Head and Director of the Undergraduate Program since 1999. He has obtained funding for undergraduate research and scholarships from the NSF. Scroggs has been director of the Graduate Financial Mathematics Program since 2005.
Frederick H. Semazzi earned a Ph.D. at the University of Nairobi in 1983. He started in the Mathematics Department in 1994 and holds a joint appointment with Marine, Earth, and Atmospheric Sciences. He works in numerical models in climate modeling, numerical weather prediction, computational schemes and algorithms.
Ralph C. Smith has a Ph.D. from Montana State University in 1990 and joined the mathematics department in 1995. His research is in model development and control design of smart material systems. Smith has published 1 book, edited another, written over 110 papers and supervised 2 Ph. D. students. He has obtained support for his research from NSF, AFOSR, DARPA and NASA. He has served as Associate Director of the Center for Scientific Computation since 1988. He was Co-Director of the Operation Research Program (2002-2004) and Associate Director of SAMSI (2005-2009). Smith has been Editor-in-Chief of SIAMs Book Series on Advances in Design and Control since 2004; on the Editorial Board of SIAMs Frontiers in Applied Mathematics(19982006); an Associate Editor on Continuum Mechanics and Thermodynamics since 2005 and Associate Editor for Dynamics of Continuous, Discrete and Impulsive Systems since 2007.

Mansoor A. Haider got his doctorate from Rensselaer Polytechnic Institute in 1996. After a postdoctorate at Duke, he came to State in 1999. Haider works in modeling in soft tissue biomechanics and partial differential equations. He has written over 50 papers and mentored $2 \mathrm{Ph} . \mathrm{D}$. students. His research has been sponsored by NSR, NIH and the Whittaker Foundation. Haider received an NCSU Outstanding Teacher Award in 2004. He received the ASME Richard Skalak Award for best paper in Journal of Biomechanical Engineering in 2004. Haider has served on the Editorial Board of Journal of Biomechanics since 2007.
Semyon Tsynkov is a native of Russia and received his Ph.D. from the Russian Academy of Sciences in 1991. Tysnkov was on the faculty at Tel-Aviv University before coming to NCSU in 2000. He works in numerical analysis of partial differential equations with applications to continuum mechanics, electromagnetics, optics and control problems. He has written 70 papers and supervised $2 \mathrm{Ph} . \mathrm{D}$. students. He has obtained research support from NSF, DOA and NASA. Tysnkov was awarded a National Research Coun-
cil Associateship (USA), an Alexander von Humboldt Research Fellowship (Germany) and an Alon Fellowship (Israel). He has served as Editor for Applied Numerical Mathematics since 2005.

Research continued to grow during the Martin administration. In the 1989-99 decade, new grant research awards averaged $\$ 1.79$ million per annum 1 In 1998-99 the faculty produced 96 research publications; research expenditures from all sources came to $\$ 3.08$ million. In the fiscal year 1999 NC State ranked sixth nationally in the NSF ranking of total and federally financed R\&D expenditures in the mathematical sciences (including statistics) at United States colleges and universities ${ }^{2}$

By the end of the Martin administration, the mathematics department had reached a high level of excellence in research and teaching. This is attested to by the following excerpt from a report by an external review committee in 1997.

## Report of External Review committee

## For the North Carolina State University

## Department of Mathematics

(February 10-12, 1997)
Committee members: Professors Walter Feit, James Glimm (Chair),
Gilbert Strang, and Dr. Samuel Winograd

## Findings, Conclusions, and Recommendations

Our first finding is that the NC State Mathematics Department has improved greatly in research quality and external recognition in recent years.

The basis for this assessment is in part the significant improvement in NRC 3 ratings for this department over a ten year period. In addition, the Committee feels that the department has improved measurably since data was collected for the most recent report, so that if rankings were redone today, additional improvement would be noted. The strong success of Professor Banks is a case in point. The strong record of the Department in external funding is another. In addition the Committee observed many other indications of success, such as the strong placement record in non-academic positions for the doctoral students. Additional details will be described below.

[^17]Our second finding is that the mathematics education at NC State is overall of a high quality. The Committee was impressed with the dedication of the department to the educational component of its mission. The fruits of this attention were apparent to the Committee. Some of the indications include:

The Deans' uniform expression of satisfaction with the mathematics education which the Department provides to their students,
The Student's appreciation for the accessibility of the mathematics faculty, and their sensitivity to the students' needs,

The placement of undergraduates in leading graduate schools, The training of TA's which can be a model to many other departments.

The recruiting efforts by the department,
The partially automated placement system for assigning students to Calculus classes, which allows students a private assessment of their own abilities and placement options.

Our conclusion is that further improvement is possible, if careful management is exercised over current and future resources. This conclusion is based on several structural factors which favor the department:

The strong technology and science departments a NC State,
A strong high tech industrial complex at $\mathrm{RTF}^{4}$,
The adjacent technology park coupled to academia at Centennial Campus,
National trends toward interdisciplinary science and technology, with good participation by the NC State mathematics department,

Increased importance of computational science and of mathematical tools and models within science and technology,
Strong departmental leadership,
A supportive administration,
The willingness of the Department to take advantage of the above opportunities.

In brief, the mathematics department at NC State has reached a position which many mathematics departments are trying to achieve. With a strong program in applications, computational mathematics and industrial outreach. NC State is participating actively in regional and national programs which support interdisciplinary research. A program in pure mathematics, with several areas of strength, preserves the value of curiosity-driven research and provides a basis for possible development of new application thrusts in the future.

[^18]Our first recommendation is for the careful and wise deployment of all available resources. Hiring which plays into strategic opportunities is a prime example. Vigorous pursuit of available resources from a variety of sources, and especially the focusing of resources from various sources, while not abundant, are sufficient to allow a significant further increase in the rankings and fundamental research quality of this department.

Our second recommendation concerns Calculus reform: to preserve the value of many of the recent changes, such as the innovation in use of technology, while considering changes to restore some elements of conceptual understanding which are missing in the Calculus text presently in use.

In 1999, the last year of the Martin administration, the faculty were:
Professors: H. T. Banks, J. W. Bishir, E.E. Burniston, S. L. Campbell, R. E. Chandler, M. T. Chu, E. N. Chukwu, L. O. Chung, J. D. Cohen, J. C. Dunn, A. Fauntleroy, J. E. Franke, R. O. Fulp, R. E. Hartwig, I. Ipsen, K. Ito, E. L. Kaltofen, C. T. Kelley, K. Koh, J. R. Kolb, X. B. Lin, J. Luh, J. A. Marlin, R. H. Martin, C. D. Meyer, K. Misra, C. V. Pao, E. L. Peterson, M. Putcha, S. Schecter, J. F. Selgrade, M. Shearer, C. E. Siewert, J. W. Silverstein, M. F. Singer, E. L. Stitzinger, R. E. White .

Adjunct Professor: R. J. Plemmons.
Associate Professors: G. D. Faulkner, J. P. Fouque, D. E. Garoutte, A. Helminck, P. Hitczenko, H. Hong, N. Jing, A. Keyfets, T. J. Lada, D. M. Latch, L. K Norris, L. B. Page, R. T. Ramsay, J. Rodriguez, J. S. Scroggs, F. H. H. Semazzi, R. Silber, H. T. Tran, W. M. Waters.

Assistant Professors: D. Brown, H. J. Charlton, R. Haas, P. Gremaud, S. O. Paur.
Lecturers: M. McCollum, J. Griggs.
Teaching Emeritus Faculty: J. M. A. Danby, D. J. Hansen, L. B. Martin, N. J. Rose, R. G. Savage.

In most sciences one generation tears down what another has built and what one has established another one undoes. In mathematics alone each generation adds a new story to the old structure.
-Hermann Hankel

## Chapter 10

## The Mathematics Department 1999 to 2002-The Burniston Years II

Bob Martin wanted to step down from the headship in 1999. Burniston agreed to take on a second term as department head while a search for a new head proceeded. It was thought the search would take a year or so; it actually took three years.

On November 9th and 10th, 2002 a Mid Atlantic Algebra Conference was held in honor of the retirement of Kwangil Koh and Jiang Luh. Professor Barbara Osofsky of Rutgers University gave the principal address. The conference was attended by about 50 people.

A Financial Mathematics Masters Degree Program was approved by the University in 2002. The program was a brainchild of J. P. Fouque and involved the departments of Mathematics, Statistics, Agriculture and Resource Economics, Economics, and Industrial Engineering. The rigorous, quantitatively-focused program lasts for four semesters and consists of six required courses providing the core of FM, along with four elective courses that permit either continuing the broad background, or to specialize. A six-credit research project or internship provides experiences applying the academic knowledge. The academics provide students with a strong mathematical background, statistical and computational tools, and a comprehensive description of financial markets.

Fouque was the director of the program until he left the university in 2005. Jeff Scroggs became interim-director in 2005, and director in 2008. The program started with 7 students in 2002 and has grown to an enrollment of 40 in 2008. A total of 49 students have graduated from the program.

In November, 2000 the people of North Carolina approved a bond referendum to meet the construction needs of the State University System for the next 10 years. Included was $\$ 13.4$ million for the renovation of Harrelson Hall. Later that year Burniston attended a meeting on the bond issue given by the university architect Mike Harwood. While talking to Harwood after the meeting Burniston said that he thought that spending $\$ 13.4$ million on Harrelson would be a waste of money and asked what the cost of a new building would be. Harwood agreed and said that a new building
would cost about $\$ 18.4$ million, but that it would not be easy to find the money or to get approval to use the bond money for a new building.

Early in 2001 Ray Fornes, Associate Dean for Research in PAMS, came to Burniston's office to discuss some other issues. Burniston mentioned that instead of renovating Harrelson, a new building could be constructed for an additional $\$ 5$ million. Fornes became a supporter of the project but realized that it might be difficult to get it done. In order to get a formal proposal in front of the administration Burniston asked Carl Meyer and Michael Shearer to make a detailed study of the arguments for a new building. In the fall of 2001, Meyer and Shearer produced a report: "The Case for a Mathematical Sciences Building." The department was searching for a new head during this time and one of the applicants reportedly told the administration that we had one of the best mathematics departments in the country housed in the worst mathematics building in the country. The Meyer-Shearer report was presented to the administration but not much happened at the time. However, this was the first step in a long process that led to the construction of SAS Hall, a new building housing both the mathematics and statistics departments, that was completed in 2009.

Research funding continued to grow. In the fiscal year 2001 NC State ranked fifth (up from sixth in 1999) nationally in the NSF ranking of total R\&D expenditures in the mathematical sciences (including statistics) at U.S. colleges and universities ${ }^{1}$

During the three years of his second term as head, Burniston made several additions to the faculty:

Robert T. Buche received his Ph.D. from Brown University in 2000. He was a Research Associate at Brown before joining NCSU in 2002. His research is in the stochastic modelling of communications systems, and he has funding from the Army Research office. Buche has published 5 papers in research journals and 10 in conference proceedings and has supervised one Ph.D. student.
Alina Chertock obtained her Ph.D. from Tel-Aviv University in 1999 and joined the department in 2002. While at Tel-Aviv she received awards for excellence in applied mathematics and teaching excellence. Chertock's research is in numerical analysis for partial differential equations. She has published 25 research papers and has received support from NSF for her research..
Min Kang received her Ph.D. from Cornell University in 1998. She taught at Northwestern and was on the Faculty Honor Roll for excellence in teaching. She arrived at State in 2002. Kang's research is probability and interactive particle systems. She has written 10 papers. Kang was honored with both the NC State Outstanding Teacher Award, and the NC State Alumni Outstanding Teacher Award for 2006-2007.
Medhin, Negash G. got his doctorate from Purdue University in 1980. He was on the faculty at Clark Atlanta University before coming to State in 2002. Medhin is interested in applied mathematics, control theory, and molecular based models for hysteresis in polymers. He has published two books and over 50 papers. He is on the editorial board of Journal of Optimization Theory and Applications, Dynamic Systems and

[^19]Applications, Communications in Applied Mathematics and Neural Parallel Scientific Computation. Medhin is co-director of the Operations Research Program.
Mette S. Olufsen is a native of Denmark and received her Ph.D. from Roskilde University in 1998. She came to the department in 2001 and is interested in mathematical biology and physiology. Olufsen has published 1 book, 1 book chapter and 26 papers. Her research has been supported by NIH. In 2003 she was invited as one of only two outstanding early career speakers at the symposium Mathematical and Computational Modeling of Biological Systems. Olufsen has supervised one Ph.D. student.
Tao Pang arrived at NC State in 2002 after getting his Ph.D from Brown University. He is interested in stochastic control and financial mathematics. Pang has published 12 papers and has had $3 \mathrm{Ph} . \mathrm{D}$. students.
Agnes Szanto is a 1999 Ph.D. graduate from Cornell University. She joined the math faculty in 2002. Szanto works in symbolic computation and solving polynomial systems of equations. She has published 20 papers. Szanto has received research support from the NSF including one of the Faculty Early Career Development Awards; this is NSF's most prestigious award for young university faculty. Szanto has mentored one Ph.D. student.
Semyon V. Tsynkov received his Ph.D. from from Keldysh Institute for Applied Mathematics, Russian Academy of Sciences (Moscow, Russia) in 1992 and a Doctor of Science degree from [Habilitation] from the Russian Academy in 2004. He was a postdoctoral fellow and later a senior lecturer at Tel-Aviv University in Israel. He also was a research associate at NASA Research Center in Hampton, Virginia. He joined the NC State faculty in 2000. Tsynkov's research is in numerical analysis of PDE's with applications to optimization and control. He has published one book and 72 research articles and has received research support from the NSF and the US Air Force Office for Scientific Research. He is on the editorial board of Applied Numerical Mathematics (an Elsevier Journal). Tsynkov has had one Ph.D. student.
Dimitry Zenkov obtained a Ph.D. from Ohio State University in 1998. He had an H. Rackham Faculty Fellowship at the University of Michigan before coming to NC State in 2001. He works in geometric mechanics, geometric non-linear control theory and integrable systems. He works in geometric mechanics, geometric non-linear control theory and integrable systems. He has published 28 papers and has supervised one Ph.D. student. Zenkov has received research support from NSF.

I believe that scientific knowledge has fractal properties; that no matter how much we learn, whatever is left, however small it may seem, is just as infinitely complex as the whole was to start with. That, I think, is the secret of the Universe.
—Isaac Asimov
For since the fabric of the universe is most perfect and the work of a most wise Creator, nothing at all takes place in the universe in which some rule of maximum or minimum does not appear.
-Leonhard Euler
The trouble with integers is that we have examined only the very small ones. Maybe all the exciting stuff happens at really big numbers, ones we can't even begin to think about in any very definite way. Our brains have evolved to get us out of the rain, find where the berries are, and keep us from getting killed. Our brains did not evolve to help us grasp really large numbers or to look at things in a hundred thousand dimensions.
— Ronald L. Graham
The mathematician's best work is art, a high perfect art, as daring as the most secret dreams of imagination, clear and limpid. Mathematical genius and artistic genius touch one another.

## Chapter 11

## The Mathematics Department 2002 to 2006-The Interim Years

After a long search, Bernard Mair was chosen to became head of the mathematics department. He assumed his duties on July 1, 2002.

Bernard Mair was born and raised in Jamaica and received his undergraduate degree there. He travelled to Canada to get his Ph.D. at McGill University in 1983. After three year stints at Texas Tech and Penn State, Mair was appointed to the faculty at the University of Florida. There, besides being a professor of mathematics, he became Co-Director of the Center for Applied Mathematics. Mair's research interests are in medical imaging, inverse problems and potential theory. He has written over 50 papers and had one Ph.D. student. His research has been supported by NSF.


Bernard Mair

Mair was attracted to State by the vibrant research program, especially in applied mathematics, and the opportunities for collaborative research with other departments and the institutions in the Research Triangle Area.

The newly organized Statistical and Applied Mathematical Sciences Institute (SAMSI) was one of the factors that attracted Mair to NC State. He felt it offered new opportunities for faculty research. SAMSI is a national institute whose purpose is to forge a new synthesis of the statistical sciences and the applied mathematical sciences to confront the hardest and most important datadriven and model-driven scientific challenges. SAMSI is a partnership of Duke, NC State, UNCChapel Hill, the National Institute of Statistical Sciences, the NSF and the Kenan Institute. SAMSI is located in the Research Triangle Park. Tom Banks served as one of the Founding Directors (2000-
2002) during the planning and development of the Institute, and subsequently (2002-2005) served as an Associate Director. Ralph Smith took over as Associate Director in 2005 and Pierre Gremaud followed him in 2009.

The department not only got a new department head, but a new departmental secretary, Charlene Wallace. Charlene replaced Dianne (Joyner) Hartgrove, who had been the departmental secretary since 1974. Dianne had survived through five different department heads: Rose, Ortega, Harrington, Burniston (two terms) and Martin.

Mair had hardly gotten his feet wet as department head when, in January 2003, he had to take a leave of absence to take care of pressing family matters. Dean Solomon selected Jean-Pierre Fouque as interim head of the department and John Franke as interim associate head. This was the first of three interim heads of the department in the period 2002-2006 which came to be known as the "interim years".

Jean-Pierre Fouque is a well-known probabilist. He received his PhD (1979) from the Pierre et Marie Curie University in Paris, France and was a postdoctoral fellow at Ohio State University. He has held positions in the French National Center for Scientific Research (C.N.R.S.), at the Ecole Polytechnique, and several visiting positions at UC Irvine. After a sabbatical at Stanford University, he came to NC State in 1998. At State he started and directed the Graduate Financial Mathematics Program. He also served twice as interim department head (Spring 2003 and 2004-2005)

Fouque's primary research interests are financial mathematics, stochastic processes, stochastic partial differential equations, and waves in random media. He has authored over 60 publications, including the well-known Cambridge University Press book Derivatives in Financial Markets with Stochastic Volatility (joint with G. Papanicolaou and R. Sircar).

In the fall of 2003 five new faculty were hired:

Bojko N. Bakalov was born in Bulgaria and studied at Sofia University before getting his Ph.D. at MIT in 2000. Bakalov's research interests are vertex algebras, infinitedimensional Lie algebras, integrable systems and conformal field theory. He has written one book and 21 research papers and has mentored one Ph.D. student.
Helge Kristian Jenssen is a 1998 Ph.D. graduate of the Norwegian University of Science and Technology, Trondheim, Norway, where he received an award for the best Ph.D. thesis in fundamental research from Esso. He works in non-linear partial differential equations and systems of conservation laws. Jenssen has written 15 papers. In January, 2005 Jenssen received an NSF Career Award for his proposal entitled "Large
and MultiDimensional Solutions of Conservation Laws". Jenssen left for a position at Penn State in July, 2005.
Irina Kogan works in the geometric study of differential equations and variational problems. She obtained her Ph.D. from the University of Minnesota in 2000. Kogan has published 17 papers. With the help of a grant from the Faculty Center for Teaching and Learning Kogan has introduced computer laboratory projects in the course Foundations of Euclidean Geometry.
Demetrio Labate is a native of Italy where he received a Ph.D. in Electrical Engineering from the Politecnico di Torino. He then obtained a Ph.D. in mathematics from Georgia Tech in 2000. Labate specializes in harmonic analysis, with emphasis on timefrequency analysis and wavelets with applications to signal and image processing. Labate has published 35 papers. In July, 2008 Labate received an NSF Career award to "develop, implement, and apply a new multiscale representation method for multidimensional data".


#### Abstract

Alun L. Lloyd comes from the United Kingdom. He studied math at Cambridge and received his D.Phil. in Biology from Oxford in 1996. Before coming to State, he was a member of the Institute of Advanced Study at Princeton from 1999 to 2003. Lloyd's research is in mathematical biology, with a particular interest in epidemiology and in spatial and stochastic models in biology. He has written 51 research papers and supervised one Ph.D. student. Lloyd is the Director of NC State's Biomathematics Graduate Program. He is on the editorial board of Biology Letters, a journal published by the Royal Society.


Fouque's daughter was taking a calculus course at State. Fouque was concerned that the large lecture format did not allow enough time for graded homework. Web-Assign, a system for automatic grading of student homework, was introduced for Physics students and was being used successfully in some introductory mathematics courses. Fouque asked a committee consisting of Page, Norris, Scroggs, Franke and Griggs to study the feasibility of using Web-Assign in the main calculus sequence. In the fall of 2003, Web-Assign made its debut in the main calculus sequence; it is now a standard part of the calculus courses.

Fouque and Franke had the departmental web page, www.math.ncsu.edu, redesigned. Among the new features added were seminar announcements and videos of colloquium talks.

When Fouque heard about the Meyer-Shearer report arguing for a new mathematics building he decided to push it along. He set up a new committee consisting of Meyer, Franke, Shearer and Olufsen to update the Meyer-Shearer report. This committee, with the help of Dean Ray Fornes, came up with a report and presented their arguments to the administration.

In the spring of 2003, Fouque, together with Meyer, Franke, Shearer and Olufsen, went directly to Chancellor Mary Anne Fox to present the department's reasons for a new building to replace Harrelson Hall. The chancellor was very supportive of the project. However, she pointed out that it would be necessary to get approval from the Board of Trustees, the Board of Governors and the State Legislature before the renovation money could be used for a new building.

The move for a new math building got a boost when, in August of 2003, Lisa Johnson, associate university architect, submitted a report stating in part:
"As this study has indicated, the renovation of Harrelson Hall will cause a loss of usable space and classroom seating capacity, and still not achieve the goals of correcting accessibility deficiencies, and improving classroom capacity and quality standards. NC State University recommends removal and replacement of Harrelson Hall with a new, $100 \%$ code-compliant general classroom building that meets the current instructional needs of NC State's faculty, and students and is designed to be flexible to better meet the needs of the classroom of the future. A new classroom building, with an equivalent amount of assignable square footage as post-renovated Harrelson, can be built for an approximately equivalent cost as that of renovating Harrelson Hall. Since a new facility will remedy many of the problems that the renovation cannot and this option will have a longer life, it is recommended that this approach be pursued rather that continuing efforts to renovate Harrelson."

By early 2004, the university had obtained approval to build a new building instead of renovating Harrelson Hall. In June of 2004, Chancellor Fox appointed an "Ad-Hoc Building Committee for the Classroom and Office Building to replace Harrelson Hall" to act as a Users Group in the development of the design of the new building. Dean Solomon was chairman of the committee. Michael Shearer and Carl Meyer were the math department representatives. The site assigned for the new building was the old Riddick Stadium and parking lot.

The new "Classroom and Office Building to replace Harrelson Hall" was originally to hold only classrooms and offices for the mathematics department. Dean Solomon had long dreamed of a "mathematical sciences building" to house both the mathematics and statistics department. While the initial planning for the replacement for Harrelson was going on, Dean Solomon, with the help of Anita Stallings, PAMS Executive Director of Development, searched for funding to make the dream a reality. In the fall of 2004 they were successful in obtaining a commitment for a substantial gift from corporate partner SAS. The gift was to be used to enable the construction of a larger building that would house both the mathematics and statistics departments. The Users Group was expanded to include members of the statistics department. Planning for the new building continued from the fall of 2004 through 2005 and 2006.

Fouque relinquished his duties as head of the department when Mair returned on July 1, 2003. John Franke stayed on as associate department head. During the six months Mair was on leave the financial situation in the State of North Carolina had turned into a severe budget crisis, and the university budget reflected this crisis. Mair was forced to cut back severely on all fronts. No money was available to start any new initiatives or to hire any new faculty.

By almost every measure the faculty continued to be very productive in research. During the calendar year 2003 there were 89 faculty publications and 145 talks given at professional meetings. The new research grants for 2002-2003 academic year totalled $\$ 2.9$ million [From data supplied by Ray Fornes] and the total research expenditures came to $\$ 4.05$ million for the same period. Although the number of Ph.D. graduates nationwide is rather flat the mathematics department $\mathrm{Ph} . \mathrm{D}$. output is
growing. There were $10 \mathrm{Ph} . \mathrm{D}$. graduates in calendar year 2002 and 16 in calendar year 2003.
In March of 2004, Lavon Page was appointed by the Provost to head the implementation of LITRE (Learning in a Technology Rich Environment). This program aims at enhancing the extensive learning with technology opportunities available to students at NC State. Page is well versed in the use of technology in instruction. In 1997 he headed the university's "Project 25 ", which sought to get 25 courses on-line by the fall of 1997. He developed three such courses himself. From 1994 until 2003 he was Director of the Multimedia Center in the Mathematics Department which managed the undergraduate computer resources of the department. Page helped in the implementation of the symbolic computation program MAPLE into the undergraduate curriculum and use of Web-Assign, a web-based homework delivery, collection, grading and recording system.

The mathematics faculty were surprised to receive the following e-mail from Bernard Mair dated May 28, 2004:
"As the (fiscal) year draws to a close, I would like to congratulate you on doing a fine job throughout the past year. Despite the many challenges, many of you have demonstrated outstanding service and commitment to the faculty, staff and students who depend heavily on the services you provide. There is no doubt in my mind that this department has a great future and will continue its rise in national prominence and stature, especially with the new building that is being planned. However, for family and personal reasons I have decided to resign from my present position, effective June 30, 2004. I will be rejoining the faculty at University of Florida.
"Thank you for the opportunity to serve the department for the past year, and I wish you the best for the future. The dean will be sending a message shortly concerning the future of the departmental leadership."

Dean Solomon consulted with the faculty and staff and announced his decision on June 24 with the following e-mail:
"I am delighted to announce that Jean-Pierre Fouque has agreed to serve as Interim Department Head affective July 1, 2004. Jean Pierre's experience and his strong reputation in the international mathematics community will serve the department well. The Department has made great strides in recent years and is on the verge of moving to the top tier nationally. The College pledges its support in pursuit of that goal."

On July 1, Dr. Fouque sent his first message to the faculty as Interim Head:
"I officially become the interim head of the department today for the year to come and I want to take this opportunity to let you know that I intend to put all my energy in this position. It is also a good time to ask you to join me in thanking Bernard Mair for his tenure and wishing him the best in the future.
"One of my priorities will be a significant improvement of the well deserved visibility of our department at all levels. Initiatives in that direction, such as the new committee "Awards and Publicity" chaired by Michael Singer, will find my full support.
"I also intend to work closely with the Faculty Advisory Committee to which I am appointing Michael Shearer who is leading our efforts in getting the best new building for the department. Larry Norris will organize the election of a FAC member to replace me.
"It is a pleasure to announce that Loek Helminck has accepted to become interim associate head and extend his responsibilities as chair of the computer committee to other departmental administrative responsibilities. I count on Loek to lead and implement some of the changes and improvements needed in order to be recognized as a top department.
"I would like to take this opportunity to thank John Franke for the great service he has provided to the department in the position of associate head during these past months. I am sure that John will continue to play an important role in our efforts to improve the department.
"I wish you all an excellent Summer and a great year 2004-05, and I am looking forward to working with all of you."

In 2005 Loek Helminck obtained support for REU (Research experience for undergraduates) which brings undergraduates to the campus during the summer to participate in research activities supervised by faculty members. The program REU+ provides a supportive REU experience for under-represented students who may not usually consider an REU program. Helminck obtained support for two additional programs: REG affords a research experience for early graduate students and S-STEM, a university wide program for needy undergraduate and graduate students, in Science, Technology, Engineering and Mathematics.

Even during this period of revolving leadership in the department, the faculty continued to produce and many received honors and awards:

Tom Banks received the Turkish Governors' Medal of Honor Award for his "outstanding research contributions" at the International Conference on Inverse Problems: Modeling and Simulation in Fethiye, Turkey, June 7-12, 2004. Banks also received the prestigious W.T. and Idalia Reid Prize in Mathematics, presented annually by the Society for Industrial and Applied Mathematics (SIAM).

Carla Savage, Professor of Computer Science and associate member of the Mathematics Department, and two collaborators, including Charles "Chip" Killian, an undergraduate in Computer Science and Applied Mathematics, solved a 30-year-old problem concerning Venn diagrams. (Science, January 31, 2003)

In March, 2004, Agnes Szanto received a National Science Foundation (NSF) Faculty Early Career Development (Career) Award. This is the first Career award for the Department. The five-year grant was awarded to Szanto for her proposal entitled "Solving Over-Constrained Systems of Non-Linear Equations by Symbolic-Numeric Methods." The Faculty Early Career Development (CAREER) Program is a Foundation-wide activity that offers the National Science Foundation's most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research.

On May 15, 2003 the students, friends and collaborators of Carl Meyer celebrated his 60th birthday with a conference Matrix Analysis and Applied Linear Algebra in his honor. Talks were given by many prominent linear algebraists including Gene Golub, Hans Schneider, Mickey Neumann, Ilse Ipsen and Robert Plemmons. The conference was attended by about 50 people.

Erich Kaltofen and co-author Pascal Koiran received the Association for Computing Machinery Special Interest Group on Symbolic and Algebraic Manipulation ISSAC 2005 Distinguished Paper Award for their paper "On the complexity of factoring bivariate supersparse (lacunary) polynomials." The paper was presented at the International Symposium on Symbolic and Algebraic Computation (ISSAC) in Beijing on July 25, 2005.

Michael Singer was elected to the Council of the American Mathematical Society in 2006.

John Griggs and Mansoor Haider were named NC State Outstanding Teachers for 2004-2005.

Ernest Stitzinger was the recipient of the Board of Governors' Award for Excellence in Teaching for 2005-2006 for the College of Physical and Mathematical Sciences.

Marilyn McCollum received a 2005 Award for Outstanding Service in Support for Teaching and Learning from the Faculty Center for Teaching and Learning at NC State.

Naihuan Jing was named a Fulbright Scholar for 2003-2004, and was a member of the Max-Planck-Institut fuer Mathematik in Bonn, Germany, from December 2003 to June 2004. He was also awarded a Humbolt Fellowship for 2004-2005, with which he will visit Bielefeld University from December 2005 to August 2005.

The Richard Skalak Award for best paper in the Journal of Biomechanical Engineering for the year 2003 was awarded to Mansoor Haider and his coauthors for the article "Alterations in the mechanical properties of the human chondrocyte pericellular matrix with osteoarthritis", (L.G. Alexopoulos, M.A. Haider, T.P. Vail and F. Guilak) in the Journal of Biomechanical Engineering, Vol. 125, pp. 323-333.

Two alumni were honored:

Joel Brawley was named the South Carolina Governor's Professor of the Year in 2002. He obtained his doctorate from NC State under Jack Levine in 1964. Brawley also received his Bachelors and Masters degrees from State. He has been in the mathematics department at Clemson since 1965. In 2006 Brawley wrote a tribute to his Ph.D. advisor In Memory of Jack Levine (1907-2005) in Cryptologia (vol. 30, pp.83-87).

Robert Bryant (BS in Mathematics, 1974) received the 2005 College of Physical and Mathematics Distinguished Alumnus Award. Professor Bryant is the J.M. Kreps Professor of Mathematics at Duke University. He is currently Director of MSRI, the NSF funded Mathematical Sciences Research Institute at Berkeley.

Some graduate students won awards:
Graduate Student John May won the Best Student Paper Award at the 2004 International Symposium on Symbolic and Algebraic Computation in Santander, Spain.

Graduate Student Rachel Levy won the Best Student Talk award at the 2004 British Applied Mathematics Colloquium. She also won a student paper prize from the Society for Industrial and Applied Mathematics (SIAM) in 2005.

Graduate Student Matthew Lasater won student paper awards at the Advanced Workshop on Frontiers in Electronics in Aruba in December, 2004, and the SIAMSEAS meeting in Charleston, South Carolina, in March, 2005.

On June 31, 2005 J. P. Fouque left NC State to join the Department of Statistics and Applied Probability at the University of California at Santa Barbara to head an interdisciplinary Center for Research in Financial Mathematics and Statistics (CRFMS). Dean Solomon appointed Loek Helminck as interim department head.

On July 1, 2006, Helminck communicated some of his ideas for running the department:
"As of today I am the interim head of the department. I'm sure you all agree that JP [Fouque] has set a high standard as head and you will all join me in thanking him for his hard work this past year. His vision and leadership have inspired us to work harder and work together to move the department forward. I am eager to work with all of you to continue to keep our math department on this positive trajectory. We wish JP all of luck in his exciting research program and we hope that he will remain active in this department for many years to come.
"It is a pleasure to announce that Hein Tran has agreed to be interim associate head. Hein brings his experience as co-director of OR to this position. We thank Negash Medhin who has agree to serve as the new co-director of OR. I count on Hein to lead and implement some of the changes and improvements needed in order to be recognized as a top department.
"It is important that we continue to enhance our programs and improve our visibility. We must continue to seek outside funding for department wide initiatives such as Vigre type grants. Our new REU program and ideas for enhanced graduate training programs make NCSU a better place for graduate students and help us attract better students. I plan to continue to seek these kinds of strategies.
"We have a tremendous opportunity with the new building to design space for us which best helps us with our mission. Positive working spaces and common areas where we can interact on an informal basis will create new synergies that strengthen our research and attract new talent. I will make sure that proper attention gets paid to the details of the building design.
"Of course I will work closely with the Faculty Advisory Committee to which I am appointing Michael Singer. This department's strength is the depth and breadth of its mathematicians and the commitment of faculty and staff alike to our endeavor. It is by working with each other that we will reach our full potential.
"I hope you are all having a productive summer with time reserved for relaxation as well. I am looking forward to working with all of you for a great year."

In 2005-2006 the faculty consisted of :
Professors: H. T. Banks, S. L. Campbell, M. T. Chu, E. N. Chukwu, L. O. Chung, J. D. Cohen, A. Fauntleroy, J. P. Fouque, J. E. Franke, R. O. Fulp, P. Gremaud, R. E. Hartwig, A. Helminck, H. Hong, I. Ipsen, K. Ito, N. Jing, E. L. Kaltofen, C. T. Kelley, A. Keyfets, X. B. Lin, R. H. Martin, N. Medhin, C. D. Meyer, K. Misra, E. L. Peterson, M. Putcha, S. Schecter, J. F. Selgrade, F. M. Semazzi, M. Shearer, C. E. Siewert, J. W. Silverstein, M. F. Singer, R. Smith, E. L. Stitzinger, H. T. Tran, R. E. White.

Adjunct Professors: E. M. Peck, P. Schlosser.
Associate Professors: G. D. Faulkner, T. J. Lada, Z. Li, A. Lloyd, S. Lubkin, L. K, Norris, L. B. Page, S. O. Paur, R. T. Ramsay, J. Rodriguez, J. S. Scroggs, S. Tsynkov, W. M. Waters.

Assistant Professors: B. Bakalov, R. Buche, H. J. Charlton, A Chertock, M. A. Haider, H. Jenssen, M. Kang, I. Kogan, D. Labate, M S. Olufsen, T. Pang, A. Szanto, D. Zenkov.

Lecturers: B. Burns-Williams, J. R. Griggs, R. Kenney, M. S. McCollum, A. McRae.
Emeritus Faculty: J. W. Bishir, E. E. Burniston, R. E. Chandler, E. N. Chukwu, L. O. Chung, H. Davison, J. M. A. Danby, J. Dunn, G. D. Faulkner, D. E. Garoutte, T. Gordon, D. J. Hansen, R. E. Hartwig, K. Koh, J. Luh, J. Marlin, L. B. Martin, P. Nickel, L. B. Page, C. V. Pao, E. L. Peterson, R. T. Ramsay, N. J. Rose, R. Savage, R. Silber, C. E. Siewert, H. Speece, R. Struble, D. Ullrich, W. M. Waters, Jr., O. Wesler, J. Wilson.

The greatest mathematicians, as Archimedes, Newton, and Gauss, always united theory and applications in equal measure.
—Felix Klein
As for the future of applied mathematics? I am not worried. Mathematics is a universal language for understanding the world around us, and it will be fed by problems in this world for as long as we care to look at them.
—Eric Vanden-Eijnden
Courant Institute Newsletter, 2009 Vol 6 No 1
Mathematics is the tool specially suited for dealing with abstract concepts of any kind and there is no limit to its power in this field.

There is no branch of mathematics, however abstract, which may not someday be applied to the phenomena of the real world.
—Nicolai Lobachevsky
The facts of mathematics are verified and presented by the axiomatic method. One must guard, however, against confusing the presentation of mathematics with the content of mathematics. An axiomatic presentation of a mathematical fact differs from the fact that is being presented as medicine differs from food. It is true that this particular medicine is necessary to keep mathematicians from self-delusions of the mind. Nonetheless, understanding mathematics means being able to forget the medicine and enjoy the food.
—Gian-Carlo Rota
Calculus as currently taught is, alas, full of inert material . . . The real crisis is that at present [calculus] is badly taught; the syllabus has remained stationary, and modern points of view, especially those having to do with the roles of applications and computing are poorly represented.
-Peter Lax,
Past President of the American Mathematical Society
(statement made in 1988)
If a nonnegative quantity was so small that it is smaller than any given one, then it certainly could not be anything but zero. To those who ask what the infinitely small quantity in mathematics is, we answer that it is actually zero. Hence there are not so many mysteries hidden in this concept as they are usually believed to be. These supposed mysteries have rendered the calculus of the infinitely small quite suspect to many people. Those doubts that remain we shall thoroughly remove in the following pages, where we shall explain this calculus.
—Leonhard Euler

## Chapter 12

## The Mathematics Department 2006 to 2009—The Helminck Years

The interim-ships of head Loek Helminck and associate head Hein Tran during the academic year 2005-2006 went smoothly. On July 1, 2006, Dean Solomon, after consultation with the faculty, made their appointments permanent. The faculty, having lived through several years of interim leadership, were hopeful that these appointments of established members of the department would last for many years.

Aloysius (Loek) Helminck was born and raised in Rotterdam, the Netherlands. He received his bachelor's and master's degrees in mathematics and physics in 1975 and 1980, respectively. He completed his Ph.D. in mathematics in 1985. All three degrees were earned at the University of Utrecht in Utrecht, the Netherlands. Helminck held visiting positions at the University of Michigan and Brandeis University, and research fellowships at the University of Twente in Enschede, the Netherlands, and the Centrum voor Wiskunde en Informatica in Amsterdam, the Netherlands. Helminck joined the mathematics faculty at


Aloysius G. Helminck NC State in 1987 and was promoted to full professor in 2000. Helminck's research focuses on symmetric spaces, their representations and applications.

Helminck obtained support for an Institute for Mathematics at NC State (IM@State) sponsored by NSF and NSA ${ }^{1}$ IM@State administers several programs to provide research experiences

[^20]for undergraduate and graduate students from around the nation (see p.78). IM@State also has programs to assist and encourage research participation of underrepresented groups of students. This is a continuation of a long-standing departmental policy of recruiting and graduating women and minority students.

The Department of Mathematics was selected as the winner of the 2006 Departmental Award for Teaching and Learning Excellence (DATLE). As part of its award, the department received a check for $\$ 5,000$ and a recurring addition of $\$ 15,000$ to its annual base funding. The awards will be used to support teaching and learning excellence in the department.

In October 2007 the Center for Quantitative Sciences in Biomedicine (CQSB) was established. It is a multidisciplinary research center at NC State whose mission is to catalyze and facilitate research projects in the biomedical sciences which require integrated collaborations among scientists in the quantitative and biomedical disciplines. The program is directed by Lloyd Marie Davidian in the statistics department with Tom Banks as co-director. Four other members of the math department are associated with the project: S. Lubkin, M. Olufsen, H. Tran and M. Haider.

Tim Kelley, together with NC State physicists Dr. Jerry Bernholc and Dr. Wenchang Lu, is leading a research team that includes scientists from the University of Tennessee, in a project to create software for the world's most powerful supercomputers. The research is being funded by a five-year, $\$ 1.7$ million grant from the National Science Foundation.

A Mathematics Department Research Training Group led by Ralph Smith, Pierre Gremaud, Mansoor Haider, Negash Medhin and Michael Shearer is developing activities for undergraduates, graduate students and postdocs with a $\$ 1.9$ million five-year grant from the National Science Foundation. The effort focuses on five areas that are fundamental to emerging technologies: orthopedic biomaterials; multifunctional materials; polymers and composites, including carbon nanotubes; dynamics of thin material layers; and laser welding. The objective of the program is to train students and postdocs for academic and nonacademic careers that bridge applied mathematics, materials science, engineering, physics, and advanced technology.

On October 13, 2006, during the PAMS Alumni and Friends Weekend, the groundbreaking for the new mathematics and statistics building took place (see photo on p . 85). The official announcement of the SAS contribution toward the new building was made at this time. SAS President Jim Goodnight and SAS Executive Vice President John Sall were instrumental in providing the gift and participated in the ceremony. Both attended NC State and remain staunch supporters of PAMS and the university. Goodnight served on the faculty of the Department of Statistics and Sall served on the College's foundation board and is currently on the university's Board of Trustees. Chancellor Oblinger, NCSU Board of Trustees Chairman Wendell Murphy, Dean Dan Solomon, math department head A. Helminck, and statistics department head S. Pantula also participated in the groundbreaking in front of a crowd of faculty, friends and alumni.

There were a number of awards and honors given to the faculty during the 2006-2009 years:
The North Carolina Council of Teachers of Mathematics (NCCTM) presented its 2006 Rankin Award to William Waters for his outstanding contributions to NCCTM and to mathematics education in North Carolina. This is NCCTM's highest award.


# Groundbreaking for the new building 

Goodnight, Sall, Murphy, Helminck, Pantula, Oblinger<br>Photo by Becky Kirkland

Michael Singer, with co-authors Ziming Li, Min Wu, and Dabin Zheng, was awarded a Distinguished Paper Award by the Association for Computing Machinery Special Interest Group on Symbolic and Algebraic Manipulation for the paper "A Recursive Method for Determining the One-Dimensional Submodules of Laurent-Ore Modules," presented at the International Symposium on Symbolic and Algebraic Computation in Genoa, Italy, on July 10, 2006.

Michael Shearer received the 2006 Elva and LeRoy Martin Teaching Effectiveness Awards. He was also named an NC State Outstanding Teacher for 2005-2006.

The NC State Alumni Association named Moody Chu as an Alumni Distinguished Undergraduate Professor for 2006.

Bojko Bakalov was awarded the Hermann Weyl Prize (at the 26th International Colloquium on Group-Theoretical Methods in Physics, organized by J. Birman and S. Catto in New York June 26-30, 2006.)

On July 11, 2006, Kazufumi Ito won a SIAM Outstanding Paper Prize for the paper "The Primal-Dual Active Set Strategy as Semi-Smooth Newton Method," SIAM J. Optimization 13 (2002), 865-888, coauthored with M. Hintermuller and K. Kunisch.

Min Kang was awarded the 2007 Alumni Outstanding Teacher Award and was also awarded an NC State Outstanding Teacher for 2006-2007.

Carl Meyer was selected for the 2007 Mathematics Department Alumni Award at Colorado State University. In November, during Math Day at the University, Meyer gave the mathematics department colloquium lecture and was presented with the award.

Jack Silverstein was elected to Fellowship in the Institute of Mathematical Statistics. He was presented with a plaque on Monday, July 30 at the 2007 IMS Annual Meeting in Salt Lake City. The citation reads: "For seminal contributions to the theory and application of random matrices."

Sandra Paur received the 2007 NCSU Faculty Adviser Award. The award recognized Paur's commitment to guiding students in career and academic paths.

Demetrio Labate was awarded a National Science Foundation CAREER Award, NSF's most prestigious award for junior faculty. He is the third member of the department to receive this honor. Labate's project was concerned with a new multiscale representation method for multidimensional data.

On February 22-23, 2008 a conference, "The Geometry and Analysis of Dynamical Systems," was held at NC State to celebrate the mathematical contributions of XiaoBiao Lin and Steve Schecter on the occasion of their 60th birthdays.

The NCSU Alumni Association named H. Thomas Banks as one of the 2008 recipients of the Association's Outstanding Research Award. Banks also won the award in 1996.

Marilyn McCollum was named an NC State Outstanding Teacher for 2007-2008.
The NC State Alumni Association named Robert Martin, Jr. an Alumni Distinguished Undergraduate Professor for 2008-2010.
H. Thomas Banks and Carl T. Kelley were inducted as fellows of SIAM, the Society for Industrial and Applied Mathematics, at the SIAM Annual Meeting, held in Denver, Colorado in July, 2009.

Seth Sullivant received a Packard Fellowship in 2009 "to introduce tools from algebraic geometry, combinatorics, and symbolic computation to address fundamentally discrete problems in evolutionary biology, causal inference, and disclosure limitation." Each Packard Fellow receives an unrestricted research grant of $\$ 875,000$ over five years.

Two graduates of the mathematics programs at State received honors:
NCSU alumnus Robert Bryant (Mathematics, 1974) was elected to the National Academy of Sciences. Bryant was also named the new Director of MSRI (Mathematical Sciences Research Institute) at Berkeley.

Amy Langville, a 2002 NC State PhD in Operations Research and a postdoctorate with Carl Meyer from 2002 to 2005, received an NSF CAREER award for her project "Updating Problems in Information Retrieval and a Mathematical Dissection Lab". Dr. Langville is an Assistant Professor of Mathematics at the College of Charleston.

Some Students, both undergraduate and graduate, received awards and scholarships:
Mathematics graduate student Brandy Benedict is one of two students nationwide to be named Mass Media Science and Engineering Fellows for summer 2007 by the American Association for the Advancement of Science. The program sends advanced science, mathematics, and engineering students to work in major news organizations.

NC State Math Undergraduates Adam Attarian, Cameron Swofford, Roberto Rodriguez and Cheryl Zapata won awards for their research posters at the AMS/MAA Joint Meetings in New Orleans in January, 2007.

Nicole Kroeger, a sophomore majoring in mathematics, won a prestigious Barry M. Goldwater Scholarship for 2008-2009.

Ryan Going, a senior in applied mathematics and electrical and computer engineering, was awarded a GatesScholarship for study at Cambridge University in 2009.

Every ten years or so the mathematics department is evaluated by an external review committee. In 1983 the reviewing group (see p. 50) stated:
"The review committee feels that the Mathematics Department is essentially in good shape and serves the University well. It is in a state of transition with many new opportunities that will require some adjustment on the part of its faculty."

In the review of 1997 (see p. 66) a more upbeat conclusion:
"The NC State Mathematics Department has improved greatly in research quality and external recognition in recent years."

In the Spring 2008 the Department had its ten-year comprehensive review by a team of prominent mathematicians: Richard Brualdi, University of Wisconsin, Carlos Castillo-Chavez, Arizona State University, David Gottlieb, Brown University, Arthur Krener, University of California, Davis and Margaret Wright (Chair), New York University. The committee concluded:
"The Mathematics Department is a nationally and internationally visible jewel that should be highly valued by the college."

Clearly the mathematics department had arrived! In fact, the university administration stated that they had never received such a favorable review for any department. Following is a listing of the main findings of the group:

1. The committee is deeply and favorably impressed by the engagement, energy, and enthusiasm of the Department
2. For the past several years, the mathematics faculty had been asked to do more with less. This situation has led to understandable stress and frustration among the faculty.
3. The applied mathematics faculty members of the Department are outstanding by any measure and the Department also contains important strength in several areas of core mathematics, specifically algebra and symbolic computation.
4. The Department has a shared vision of excellence in both applied and core mathematics-a highly unusual feature in a mathematics department.
5. Faculty members in the Department display notable collegiality and mutual respect at all levels.
6. Loek Helminck, the Department head provides unifying and effective leadership that is greatly valued by his colleagues.
7. The governance structure of the Department-the Faculty Advisory Committee-appears to be working well by providing an inclusive mechanism that allows efficient functioning.
8. The Department has obtained external research funding at levels that are untypically high among mathematics departments, and has made effective use of that funding to perform highly regarded research and to develop new programs and activities.
9. The Department displays a clear and determined commitment to education and support of students at all levels.
10. The Ph.D. program is excellent in several dimensions. Students appreciate the Department's deep commitment to a high-quality educational program that respects individual needs and career choices. The committee takes a very positive view of the Department's focus on attracting domestic Ph.D. students. We commend the Department for the obvious care and attention dedicated to recruitment and retention of women and underrepresented minority Ph.D. students. In particular, the Department's achievement in graduating African-American Ph.D.'s sets a high standard for a mathematics department at a research university that is not minority-serving.
11. The committee expresses admiration for the high value placed by the Department on undergraduate education, including responsive service teaching, and for the size and quality of the undergraduate honors program.
12. Faculty members in applied mathematics have created research and educational paradigms, such as the Center of Research in Scientific Computing (CRSC), started in 1992, and associated Industrial Mathematical and Statistical Modeling workshop for graduate students, started in 1995.
13. The Department has been a leader at NC State and nationally in developing creative and effective approaches to interdisciplinarity that do not require major organizational changes within the University. The Center for Research in Scientific Computation, the faculty's participation in SAMSI (Statistical and Applied Mathematics Sciences Institute), and the new and entrepreneurial Center for Quantitative Sciences in Biomedicine illustrate the Department's commitment to interdisciplinary research and outreach to other fields.

The committee suggested to PAMS that the department needed to have more faculty, that stipends for graduate assistants needed to be upgraded and that funding should be provided for a healthy postdoc program across all areas of the department. It recommended to the department that, because of the current senior profile of the department, a faculty renewal plan covering the next
decade or so should be adopted. It recommended that the interdisciplinary programs in Biomathematics and Financial mathematics should be strengthened. The Committee also recommended that the department should supply more information and guidance in selecting Ph.D. advisors.

The reviewers encouraged the department to continue to develop interdisciplinary graduate and undergraduate programs. The interdisciplinary Ph.D. program is now a concentration and should soon be a full degree program. An interdisciplinary BS and a new general BA in math are both in the planning stages.
One new faculty member joined the department in 2006:

Nathan Reading received his Ph.D. degree from the University of Minnesota in 2002 and held a postdoctorate at the University of Michigan before coming to State in 2006. Reading's research is in algebraic and geometric combinatorics, particularly the combinatorics of Coxeter groups. He has published 17 papers.

Four new faculty members were hired in 2008:

Patricia Hersh was on the faculty at Indiana University before joining the NC State faculty. She earned her doctorate from MIT in 1999. Her specialty is algebraic and topological combinatorics. Hersh has published 20 papers. She has research support from NSF.
Seth Sullivant obtained his Ph.D. from the University of California, Berkeley. He spent three years as a Junior Fellow at Harvard before coming to State. Sullivant's research interests are in applying algebraic techniques to problems in statistics and biology. He has written two books and 27 research papers. In 2009 Sullivant received a Packard Fellowship given to promising researchers early in their career. Of the 16 Fellows in 2009, Sullivant was the only mathematician to receive an award.
Alina Duca joined the department as a Teaching Assistant Professor, a new type of position for the department. Their charge is to focus on excellence and innovation in teaching. Duca received her Ph.D. from the University of Mantibo, Canada in 2007. She held a visiting position at Vassar College for a year. Duca's research is in the theory of rings and modules.
Molly Fenn also came to State as a Teaching Assistant Professor. Fenn obtained her Ph.D. at the University of Massachusetts in 2008.

Two new faculty joined the department in 2009:

Mark Hoefer obtained his Ph.D. from the University of Colorado at Boulder in 2006. He held a postdoctorate at the National Institute of Standards and Technology in Boulder, Colorado, 2006-2008. He received an NSF fellowship to spend the 2008-2009 academic year at Columbia University. Hoefer is an applied mathematician and has published 8 papers.

John Harlim obtained his Ph.D. from the University of Maryland in 2006. He was a postdoctoral fellow at the Courant Institute from 2006 to 2009. Harlim is an applied mathematician interested in Applied dynamical systems, numerical weather forecasting, filtering turbulent complex systems, atmospheric predictability, and digital halftoning. He has one book in preparation and has published 12 papers.

The Department hosted its first Alumni Reception at the Joint Mathematics Meetings at San Diego, California in January, 2008. Alumni and friends of the department were invited for hors d'oeuvres, conversation, and department news. Alumni-and-friends receptions were also held at the SIAM national meeting in San Diego in July 2008 and at the Joint Mathematics Meetings in Washington in January 2009. Helminck plans to make these receptions annual events at the national meetings.


Shearer talks at the Alumni brunch
(Photo by Steve Townsend)
Mathematics was featured at the 2008 PAMS Alumni and Friends Weekend. Donald Saari, a mathematician at the University of California at Irvine, gave a fascinating keynote address on the mathematics of voting. A brunch for Mathematics Department alumni was well attended. A poster display presented six student research projects. There were short talks by Ralph Smith on the Department's achievements, and by Michael Shearer on plans for the future (see photo above).

Professor Emeritus LeRoy B. Martin Jr. (MS '52 Mathematics) was selected as the College's 2008 Distinguished Alumnus (see photo on p91. Established in 1990, the PAMS Distinguished Alumnus Award recognizes alumni whose exceptional achievements have brought honor and distinction to the College of Physical and Mathematical Sciences and NC State. In addition to his contributions to both the mathematics and computer science departments, Dr. Martin was cited for his work as assistant provost for university computing where he led the charge to upgrade university computing facilities.

In recognition of Dr. Martin's contributions to mathematics at NC State, Jim Goodnight from SAS has endowed the LeRoy Martin Distinguished Professorship. This is the first privately endowed distinguished professorship for the mathematics department. Goodnight's reasons for making this particular gift go all the way back to his freshman year when he took a course under Dr. Martin. "LeRoy was a great teacher, and he inspired me to continue in applied math," Goodnight said. "After 47 years of knowing and working with him, I felt it was time to recognize his academic achievements and his years of service to this great university by naming a distinguished professorship for him."

The American Mathematical Society Spring Southeastern Section Meeting was held at NC State April 4-5, 2009. The Einstein Public Lecture was given by Michael S. Waterman of the University of Southern California. The title of the lecture was


Solomon presenting award to Martin
(Photo by Marc Hall) "Reading DNA sequences: Twenty-first century technology with eighteenth century mathematics". The original plan was to have the meeting in the new mathematics and statistics building. However the building was not quite ready so the meeting was held in Riddick Hall.

The mathematics faculty played a big part in the program as organizers or co-organizers of special sessions or speakers: B. Bakalov, A. Chertock, A. Duca, M. Fenn, J. Franke, R. Fulp, P. Gremaud, M. Haider, A. Helminck, P. Hersh, H Hong, M. Kang, I. Kogan, N. Jing, E. Kaltofen, T. Lada, Z. Li, K. Misra, N. Reading, C. Savage, J. Selgrade, M. Singer, S. Sullivant, A. Szanto, D. Zenkov. Ph.D. students J. Collins, D. Long, M. Nehring, K. Thompson, G. Yuhasz also participated.

The construction of the new mathematics and statistics building was completed in the spring of 2009 (see photos on p .92 ). The $\$ 32$ million building was made possible by the Higher Education Bond Referendum of 2000, as well as by gifts from private donors, including a substantial contribution from SAS. The dedication for the building occurred on May 1. At the dedication ceremony NC State Chancellor James L. Oblinger announced that the building would be named SAS Hall, in honor of the founders of the Cary, North Carolina-based software company. Over 300 faculty, students, alumni and friends attended the dedication. Dean Dan Solomon, Loek Helminck, Statistics Head Sastry Pantula, SAS President James Goodnight and SAS Executive Vice President John Sall participated in the ceremony. John Sall made a few remarks:
"At SAS, we believe that it is vital for students in the mathematical and statistical sciences to learn in an environment that provides state-of-the-art facilities and instructional technologies. It is also critical that they participate in the kind of collaborative initiatives they'll experience in the work place. That type of environment produces the type of employee and person we want at SAS, and it is the type we want to produce at NC State. That's why we decided to make a significant contribution toward ensuring that this building would become a reality."

SAS Hall contains about 19,000 square feet. There are 10 classrooms, a 250 -seat lecture hall and almost 200 offices for faculty, staff and graduate students. In addition there are large commons ar-


The Dedication Plaque for SAS Hall
(Photo by Richard Chandler)
eas, seminar rooms, meeting rooms, computer labs, a tutorial center and a library. The classrooms and the lecture hall have state-of-the-art audio-visual equipment supplied by Cisco and the NWN
corporation. Overhead projectors, computers and DVD players are available for audio-visual presentations. In addition, course materials can be captured for later viewing or streamed to remote locations.


## The SAS Hall Golden Spiral

An interesting feature of SAS Hall is the "golden spiral" that starts outside the north entrance of the building moves past Park Hall, across Stinson Drive into the West wing of SAS, then back out into the courtyard, finally spiraling into its center as shown in the picture above. (A golden spiral ${ }^{2}$ is associated with a golden rectangle. It is a logarithmic spiral having the property that a change of the polar angle of $90^{\circ}$ changes the radius by a factor of the golden mean.)

Just inside the main entrance to SAS Hall is a dramatic four-story atrium. A large colorful mobile hanging from the fourth floor ceiling graces the atrium as shown in the picture to the right. The mobile was inspired by a work by the artist Barbara Baer that hangs on the SAS campus. The mobile was designed and constructed by a group of students in the NCSU College of Design during the spring of 2009. The students were Samuel Lewis Davis III, Marie Hermansson, Margaret Jamison, Michelle Ko, Elena "E" Page and Claudia Povenski. The students worked with guidance from Barbara Baer and under the direction and support of Professor Jan-Ru Wan and David Knight of the College of Design.

The summer of 2009 was a busy one at SAS Hall. There were 40 undergraduate students from around the country participating in the REU programby far the largest math REU in the nation. An additional 30 graduate students


The Mobile were involved in the REG program. The REU program introduces bright undergraduates to research, but they are also introduced to NC State. Since the program began in

[^21]2005, several students have decided to do their graduate work here. On top of that, the Industrial Mathematical \& Statistical Modeling Workshop (IMSM) brought 40 graduate students to campus for a week. This program, sponsored by CRSC, SAMSI and NC State and funded by NSF, introduces students to challenging and exciting real-world problems arising in industrial and government laboratory research.

Ethelbert Chukwu retired in 2006. Robert Hartwig and Chuck Siewert completed their phased retirement in 2008 and Ron Fulp started his phased retirement in 2008. Marilyn McCollum retired in January 2009.

A complete listing of department personnel as of the fall of 2009 follows.
Department administration: A. G. Helminck, Department Head; H. T. Tran, Associate Head; J. S. Scroggs, Director of Undergraduate Program; S. L. Campbell, Director of Graduate Program; E. L. Stitzinger, Administrator of Graduate Program; J. R. Griggs, Coordinator of Classroom Instruction; H. J. Charlton, Scheduling Officer and Director of Summer School; S, Paur, Director of the Honors Program; H. T. Banks, Director of CRSC, Co-Director of CQSB; R. Smith, Associate Director of CRSC; P. Gremaud, Associate Director of SAMSI.

Professors: H. T. Banks, S. L. Campbell, M. T. Chu, J-A Cohen, A. Fauntleroy, J. E. Franke, R. O. Fulp, P. Gremaud, A. Helminck, H. Hong, I. Ipsen, K. Ito, N. Jing, E. L. Kaltofen, C. T. Kelley, A. Keyfets, T. J. Lada, Z. Li, X. B. Lin, S. Lubkin R. H. Martin, N. Medhin, C. D. Meyer, K. Misra, M. Putcha, S. Schecter, J. F. Selgrade, F. M. Semazzi, M. Shearer, J. W. Silverstein, M. F. Singer, R. Smith, E. L. Stitzinger, H. T. Tran, R. E. White.

Adjunct Professors: E. M. Peck, P. Schlosser.
Associate Professors: A. Chertock, M. Haider, P. Hersh, A. Lloyd, M. Kang, L. K, Norris, M. S. Olufsen, T. Pang, S. O. Paur, J. Rodriguez, J. S. Scroggs, A. Szanto, S. Tsynkov, D. Zenkov.

Assistant Professors: B. Bakalov, H. J. Charlton, A. Duca, M. Fenn, J. R. Griggs, J. Harlim, I. Kogan, N. Reading,, S. Sullivant.

Lecturers: B. Burns-Williams, E. Dempster, R. Kenney, L. Kurtz, , S. Whitt.
Emeritus Faculty: J. W. Bishir, E. E. Burniston, R. E. Chandler, E. N. Chukwu, L. O. Chung, H. Davison, J. M. A. Danby, J. Dunn, G. D. Faulkner, D. E. Garoutte, T. Gordon, D. J. Hansen, R. E. Hartwig, J. Luh, J. Marlin, M. S. McCollum, P. Nickel, L. B. Page, C. V. Pao, E. L. Peterson, R. T. Ramsay, N. J. Rose, R. Savage, R. Silber, C. E. Siewert, H. Speece, R. Struble, D. Ullrich, W. M. Waters, Jr., O. Wesler, J. Wilson.

The staff: S. Bennett-Shabbir, Webmaster and Teaching Technician; D. Bucklad, Undergraduate and Financial Math Secretary; J. G. Burt, Teaching Technician; J. Cason, Computing Support; N. N. Dahlke, Administrative Support Specialist; L. Denning, CRSC Administrative Assistant; J. Gaddy, Accounting Technician II, C. Gunton, Assistant Scheduling Officer; D. Leistikow, SAMSI Program Assistant; B. Priser, Contract/Grant Specialist; D. Seabrooks, Graduate Secretary; F. Stephenson, Executive Assistant; C. Wallace, Administrative Support Associate.

This History now comes to a close. The author has had the pleasure of being associated with the mathematics department for over 40 years. He has seen it grow and mature into one of the best departments in the nation. The department, with a new building, excellent leadership, a superb faculty and a competent and experienced staff, is poised for even greater accomplishments in the years to come.

$$
\text { Agis Quod Adi } \sqrt{3}
$$

One would have to have completely forgotten the history of science so as to not remember that the desire to know nature has had the most constant and the happiest influence on the development of mathematics.
-Henri Poincaré
The excitement that a gambler feels when making a bet is equal to the amount he might win times the probability of winning it.
-Blaise Pascal
It is remarkable that this science (probability), which originated in the consideration of games of chance, should have become the most important object of human knowledge.
-Pierre-Simon de Laplace

[^22]
## Bibliography

Burton F. Beers and Murray S. Downs, North Carolina State University: A Pictorial History, (1986); ISBN: LD3928.

Hardy D. Berry, Place Names of North Carolina State University: , (1995); ISBN: LD3928.
H. S. M. Coxeter, Introduction to Geometry, (Second Edition), John Wiley \& Sons, New York, London (1969).

David Lockmiller, History of North Carolina State College of Agriculture and Engineering of the University of North Carolina, 1889-1939 (1939); ISBN: LD3928.

Alice E. Reagan, North Carolina State University: A Narrative History, (1987); ISBN: LD3928.

## Index

African-American Students, 31
African-American, Ph.D., 40
Agromeck, 7
Air Force Academy, 30
Alabama Polytechnic Institute, 19
Algebra, 51, 62
Alumni and Friends Weekend, 84
American Mathematical Society Meeting-1952, 18
American Mathematical Society Meeting-2009, 91
Anderson, C., 19, 22, 32, 44,54
Applied Math Group, 29.49
Applied mathematics, 62
Archimedes, 81
Asimov, I., 72
Attarian, A., 87
Auburn University, 19
Audio-Visual Tutorial Center, 36, 40, 53
Award for Teaching and Learning, 84
Awards Day, 50
B.S. in Applied Mathematics, 25

Bachelor of Applied Mathematics, 25
Bachelor of Engineering Mathematics, 19
Bachelor of Science in Applied Mathematics, 29
Baer, B., 93
Bakalov, В., 74, 81, 85, 91,94
Banks, H. T., $54,60,62,66,68,73,78,81,84$ 8694
Barnhardt, E., 57
Bell Tower, iv
Benedict, B., 86
Bennet-Shabbir, S., 94

Biomathematics, 62
Bishir, J., v, 24, 26, 32, 44, 46, 57, 68, 81,94
Board of Trustees, 35
Bond referendum, 69
Brant, D., 19, 32, 44
Brantley, V., 22, 32
Brauer, A., 19
Brawley, J., 25,79
Brickyard, 30
Brown, D., 68
Browne, B. F., 11
Brualdi, R., 87
Bryant, R., 86
Buche, R., 70,81
Bucklad, D., 94
Bullock, R., 15, 19, 22, 32, 54
Burniston, E., $\mathrm{V}, 25,27,29,32,44,49,52,54$, 57, 59, 68, $70,74,81,94$
Burns-Williams, B., 81,94
Burt, J., 94
Butler, N. M., 12
Byers, R., 52

Caldwell, G., 22
Caldwell, J., 31
Campbell, S., $41,44,57,61,68,81,94$
Canady, E., 22
Caraway, T. J., 25, 32
Carlitz, L., 19
Cason, J., 94
Castillo-Chavez, C., 87
Cell Library, 34
Cell, J., 15, 21, $25,29,32,34,49,54$

Center for Quantatative Sciences in Biomedicine, Dunn, J., 41, 44, 57, 61, 68, 81, 94
84
Dynamical Systems, 86
Center for Research in Scientific Computation, Dynamical systems, 51 52. 62

Chandler, R., v, 27, 30, 32, 36, 40, 44, 52, 57,
68, 81, 94
Charlton, H., $29,32,44,57,68,81,94$
Chertock, A., 70, 81, 91,94
Chu, M., 52, 54, 57, 68, 81, 85, 94
Chukwu, E., 55, 57, 68, 81, 94
Chung, L., 41, 44, 57, 68, 81, 94
Clarkson, J., 15, 19, 22, 32
Class of 1938, iv
Class of 1939, iv
Cohen, J., 41, 54, 57, 61, 68, 81, 94
College of Design, 93
College of Physical and Mathematical Sciences, Faculty and Staff-2009, 94
24
Collins, J., 91
Cooke, H., 19, 22, 32, 44, 57
Courant, R., 22
CQSB, 84,94
Crouch, H., 29, 32, 44
CRSC, 52, 60, 88,94
Cupitt, M. M., 53
Curved blackboards, 30
Dahlke, N., 94
Dalton, R., 25
Danby, J. M. A., 28, 44, 57, 68, 81, 94
DATLE, 84
Davis, C., 32
Davis, S. L., 93
Davison, H., 29, 32, 44, 81, 94
Dempster, E., 94
Denning, L., 94
Departmental Teas, 29
Descartes, R., 12
Differential equations, 51,62
Dirac, P., 81
Distinguished Lecturer Series, 46
Dotson, W., 28, 32, 44
Duca, A., 89, 91, 94

Eargle, G., 32
Education School of, 21
Einstein, A., 22, 48, 58
Elva and Leroy Martin Award, 85
Engineering Mathematics, Master of, 17
Estes, J. G., 15
Euler, L., 72, 82
Evans, M., 50, 54,55
External review-1983, 50
External review-1997, 53, 66
External review-2008, 87

Faculty-1923, 11
Faculty-1932, 11
Faculty-1966, 32
Faculty-1976, 44
Faculty-1989, 57
Faculty-1999, 68
Faculty-2005, 81
Faculty-2009, 94
Faulkner, G., 41, 52, 57, 68, 81, 94
Fauntleroy, A., 55, 57, 68, 81, 94
Fenn, M., 89, 91, 94
Financial Math, Graduate Program, 63,69
Fisher, H., 9, 11, 13, 17, 21,23
Fitzpatrick, B., 63
Fontaine, J., 11
Fornes, R., 54, 66, 70, 75
Fouque, J. P., v, 63, 68, 69, 74, 75, 77, 80,81
Fox, Mary Anne, 75
Franke, J., 42, 44, 52, 57, 61, 68, 75, 78, 81, 91,

$$
94
$$

Fray, Capt., 7
Fuller, T., 50
Fulp, R., 42, 44, 57, 68, 81, 91, 94
Gaddy, J., 94
Galbraith, A., 32

Gardner, M., 44
Garoutte, D., 28, 44, 61, 68, 81, 94
Garren, J., 22
Garren, M., 32
Gauss, C., vi 81
Gellar, R., 44
General Assembly, 2
Gibson, P., 32
Going, R., 87
Golden spiral, 93
Goldstine, H. H., 19
Goldwater Scholarship, 87
Goodnight, J., 26, 84, 91
Gordon, T., 29, 32, 44, 53, 81, 94
Gottlieb, D., 87
Graduate Administrator, 23, 36, 53, 61
Graduate Program, 40, 52
Graduate Program, Director of, 61
Graham, F., 15,19
Graham, R., 72
Gremaud, P., 63, 68, 81, 84, 91, 94
Griggs, J., 61, 63, 68, 75, 81, 94
Groundbreaking, 84
Gunton, C., 94
Haas, R., 57
Hadamard, J., 6
Haider, M., 65, 81, 84, 91,94
Haldane, J. B. S., 32
Hall, M., 91
Halmos, P., 48
Hankel, H., 68
Hansen, D., 27, 44, 57, 68, 81, 94
Harlim, J., 90,94
Harrelson v's, $16,34,36$
Harrelson Hall, 30,76
Harrelson, J., 13, 14
Harrington, W., 25, 29, 32, 44, 46, 49, 74
Harris, A. M., 22
Harris, T., 32
Hartgrove, D., 74
Hartwig, R., $34,44,57,68,81,94$
Harwood, M., 69

Haynes, T., 7
Heinbockel, J., 25
Helminck, A., v, 55, 57, 68, 78, 80, 81, 83, 84,
91, 94
Heofer, M., 89
Hermann Weyl Prize, 85
Hermansson, M., 93
Hersh, P., 89, 91, 94
High School Math Competition, 50
High School Teacher, courses for, 39
Hilbert, D., vi, 6, 22
Hitczenko, P., 68
Holladay, A. Q., $3-5$
Honeycutt, R., 19, 22, 32
Hong, H., 63, 68, 81, 91,94
Honors program, 43, 46, 47, 50, 88,94
Hoomani, J., 32
Huneycutt, J., 44
IEEE,63
IM@State,84
Industrial Applied Mathematics Program (IAMP), 60
Industrial Mathematical \& Statistical Modeling Workshop (IMSM), 94
Institute of Physics, 63
Integration, 31
Interim years, 74
Ipsen, I., 64, 68, 81, 94
Ito, K., 60, 68, 81, 85, 94
Itoh, M., 32
Jamison, M., 93
Jenssen, H., 74,81
Jing, N., $64,68,81,91,94$
Joyner, D., 36
Kaltofen, E., 64, 68, 81, 91, 94
Kang, M., 70, 81, $85,91,94$
Kazufumi, I., 64
Kelley, C. T., $42,52,57,68,81,84,94$
Kelley, J., 58
Kenney, R., 81,94

Keyfets, A., 81,94
Kheyfets, A., 55,57
Klein, F., 6,81
Knight, D., 93
Knight, G., 32
Ko, M., 93
Kogan, I., 75, 81, 91,94
Koh, K., 26, 32, $40,44,57,68,69,81$
Kolb, J., 28, 32, 44, 57, 68
Kovalevskaya, S, 58
Krener, A., 87
Kroeger, N., 87
Kurtz, L., 94
Labate, D., 75, 81, 86
Lada, T., 42, 44, 57, 81, 91, 94
Land-Scrip Fund, 1,2
Langville, A., 86
Laplace, P., 11, 58, 95
Lasater, M., 80
Latch, D., 42, 44, 57
Lax, P., 82
Lee, F., 11
Leistikow, D., 94
Leroy Martin Distinguished Professorship, 26, 91
Levine, J., $15,-17,19,21,22,25,32,40,44,54$, 57, 79
Levine-Anderson Award, 19
Levy, R., 80
Lewis, C., 17, 20, 22, 32, 44, 54, 57
Lewis, P., 20, 22, 32, 44
Li, X., 56, 86
Li, Z., 64, 81, 91
Lin, X., 55, 68, 81, 94
Lincoln, President, 1
Little, C., 20, 22, 32, 44
Littleton, I. T., 34
Lloyd, A.,75, 81,94
Lobachevsky, N., 82
Long, D., 91
Lord Corporation Fellowships, 61
Lubkin, S., 64, 81, 84, 94

Luh, J., 34, 44, 68, 69, 81, 94
MacNerney, J., 19
MACSYMA, 54
Maddry, L., 3637
Mair, B., v, 73, 76, 77
Maltbie teaching awards, 46,49
Maltbie, A., 20, 22, 24, 32, 44, 46, 54
MAPLE, 28,54,62
Marlin, J., 27, 32, 44, 62, 68, 81, 94
Marshall, A., 22
Martin, C. M., 26
Martin, L., 26, 32, 54, 57, 68, 81, 90, 91
Martin, R., v, 42, 44, 57, 59, 68, 74, 81, 86, 94
Math and Science Educ., Dept. of, 21,28
MATHEMATICA, 62
Mathematical Magic Show, 27, 34
Mathematics courses-1906, 8
Mathematics of Finance, 17
Mathematics, Agricultural, 9
Mathematics, Farm, 9
May, J., 80
McAuley, L., 19
McCollum, M., 17, 40, 53, 56, 57, 68, 81, 86, 94
McKee, F., 50
McRae, A., 81
McVay, J., 32
Medhin, N., 70, 80, 81, 84,94
Menius, A., 24
Meyer, B., v
Meyer, C., V, 34, 37, 44, 52, 57, 68, 70, 75, 81, 85, 94
Meyer-Shearer report, 70, 75
Misra, K., 56, 57, 68, 81, 91, 94
Mittag-Leffler, G., 72
Mobile, 93
Mock, H., 11
Morrill Land-Grant Act, 1
Morson, H., 7
MSRI, 86
Multimedia Center, 36
MUMATH, 54
Mumford, C., 11, 15, 16, 19, 22, 23, 32, 54

Mumford, N., 39
Murphy, W., 84
Nahikian, H., 15, 16, 22, 23, 32, 36, 39,57
Napoleon, 11,12
NASA at Langley, 30
NCCTM, 84
Nehring, M., 91
Nelson, J., 40 44
Newton, I., 2, 48, 81
Nichols, N., 52, 57
Nickel, P., 28, 32, 44, 57, 81, 94
Nolstad, A., 20, 22, 32, 44
Norris, L., 56, 57, 75, 81, 94
North Carolina College of Agriculture and Engineering., 9
North Carolina College of Agriculture and Mechanic Arts, 2
North Carolina College, for Women, 14
North Carolina State University, 2,31
NSF, 94
NSF Career Award, 74, 75, 78, 86
Numerical analysis, 51,62
Oblinger, Chancellor, 84,91
Olufsen, M., 71, 75, 81, 84, 94
Operations Research, 65, 71
Ortega, J., 45, 46, 74
Packard Fellowship, 86, 89
Page, E., 93
Page, L., $36,42,44,46,53,54,57,68,75,77$,
8194
Page, W. H., 1
PAMS Alumni and Friends Weekend, 90
Pang, T., 71, 81,94
Pantula, S., 84,91
Pao, C., $43,44,57,68,81,94$
Park, H., v, 15, 16, 22, 23, $32,36,39,44,45,54$, 57
Parker, W. V., 19
Pascal, B., 95
Patton, C., 20, 22, 32, 36

Paur, S., 43, 44, 47, 57, 68, 81, 86, 94
Peck, E., 81,94
Perry, J-E, 40
Peterson, D., 22, 32, 44
Peterson, E., 47, 57, 68, 81, 94
Petrea, H., 20, 22, 32, 44, 50, 54, 57
Ph.D. program, 25, 40
Pi Mu Epsilon, 24,25
Pickard, J. C., 40
Plato, 32
Plemmons, R., 52, 56, 57, 60, 68
Poincaré, H., 12, 48, 95
Polk, L. L., 1
Poulton, Chancellor, 54
Povenski, C., 93
Priser, B., 94
Proctor, T., 25
Proctorial system of Instruction, 36
Progressive Farmer, The, 1
Project 25,77
Pullen, R. S., 2
Pure Mathematics, Dept. of, 5
Putcha, M., 43, 44, 57, 68, 81, 94
Querry, J., 32
Raleigh Male Academy, 7
Ramsay, R., 29, 44, 50, 54, 57, 68, 81, 94
Reading, N., 9194
REG, 78, 93
Reid, D., 32
Reid, W. T. and Idalia, 63
Research, 17, 44, 54, 66, 70
Research expenditures, 76
Research experience for graduates (REG), 78
Research experience for undergraduates (REU), 78
Research Training Group, 84
Research, annual expenditures, 66,70
Research, faculty, 66
Research, new grants, 54,66
Research, sponsored, 21
REU, 78, 80,93

REU+,78
Riddick, W., 4, 5
Riemann, G. F. B., 12
Roberts, J., 25
Roberts, L., 32
Rocket Science, 21
Rodriguez, J., 48, 57, 68, 81, 94
Rodriguez, R., 87
Rohrbach, J.,57
Rome Press, iv, 92
Rose, M., V
Rose, N. J., 35, 37, 39, 44, 45, 54, 57, 68, 74, 81, 94
Rota, G-C, 82
ROTC, 4
Roulier, J., 44
Rulla, J., 57
Russell, B., vi, 6
S-Stem, 78
Saari, D., 90
Sagan, H., 26, 30, 32, 36, 44, 57
Sall, J., 84,91
SAMSI, 63, 65, 73, 88, 94
SAS, 26, 84,91
SAS Hall, 70, 91, 93
SAS Hall, dedication, 91
Savage, C., 91
Savage, R., 26, 32, 36, 40, 44, 53, 57, 68, 81, 94
Schecter, S., 43, 44, 56, 57, 61, 68, 81, 86, 94
Schiermeier, M., 57
Schlosser, P., 81,94
School of Physical and Mathematical Sciences, 35
School of Physical Sciences and Applied Mathematics, 24
Scroggs, J., 50, 65, 68, 69, 75, 81, 94
Seabrooks, D., 94
Selgrade, J., $43,44,57,68,81,91,94$
Semazzi, F., 65, 68, 81,94
Shahdan, P., 32
Shearer, M., $56,57,61,68,70,75,81,84,85$, 90,94

SIAM,63, 78,86
Siewert, C., 47, 57, 68, 81, 94
Silber, R., 25, 34, 44, 57, 68, 81, 94
Silverstein, J., 47, 57, 68, 81, 86, 94
Sims, L., 52
Singer, M., $43,54,57,68,80,81,85,91,94$
Slide rule, 35
Smith, R., $65,74,81,84,90,94$
Sneddon, I., 28, 29,32
Solomon, D., 74, 76, 77, 83, 84, 91
Somerville, M., 58
Sox, J., 21, 32, 44
Speaker Ban Law, 31
Speece, H., 21, 22, 32, 44, 54, 57, 81, 94
Speidel, G., 29,32
Sputnik, 41
Stallings, A., 76
State Chronicle, The, 1
Statistical and Applied Mathematical Sciences Institute, 73
Stephenson, F., V, 94
Stitizinger, E., 61
Stitzinger, E., 43, 44, 57, 61, 68, 81, 94
Strobel, C., 21, 22
Struble, R., 25, 32, 44, 81, 94
Sullivant, S., 86, $89,91,94$
Supercomputers, 84
Superior student program, 24
Swofford, C., 87
Symbolic computation, 54,62
Szanto, A., 71, 78, 81, 91,94
TA's, training of, 67
Taussky, O., 19
Thomas, D. , 19
Thompson, K., 91
Ting, T., 29, 32
Todd Fuller Competition, 50
Tompkins Hall, 29
Topologist, 58
Townsend, S., 90
Tran, H., 25, 57, 68, 80, 81, 83, 84, 94
Transcendental numbers, 32

Trojanowski, H., v
Tsynkov, S., 65, $71,81,94$
Turner, W., 22
Ullrich, D., 29, 32, 44, 57, 81, 94
Undergraduate program, 50
Undergraduate Program, Director of, 29, 36, 50, 65
Underhill, R., v
University of North Carolina at Chapel Hill, 1 , 14, 19, 24
University of North Carolina, the consolidated, 14, 31
van der Vaart, H., 27, 32, 44,57
Vanden-Ejnden, E., 81
Vietnam War, 35
Wake Forest University, 7
Wallace, C., v, 74,94
Walton, I., 32
Wan, J-R, 93
Warmbrod, G., 32
Watauga Club, 1
Waterman, M., 91
Waters, W., 44, 57, 68, 81, 84, 94
Watson, G., 21, 22, 32
Web-Assign, 75
Welch, J., 25
Wesler, O., 27, 32, 44, 57, 81, 94
White, R., 44, 52, 57, 68, 81,94
Whitt, S., 94
Whitten, J., 59, 60
Williams, H. P., 11, 22
Wilson, J., 25, 32, 44, 46, 50, 57, 81, 94
Winton, L., 16, 22, 23, 32, 36, 39, 46, 54
Women Ph.D's ,40
Women students, 40
World War II, 17, 21
Wright, H., 40
Wright, M., 87
Wright, S., 5257
Wylie, D., 22

Yates, R., 4, 5, 7, 11
Yuhasz, G., 91
Zapata, C., 87
Zenkov, D., 71, 81, 91,94
Zund, J., 32


[^0]:    ${ }^{1}$ Berry, p. 31

[^1]:    ${ }^{1}$ Lockmiller, p. 127
    ${ }^{2}$ Reagan, pp. 193-194.

[^2]:    ${ }^{3}$ Reagan, p. 31.

[^3]:    ${ }^{4}$ Reagan, p. 38.

[^4]:    ${ }^{1}$ From "A Tidal Wave Of Enthusiasm " by Tony Haynes on the Gopack website
    ${ }^{2}$ Adapted from 1909 Agromeck Yearbook

[^5]:    ${ }^{3}$ Reagan, p. 58

[^6]:    ${ }^{4}$ Reagan, p. 75

[^7]:    ${ }^{1}$ Reagan, pp. 93-94

[^8]:    ${ }^{2}$ College of Engineering, Annual Reports, Dept of Mathematics,UA \# 105.2.29, NC State Archives.

[^9]:    ${ }^{1}$ Reagan, pp. 182-184

[^10]:    ${ }^{2}$ Reagan, pp. 187-189

[^11]:    ${ }^{1}$ The course number was chosen because 127 is the only Mersenne prime with 3 digits.

[^12]:    ${ }^{2}$ Cell Folder, UA \# 9.3, NC State University Archives

[^13]:    ${ }^{3}$ Beers and Downs, p. 120

[^14]:    ${ }^{1}$ information supplied by Ray Fornes, Associate Dean for Research in the college of PAMS

[^15]:    ${ }^{2}$ Distance Education and Learning Technology Applications

[^16]:    ${ }^{3}$ SIAM's Special Interest Activities Group

[^17]:    ${ }^{1}$ From data supplied by Ray Fornes, Associate Dean of Research for CPAMS
    ${ }^{2}$ See [http://www.nsf.gov/sbe/srs/srs01407/start.htm](http://www.nsf.gov/sbe/srs/srs01407/start.htm), table B-56
    ${ }^{3}$ National Research Council

[^18]:    ${ }^{4}$ Research Triangle Park

[^19]:    ${ }^{1}$ See [http://www.nsf.gov/sbe/srs/nsf03316/sectb.htm](http://www.nsf.gov/sbe/srs/nsf03316/sectb.htm), table B-56

[^20]:    ${ }^{1}$ National Security Agency

[^21]:    ${ }^{2}$ Coxeter, p. 164

[^22]:    ${ }^{3}$ Do well what you do

