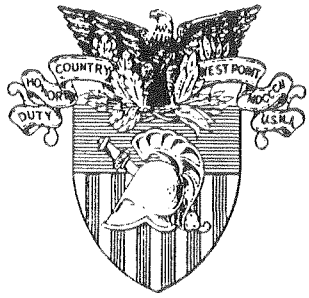

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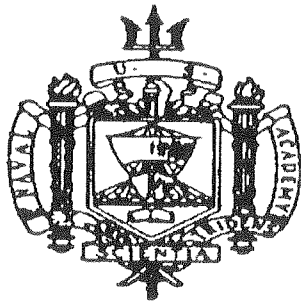

Departmental Histories: *Traditions of Excellence*

Dedicated to Professors James C. Abbot, Theodore J. Benac, and Ebon E. Betz on their 50th Anniversary at the U.S. Naval Academy

VOLUME 2, ISSUE 2
SPRING, 1991

EDITOR'S NOTES

When we first selected the theme for this issue, the editorial staff was unaware of the 50th anniversaries of Professors **James C. Abbott, Theodore J. Benac,** and **Ebon E. Betz**. We are delighted that this issue celebrating the histories of our departments is coincident with the Naval Academy's celebration of the contribution of these three scholars. Certainly our entire readership joins us in congratulating Jim Abbott, Ted Benac, and Ebon Betz.

The histories of our departments are fascinating. As you read the articles, watch for the interplay of names between the histories. We see several instances of one academy using a text written at another. We hope that this issue is informative as well as entertaining, especially for our students and recent faculty arrivals who may not be aware of the rich traditions we possess.

The **Service Academy Student Mathematics Conference '91** was held at West Point 1-3 February and was a tremendous success. We will publish full proceedings next issue. We are very grateful for the efforts and assistance of LtCol **David Jensen,** USAFA, and LT **Chris Sagovac**, USNA, who were the faculty representatives from their institutions. We are especially grateful for the splendid job done by our Managing Editor, CPT **Dave Olwell**, in organizing the conference. Plans are underway for SASMC '92 in the late spring of next year, with USNA as the tentative host.

Congratulations to **Bob Mitchell**, our USAFA Associate Editor, on his promotion to Lieutenant Colonel. Well done!

We will be laying out the themes for next years' issues later this spring. If you have a suggestion for an issue, we would be very pleased to receive it.

As always, we express our gratitude to Mr. **Francisco Collazo**, President of **COLSA, Inc.**, for the underwriting of this publication. *Mathematica Militaris* would not be published without the generous support the COLSA, Inc. provides the **West Point Association of Graduates**.

-Editorial Staff

EDITORIAL STAFF

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Fifty Years of Teaching Excellence

On July 1, 1991, the Mathematics Department of the Naval Academy will celebrate a very rare and wonderful event. That date marks the 50th anniversary at the Naval Academy for three remarkable men, Professors **James C. Abbott, Theodore J. Benac, and Ebon E. Betz.**

All three reported to the Mathematics Department on July 1, 1941, five months before Pearl Harbor when the Academy was about half its present size. Since then, they have taught several generations of naval officers and have witnessed and been architects to many changes and improvements in our academic program. Of the 55,000 midshipmen who graduated from the Naval Academy since its founding in 1845, 40,000 graduated since 1941, during their tenure. These three have been outstanding teachers, scholars, and administrators. They remain inspirations to their students and colleagues.

The Mathematics Department will be celebrating this remarkable 50th anniversary with a buffet dinner party on Sunday, April 14, 1991 at the Bay Ridge Inn in Annapolis starting at 3:30 pm. The charge is $25 per person and all students and friends of Professors Abbott, Benac, and Betz are invited to join us. If you are interested, please call or write to Prof. **J. D'Archangelo**, Chrmn Math Dept, U.S. Naval Academy, Annapolis, MD 21402, (301)-267-2795.

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James C. Abbott
Theodore J. Benac
Ebon E. Betz

For those of you who are unfamiliar with Jim, Ted, and Ebon, here are a few notes from 150 years of dedication and service.

Jim Abbott graduated from Harvard with an A.B., Summa Cum Laude, in 1938 and received his M.A. there in 1939. In 1941, he completed his Ph.D. at Notre Dame. His thesis, under **Karl Menger**, was on non-Euclidean geometry.

Professor Abbott has written and edited five volumes on mathematics, including the Chauvenet Papers, Boolean Algebra, and Lattice Theory. His research work includes the development of the theory of implication algebras as an extension of classical Boolean and universal algebras. In 1966, Professor Abbott took a sabbatical leave and gave a visiting lecture series at twenty-five major universities in France, the Soviet Union, Poland, Romania, Yugoslavia, Israel, Greece, Italy, Switzerland, Germany, Holland, England, and Scotland. Over the years he has also presented technical papers at numerous professional mathematical meetings throughout the United States.

Throughout his teaching career, Jim has often identified mathematically gifted midshipmen and nurtured their talent so that they could become Trident Scholars or enter immediate graduate education in mathematics. Lately he has been developing a course and writing a textbook in mathematical logic which employs the computer language PROLOG and has applications to computer science.

Professor Abbott has also been very active in extracurricular activities. He was a Naval Academy Sailing Squadron Coach on large boats for over twenty-five years. He skippered ocean races from Newport to Halifax, Annapolis to Newport, Newport to Bermuda, Buenos Aires to Rio de Janiero, and a transatlantic race from Bermuda to Sweden. Last year, former midshipmen crew members of Jim's, who sailed with him during the 1950s and 1960s, treated Jim and his wife, **Bunny**, to a week-long cruise to Bermuda.

Architecture, carpentry, and woodworking are among Professor Abbott's other interests. He designed and built two houses, one in Massachusetts and another in Annapolis. Much of the furniture and interior finishings are also products of his creative handiwork.

Ted Benac came to the U. S. Naval Academy, after

completing a Ph.D. in mathematics at Yale. He majored in chemistry as an undergraduate at St. Michael's College, but then switched to mathematics, receiving an M.S. from Connecticut State College. Ted taught mathematics and physics at St. Michael's before attending Yale. During his fifty years at the Naval Academy, Professor Benac has also taught summers at the University of Michigan, the Chrysler Institute of Technology, and was an adjunct professor at the Catholic University of America for ten years.

Professor Benac's publications include textbooks on probability, programming in Turbo Pascal, calculus with computers, translations of classical works on higher algebra, pedagogical articles on his work with calculus and the computer, and research papers in such prestigious journals as the Bulletin and Notices of the American Mathematical Society.

Ted has taught the full spectrum of undergraduate courses in mathematics at the U. S. Naval Academy, as well as courses in mechanics, fluid mechanics, and thermodynamics. In 1970, after teaching mathematics for thirty years, he created a new two semester Calculus with Computer sequence. Based on the idea of completely integrating calculus and introductory computer science, this program continues to be one of the department's more innovative core offerings, with over one hundred students enrolled in it every year. Professor Benac has frequently lectured on this program at other schools, and it has become a model for other programs of this type.

From 1976 to 1982, Ted was Chairman of the Mathematics Department. He has served on many department and academy-wide committees: Grand Marshal for the Academic Procession at Graduation for the past nine years; member of the Naval Academy Admissions Board, 1973-76; and academic advisor for the Navy Postgraduate Selection Board, 1973-75. One of his most important roles has been as a member of the Naval Academy Preparatory School (NAPS) program review team, for the past 14 years. His recommendations have led to better performance of NAPS students in mathematics courses and greater academic success at the Naval Academy.

Outside the Academy, Professor Benac has been active in mathematics from the high school to the graduate level. He was director of the Annapolis Secondary School Science program from 1958 to 1961. He served as Governor of the MD-DC-VA section of the Mathematics Association of America 1977-80. While an adjunct professor at The Catholic University of America, he served as an advisor for all doctoral candidates who wrote theses in algebra during the period 1962-71.

Professor Benac has long been recognized within the Naval Academy for his teaching ability. In 1989 he received the Civilian Faculty Award for Teaching Excellence from the USNA Alumni Association. Most recently, his contributions to both the Naval Academy and the mathematical community were honored when he was selected Maryland's Professor of the Year for 1990 by the Council for Advancement and Support of Education.

Ebon Betz was born and brought up on a farm in Jackson County, Michigan. His elementary schooling took place at the Landon School, a one room rural school. He graduated as valedictorian from Springport High School. In 1934 he graduated Summa Cum Laude from Albion College, with a major in mathematics and a minor in physics. Elected by the faculty of the college to a fellowship at the University of Michigan, he received a master's degree there in 1935. An assistant professorship at the University of Pennsylvania enabled him to continue graduate work, and he received his Ph.D. in 1939, having studied under the direction of Professor J. R. Kline in the field of topology.

After two years in the Mathematics Department at Haverford College, Ebon became an instructor at the United States Naval Academy in 1941. In 1942, he was commissioned as an officer in the United States Naval Reserve. Starting as a Lieutenant (junior grade), he was promoted to Lieutenant after about nine months. He returned to the Naval Academy after release from active duty in 1945.

Professor Betz has a reputation as one of the Naval Academy's most dedicated teachers. He has taught almost every mathematics course offered including topology, complex variables, and numerical analysis. He has often served as course coordinator in multi-section courses. One of his most important administrative assignments was as Class Chairman for the Class of 1966, when he had general responsibility for all of the mathematics instruction for the entire class. Because of his reputation as a thorough and careful teacher, he has often been sought by publishers to review manuscripts for textbooks.

The record indicates that Professor Betz was the instructor of **Alan Shepard**. Another astronaut whom he taught was **Bruce McCandless**. **G. Ralph Strohl**, a student of his at Haverford College, became a colleague when he came to the Naval Academy Mathematics Department in 1947. Prof. Strohl was Department Chairman from 1970 until 1976. Several midshipmen who were students of Professor Betz have returned to the Academy as instructors in the Mathematics Department. Captain **V. J. Gilroy**, former Director of the Division of Mathematics and Science, was once a student of Professor Betz, as was Captain **W. D. Key**, the current Division Director.

-James M. D'Archangelo

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William Chauvenet

Early Days of USNA

The establishment of the mathematics department was coincident with the founding of the USNA. In fact, it precedes the Academy because mathematics was one of the principal courses of study for midshipmen at the old school at the Naval Asylum in Philadelphia. The Naval Asylum School (Shore School for Midshipmen) was located in a home at a hospital for aged seamen. It was under the direction of Professor David McClure, until his death in 1842, at which time William Chauvenet became his successor.

Professor Chauvenet is regarded as having been second only to George Bancroft, Secretary of the Navy, in his influence with congress to organize the Academy. Their efforts concluded 40 years of attempts by the Navy to seek congressional approval. During that period many in congress voted against any such appropriations including those for continuing West Point. The game plan seems to have been a subterfuge. A successful course of study was initiated and then congressional approval was obtained.

The USNA began as the Naval School in 1845 on 10 acres of the old Fort Severn in Annapolis. The first head of the mathematics department, William Chauvenet, was then 25 years of age. Professor Chauvenet is reported to have been the most prominent member of the original academic staff and is said to have added much to the prestige of the school. In 1850, the Naval School became the USNA and a new curriculum went into effect requiring four years of study and training aboard ships each summer. Prior to that a preliminary course of one year for junior members and a finishing course of eight months for seniors were all that could be accomplished.

During his 19 year tour in Annapolis, William Chauvenet served in various capacities including Head of the Academic Board, Professor and Head of the Department of Navigation and Astronomy, and Librarian. He authored numerous text books and papers including his famous "Treatise on Plane and Spherical Trigonometry" which was written while he was at the Academy. This book became a classic and was for many years used by the leading colleges of America.

Twice during his tenure at the Academy, Chauvenet was offered the chair at Yale University but declined because he felt that his work here was not yet completed. Chauvenet went to Washington University, St. Louis and was appointed Chair of Mathematics and Astronomy in 1859. Professor Chauvenet became the second Chancellor.

The Chauvenet Prize

In 1925 the Mathematical Association of America established a prize with the intent of stimulating the writing of expository and survey articles on mathematics. At the suggestion of the MAA President, Julian L. Coolige, the prize was named in honor of William Chauvenet as a tribute to his skill and reputation as an expositor.

The prize is awarded at the annual MAA meeting for a noteworthy paper published in English that provides profitable reading for a large number of association members. No more than one award is granted each year. Recommendations are made by the MAA standing committee on the Chauvenet Prize. The awarding of the prize is considered one of the most outstanding activities of the MAA. The list of winners includes many of the world's leading mathematics. Professor **G. A. Bliss** was the recipient of the first prize for his article "Algebraic Functions and Their Divisors" which appeared in the Annals of Mathematics.

Chauvenet Hall

Chauvenet Hall, the permanent location of the USNA Mathematics Department, was dedicated on 17 October 1969. The dedication ceremonies were:

1. National Anthem
2. Invocation by Chaplain **Robert F. McComas**, USN
3. Welcoming remarks by Rear Admiral **James Calvert,** USN
4. Remarks on the Chauvenet Prize by Professor **Gail S. Young**, Tulane University and President of the MAA
5. Dedication address by Dr. **Athelstan F. Spilhaus,** President Elect, American Association for the Advancement of Science
6. Benediction by Chaplain **Robert F. McComas**, USN.

The Chauvenet Memorial Symposium followed the ceremonies. These proceedings are published as the "Chauvenet Memoirs," six papers written for the Chauvenet Symposium by the MAA (editor **James C. Abbott**). They appear as a preprint Mathematical Monthly, vol. 77, #5 & #6, vol. 78, #5. There are excellent descriptions and a detailed summary of the early history of the USNA and William Chauvenet in the Dedication Ceremony Program authored by Professor **John Tierney** (see the archives, Nimitz Library).

A Brief History of USNA's Mathematics Department

Founded as The Naval School in 1845, retitled the Naval Academy in 1850, a four year course of instruction was adopted in 1851.

1858 ACADEMIC STAFF of 20, 3 in mathematics. Brigade of 161 with graduating class of 15.

MATH CURRICULUM (text and meetings per week):

1st yr: Davies' University Arithmetic; Davies' Bourbon's Algebra; and Davies' Legendre's Geometry; 5/week.

2nd yr: finish Legendre; Davies' Mensuration; Davies' Descriptive Geometry; 6/week.

3rd yr: 1st sem. Smyth's Analytic Geometry; Smyth's Analytic Geometry; Smyth's Differential Calculus (for higher sections); 3/week.

The commandant was also an instructor in seamanship.

Chauvenet was not in math, but was Professor of Navigation
and Nautical Astronomy.

1870 ACADEMIC STAFF of 66, 9 in mathematics. Brigade of 244 with graduating class of 68

MATH CURRICULUM: A review of arithmetic, algebra, geometry (plane solid), trigonometry, application of algebra and trig, descriptive geometry, analytical geometry, differential and integral calculus. For academic years 1876-77 and 1877-78 Ensign **Albert Abraham Michelson** is listed as an Instructor in Physics and Chemistry.

1880 ACADEMIC STAFF about the same sizes as 1870, at this time there were two groups in the brigade:

Cadet-Midshipmen, total of 221 with 77 seniors

Cadet-Engineers, a total of 105 with 25 seniors

MATH CURRICULUM: About the same as 1870.

1890 ACADEMIC STAFF of 56, 7 in mathematics and 4 in mechanics and applied math. Brigade of 241 with graduating class of 48.

MATH CURRICULUM (text and meetings per week):

1st yr. 1st sem. Todhunter's Higher Algebra and Chauvenet's Geometry; 6/week.

1st yr. 2nd sem. Hall and Knight's Higher Algebra; Bowditch's Useful Tables; Chauvenet's Geometry; 5/week.

2nd yr. 1st sem. Church's Descriptive Geometry and Todhunter's Trigonometry; 5/week..

2nd yr. 2nd sem. Church and C. Smith's Conic Sections and Aldie's Solid Geometry; 5/week.

SUMMER CRUISE was on the U. S. Practice Ship Constellation.

1900 ACADEMIC STAFF of 57, 10 in mathematics. Brigade of 281 with graduating class of 67.

MATH CURRICULUM, changes since 1890:

Gauss's Tables of Logarithms added reference book.

Bourser's Trig replaced Todhunter's Trig.

3rd yr. Added Rice and Johnson's Differential Calculus and Johnson's Integral Calculus; 2/week.

1910 ACADEMIC STAFF of 103, 15 in mathematics and mechanics. Brigade of 758 with graduating class of 198.

MATH CURRICULUM (text and meetings per week):

1st yr. 1st sem. Brown and Capron's Practical Algebra; Brown's Graphic Algebra; Baker's Elements of Solid Geometry; 6/week.

1st yr. 2nd sem. Brown's Trig and Stereographic Projections and Bowditch's Useful Tables; 6/week.

2nd yr. Brown's Analytic Geometry and Capron's Calculus; 5/week.

(no more math taken, some mechanics taken)

SAMPLE ADMISSION QUESTION: Prove that the exterior angle of a triangle is equal to the sum of the interior opposite angles of the triangle, and then find find the sum of the angles of the triangle.

1920 ACADEMIC STAFF of 254, 39 in mathematics. Brigade of 2253 with graduating class of 273

MATH CURRICULUM (text and meetings per week)

1st yr. 1st sem. Baker's Solid Geometry; Rietz and Crathorne's College Algebra; 6/week.

1st yr. 2nd sem. Brown's Trig and Stereographic Projections and Wilson's and Tracey's Analytic Geometry; 6/week.

2nd yr. Granville's Differential and Integral Calculus (a later edition of this calculus book, used at VPI in 1941 is in my office); 5/week.

1930 ACADEMIC STAFF of 225, 30 in mathematics. Brigade of 2057 with graduating class of 448

MATH CURRICULUM (text and meetings per week):

1st yr. 1st sem. Hawkes, Luby, and Touton's Solid Geometry; Bullard and Kiernan's Plane and Spherical Trig and Logs; 6/week.

2nd yr. 1st sem. continue with calculus; 5/week.

2nd yr. 2nd sem. Elementary Mechanics (pub by USNA); 5/week.

3rd. yr. 1st sem. Bullard and Kiernan's Spherical Trig; Philips' Differential Equations; 5/week.

1940 ACADEMIC STAFF of 281, 41 in mathematics. Brigade of 2602 with graduating class of 400

1941 includes Instructors Abbott, Benac, and Betz.

1950 ACADEMIC STAFF of 434, 64 in mathematics. Brigade of 3686 with graduating class of 728

MATH CURRICULUM (text and meetings per week):

Plebe summer. Muhly and Saslaw's Plane and Spherical Trig

1st yr. 1st sem. W. L. Hart's Brief Colleg Algebra; Roscoe Woods' Analytic Geometry

1st yr. 2nd sem. Smith, Salkover, and Justice's Unified Calculus

2nd yr. 1st sem. continue with calculus and diff. eq.

2nd yr. 2nd sem. mechanics

3rd yr. 1st sem. spherical trig and strength of materials

1960 ACADEMIC STAFF of 444, 68 in mathematics. Brigade of 3905 with graduating class of 798.

MATH CURRICULUM (text and meetings per week):

Plebe summer. Plane Trig for some

1st yr. 1st sem. Sisam's College Mathematics; Britton's Calculus; 5/week.

1st yr. 2nd sem. continue with calculus; 5/week.

2nd yr. 1st sem. continue with calculus; 5/week.

2nd yr. 2nd sem. mechanics (includes vectors); 5/week

3rd yr. 1st sem. Spiegel's Applied Differential Equations; 3.5/week.

MANY ELECTIVE COURSES OFFERED.

1970 Brigade of 4375 with graduating class of 908. 181 seniors had majors, 35 in math. 849 seniors had minors, 131 in math.

1980 Brigade of 4528 with graduating class of 978; 60 seniors were math majors.

1988 Brigade of 4549 with graduating class of 1088; 109 seniors were math majors.

Over the last thirty years there has been fairly little change in incoming class size and mean SAT scores. The number admitted has been 1373 ± 141, the mean verbal SAT has been 576 ± 20, and the mean math SAT has been 652 ± 18. The number graduating has been 940 ± 137 and there has been a tendency for attrition to decrease from about 35% to about 23%.

(Primary reference source: Annual Register, USNA)

Anecdotes Concerning William Chauvenet

William Chauvenet was born 24 May 1820 in Milford Pennsylvania. He graduated from Yale University with distinction and at the age of 21 years was appointed Professor of Mathematics, U. S. N. After serving at sea on board the steamer USS Mississippi in the capacity of instructor of mathematics and navigation, he proceeded to Philadelphia in 1842 and assumed charge of the Shore School for Midshipmen. He was instrumental in the founding of the US Naval Academy at Annapolis (October 1845), then known as the Naval School. He served in influential positions there for a period of 19 years and left to become the second Chancellor of Washington University, St. Louis, Missouri. He died 13 December 1870 in St. Paul, Minnesota.

Professor Chauvenet was regarded as a brilliant scholar on par with Professor Benjamin Pierce of Harvard. Few scientists of distinction had more varied interests outside their specialities. Chauvenet was a highly regarded music critic and accomplished pianist. He had broad knowledge of English literature and was the author of numerous books and scientific papers. He designed navigational instruments and performed the stress-strain calculations necessary for the construction of the Eads Bridge spanning the Mississippi at Saint Louis. Professor Chauvenet was a member of the American Academy of Sciences, a Charter member of the National Academy of Sciences and at the time of his death was President of the American Association for the Advancement of Science and Vice President of the National Academy of Sciences.

As an aside, I note a story that I came across in researching this article. The story goes that one day a midshipmen was strolling through the Yard in his dress whites when one of Chauvenet's sons who was hiding in a tree threw a cherry pit soiling the midshipman's uniform. The boy was promptly pulled out of the tree and given a good spanking. Mrs. Chauvenet insisted that the midshipman be expelled. But, Chauvenet was able to convince her that justice would be served by having the midshipmen spend time in the brig. The young midshipman's name was Thomas Dewey. (Admiral Thomas Dewey later lead the US victory at Manila Bay and is well remembered for the expression, "Damn the torpedoes and full speed ahead.")

The History of the Department Of Mathematical Sciences USMA

Mathematics instruction at West Point began in 1801. George Baron taught a few Cadets of the Artillery and Engineers some of the fundamentals and practical applications of algebra. On 16 March, 1802 Congress established the United States Military Academy at West Point. The first acting Professors of Mathematics were Captains Jared Mansfield and William Barron. They taught the first few cadets algebra, geometry, and surveying. Ferdinand Hassler and Captain Alden Partridge soon took over those professorships and continued similar instruction until 1813.

The distinguished scientist and surveyor Andrew Ellicott became Professor of Mathematics in 1813. He was able to add instruction in trigonometry, series, conic sections, and fluxions (the rudiments of calculus). Ellicott was still serving in that position when Sylvanus Thayer became Superintendent of the Academy in 1817. Thayer had studied the military and educational systems of Europe for several years and reorganized the Academy according to the French system of the Polytechnic School of Paris. Through the leadership of Thayer and the technical expertise of Ellicott, the Department of Mathematics combined the French theories with the practical methods of the English to establish a new model for America's program of undergraduate mathematics. This program of instruction in mathematics grew over several decades and was emulated by many other schools in the country.

One of Thayer's significant accomplishments was to bring back from Europe numerous mathematics and science books. Thayer's book collection included many of the finest books available at that time in Europe. His books provided a solid foundation for the USMA library to build upon. The Department Heads during the rest of the 19th century were able to increase the size and quality of the collection by maintaining close ties with mathematicians in France and England and obtaining the latest French and English books on subjects in undergraduate mathematics. Today, the West Point Library has one of the finest collections of pre-20th century mathematics books in the world. A complete bibliography of this collection is being compiled for publication in the near future.

During his trip to Europe, Colonel Thayer recruited the famous French mathematician Claude Crozet who brought to America expertise in Descriptive Geometry (engineering drawing of the 20th century), advanced mathematics, and fortification engineering. It was Crozet and other professors at USMA that first used the blackboard as the primary tool of instruction.

Ellicott's best student, Charles Davies became the professor of Mathematics in 1823. Davies was a prolific author. He translated several French works by Bourdon, Lacroix, and Legrendre and wrote over 30 textbooks in mathematics and many journal articles. His textbooks were used in schools throughout the country at all the levels from grade school to college. He had tremendous influence on the entire educational system of America throughout the 19th century. It was during Davies time as the Head of the Department of Mathematics that calculus was taught to all cadets and later used in the development of the science and engineering courses.

Albert Church succeeded Davies and improved and developed the curriculum. He also wrote several textbooks. Church's tenure as Department Head was remarkable in many ways. He was Professor of Mathematics at USMA from 1837-1878. Along with fellow department heads in science and engineering, William Bartlett and Dennis H. Mahan, Church presided over a curriculum that produced many successful mathematicians and scientists. West Point graduates Hoarce Webster, Edward Courtenay, Alexander Bache, James Clark, Francis Smith, Richard Smith, Henry Lockwood, Henry Eustis, Alexander Stewart, and William Peck filled positions as professors of mathematics or college presidents at other schools such as U. S. Naval Academy, Geneva College, University of Virginia, University of Pennsylvania, University of Mississippi, Yale, Brown, Harvard, Columbia, Virginia Military Institute, Cooper Institute, and Brooklyn Polytechnic Institute. The West Point model of undergraduate mathematics education was exported throughout the nation by capable individuals such as these.

During the 19th century, USMA instructors used elaborate physical models to explain the structures and concepts of geometry. This magnificent collection of string models is still in the Department today. The models were made by Theodore Oliver in France in the early 19th century.

Edgar Bass succeeded Church. Bass continued the practice started by his predecessors Davies and Church of authoring mathematical textbooks. His book on the calculus improved and modernized the earlier works of Davies and Church. Wright Edgerton chaired the Department as it entered the 20th century and celebrated its centennial in 1902. Edgerton and his successor Charles Echols revitalized the mathematics curriculum. Echols visited schools in Europe and began using new teaching methods at the Academy.

During the professorship of Harris Jones, West

Point entered its first competition in mathematics. A mathematics challenge match between Harvard and USMA was conducted in the spring of 1933. The two competing teams made up of 12 second-year students took a test written by the president of the Mathematics Association of America. The West Point "mathletes" defeated Harvard in the competition that was the precursor to the national Putnam Competition. A few years later in 1944, the slide rule was used in all plebe mathematics classes.

Colonel William Bessell replaced Jones as Head of the Department in 1947. During Bessell's tenure, the old riding stable was converted into the Thayer Hall academic building. Under Bessell's direction, the mathematics classrooms at West Point were modernized with overhead projectors and mechanical computers. Bessell introduced a course in probability and statistics into the core curriculum and began a limited electives program for advanced students. He was also instrumental in getting faculty members educated with advanced degrees from civilian universities and starting a computer center at West Point.

Bessell transferred control of the Department of Mathematics to capable hands of Charles Nicholas in 1959. Nicholas had previously served as one of the organizers for the Central Intelligence Agency. He wrote a rigorous and comprehensive mathematics textbook that cadets used in their entire core mathematics program. He was able to adapt the USMA mathematics program to keep up with the increasing demands of modern science and engineering.

Professors **J.S.B. Dick** and **Jack M. Pollin** guided the Department during the 1970s and 1980s. Their leadership kept the Academy at the forefront of undergraduate mathematics education. The calculator was introduced and used in all mathematics classes. Curriculum changes that provided new courses and the opportunities for cadets to major in mathematics and to study operations research were introduced. Under Colonel Pollin's guidance, a mathematics consulting element was established that allowed faculty members and students to support the research needs of the Army.

David Cameron was the Head of the Department from 1985-1988. Colonel Cameron directed a redesign of the curriculum to take advantage of the increase in the number of electives in the cadet program and the use of computers in the classroom. Colonel Cameron continued to develop the Department's research and consulting effort.

The current Department Head is Colonel **Frank R. Giordano.** Colonel Giordano has modernized the mathematics classrooms with mobile classroom computers with overhead display devises and advanced computational software. In 1990 the Department introduced a new mathematics course in discrete mathematics to the core curriculum. The Department also changed its name in 1990 to the Department of Mathematical Sciences to reflect broader interests in applied mathematics, operations research, and computation.

The Department of Mathematical Sciences, USMA, is very proud of the accomplishments of its faculty members and students. The USMA mathematics program has had great influence on mathematics education in America throughout its history. A complete history of the Department is being compiled for publication on the bicentennial of the Academy in 2002.

- LTC D.C. Arney

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The History of the Department of Mathematical Sciences USAFA

In 1978, in response to the 25th Anniversary of the United States Air Force Academy, the Dean of the Faculty initiated the writing of a collection of essays describing the twenty-five years of the Academy. These essays were collected in a volume entitled ***The First Twenty-Five Years*** and published in 1979. Extensive excerpts from chapter two, describing the Department of Mathematical Sciences, are included below. The changes which have occurred since 1979 are at the end of the article.

From Slide Rule to Programmable Calculator: The First Twenty Five Years

In 1955 when the fledgling Air Force Academy began educating cadets of the Class of 1959, the Department of Mathematics was, in many ways, indistinguishable from her mother organization, the Department of mathematics of the US Military Academy at West Point. ... The traditions formed during the first twenty-five years of the Air Force Academy Mathematics Department would prove to be a blend of military heritage and youthful flexibility that could accommodate a varied faculty and student body as well as adjust curricula and teaching methods to the demands of an ever-changing world.

... [A] prospective instructor could be a mathematician, an engineer, a statistician, or a physicist. He could be an Academy graduate or not, he could possess a masters or a PhD degree, and his primary Air Force duty could be as a pilot, a navigator, an analyst, a computer technician or whatever.

... The first Department Chairman was Colonel ***Archie Higdon,*** *a nationally recognized figure in the field of Engineering Mechanics. Also one of the original nine faculty members, the second chairman was Lt Col* ***John Ault.*** *... [T]hree of the nine original instructors held aeronautical ratings, and eight were World War II veterans. ...*

In 1976, the Air Force Academy originated a program of appointing civilian Distinguished Visiting Professors (DVPs) to academic departments to meet the need for civilian interaction with cadets and faculty for broadening, stimulation, and evaluation. The Math Department appointed its first DVP in 1978.

The AFA of today remains committed to a predominantly military faculty as a means of providing a role model of the professional officer with varying specialties, and with a solidarity of commitment to and pursuit of excellence in every endeavor. ...

As an early experiment, three different levels of difficulty of mathematics courses, called "tracks" were offered to entering cadets. ... From 1960 to 1965, the three-track system was replaced with a two-track system and then in 1965, the three-track approach was tried again to provide for cadets of differing ability .... In 1970, the three track system was abandoned in favor of a one-track system in which cadets with different math abilities were placed into the track at different positions, with the cadets who needed remediation having to take algebra and trigonometry to catch up with their peers. Another modification of the math curriculum occurred in 1977 with the institution of "honors" sections of most of the core courses. These honors sections contained the best math students and stressed more breadth and more depth than the regular sections of a course.

... [I]n recent years, the Department has changed emphasis from a theoretical mathematics stance to a more applied one which was reflected in the changing of its name in 1973 from the "Department of Mathematics" to the "Department of Mathematical Sciences."

... The Math Department in particular may point with pride to the twenty [USAFA] Rhodes Scholars, two of whom were math majors, as well as to the eleven math and engineering sciences majors of the forty [USAFA] National Science Foundation Fellowship winners.

Perhaps a large part of the success of her graduates may be attributed to the Math Department's curriculum, which from the very beginning has been constantly revised and improved to reflect changing needs.

Since the Academy's inception, mathematics has occupied more cadet class time than any other required subject. During the first year, 1955-1956, all cadets were given a pre-calculus course consisting of algebra, trigonometry, coordinate geometry, and, for the better prepared or more able students, short courses in vector analysis, mathematics of finance, and statistics. Upon a reappraisal of cadet abilities and in response to the needs of other subjects, calculus was introduced into the fourth class curriculum in the following year, where is has remained.

Although course numbers have changed and semester hours have been modified, fluctuating from 9 to 13 1/2 semester hours required during the fourth class year, the subject matter has remained somewhat constant: calculus continues to comprise the largest bulk of the fundamental mathematics sequence. After a long period of gradual but steady change, we have moved from a program of no calculus during the fourth class year to a sequence that provides pre-calculus mathematics to approximately 20% of the entering cadets, who require remedial work in algebra and trigonometry.

... [S]tatistics has been a part of the required mathematics program since the earliest days of the Academy. The offering has varied in its nature, sometimes as a unit within one of the required courses and sometimes as a separate course. Nevertheless, the application of statistics to current Air Force topics was stressed from the very beginning, when the subject was taught from a set of notes written by members of the Department.

Several technological advances influenced the mathematics curriculum at the Academy. ... Thus, in 1957 a course titled "Introduction to Machine Computation" was taught to eight cadets, followed in later years by course in computer programming and numerical analysis. In 1965, the programming courses were transferred to the Department of Astronautics and Computer Science, where they have remained.

As another example of changing technology, the slide rule was used by all math students until 1975, but now has been totally replaced, as it has in most colleges and engineering schools, by the electronic handheld calculator.

... The requirement for each cadet to specialize by completing an academic major was instituted in 1964. Mathematics was one of the subjects in which cadets could complete a major without taking enrichment or overload courses. ... Courses in differential equations and advanced engineering mathematics were already in the curriculum; additional course in modern algebra, advanced calculus, probability, and complex variables completed a program for the undergraduate mathematics major. ... In 1965 there were 200 cadets majoring in mathematics and 34 members of the Class of 1966 graduated with a major in mathematics.

In subsequent years, the number of mathematics majors dwindled, perhaps because more alternatives were presented; at the present time about thirty-six cadets major in mathematics, and thirty-two enrolled in the new major in operations research, which is under the joint direction of the Department of Mathematical Sciences, and the Department of Economics, Geography, and Management.

Although the Military Academy at West Point had a strong influence on the early methods of teaching mathematics at the Air Force Academy, the AFA Math Department gradually developed her own variations of the traditional teaching approach. The Department continued the West Point traditions of expecting cadets to prepare lessons thoroughly before coming to class and, once there, to participate totally, with always the possibility of extra instruction (EI) by faculty members outside of class for those cadets who need it. In addition, continual feedback about the cadet's math progress has been provided to both the cadet and his instructor through the years.

The "Lesson Assignment Sheets" for the first cadets, which simply listed the daily assigned reading and homework problems to prepare before class, are a far cry from the present "Notes to Cadets" which within the last ten years have become so detailed and comprehensive in some math courses that there is scarcely a need for a textbook.

From the beginning, small class sizes (15-20 cadets) at both the Air Force Academy and at West Point were conducive to cadet participation, and although graded boardwork was not mandated at the Academy as it was at West Point, still at least as much time was given to cadets working problems at the boards as to expository lectures by the instructors, a practice that continues to this day.

Virtually unlimited EI is one feature that sets the AFA and West Point apart from other undergradu-

ate institutions. In the early days, cadets signed a mathematics EI roster and attended group EI sessions after classes in the afternoon. This group EI gradually gave way to more individualized EI with individual instructors until in the early 1970's, an "EI Room" was made available and manned by instructors for group EI all during the academic day, five days per week. The EI Room was short lived, however, and individualized EI, the efficiency of which is now being closely monitored, is again on the increase. Thus, though the mode of EI has fluctuated during the years, it remains one of the fundamental tools of mathematics education at the Academy.

Another fundamental principle that has survived the first twenty-five years at the AFA is that of giving continual feedback to both the student and his instructor about the student's math progress. Although the methods of administering tests and assigning grades to test results have changed since the AFA began, testing has always been frequent, comprehensive, and centrally controlled.

From the beginning, the Academy evaluated cadets almost daily by means of 5-10 minute quizzes called "graded recitations." Larger exams were administered every 10-15 lessons. These larger exams, called "graded reviews (GRs)," were comprehensive back to the previous GR and the results were used to reassign all the cadets in a course into homogeneous classes. The final exam of a course was comprehensive over all of the course material.

Throughout the first twenty-five years, each course director (the instructor in charge of a course) has written the exams for his course and has administered these same standardized tests to all of his students; however, the method of test administration has changed dramatically. In the beginning, the same test was given on succeeding days in every-other-day courses, but in response to the Academy cheating scandal of 1965, the White Commission recommended that different versions of the test be given on alternate days. Along the same line, the West Point cheating scandal of 1976 prompted an AFA decision to require different versions of morning and afternoon tests given on the same day. This same 1976 change of policy dictated that no work done by cadets outside of class could be graded, which eliminated the graded take-home problem sets that had been especially prevalent in upper division math course since the Academy began. ...

In addition to striving for excellent mathematics preparation of Academy cadets, the Department has from the beginning sought to prepare and maintain the teaching expertise of its instructors. One such preparation tool has been a training session during the summer for newly-assigned instructors, a short course that has evolved from a predominantly "practice teaching" medium to one that today also encompasses some orientation to the Academy as a whole. ...

In addition to teaching mathematics, which has always been the principal occupation of the Department faculty, between 5% and 10% of our time has been spent in the general area of research: academic, education, and "sponsored" research (consulting).

The number of instructors currently assigned to the Department is 49. The number of cadets enrolled in the math major has begun increasing and there are currently 100. Current enrollment in the operations research major is 132. The core math curriculum is now three courses: Calculus I, Calculus II, and Probability and Statistics. Additionally two courses are required for most technical majors: Calculus III and Ordinary Differential Equations.

Probably the largest change since 1979 besides the reduced curriculum has been in the methods of teaching and testing. "Notes to Cadets" have been significantly reduced, now more closely resembling the original assignment sheets. This has resulted in an increase of "Notes to Instructors" from the course director highlight important lesson topics which should be stressed in class. While take-home examinations are rare still, graded homework and projects have been on the increase.

In response to another cheating scandal a morning GR period has been established. This period is before the first academic period of the day. Large courses (especially in the core) give a GR to the entire course at one time during this early morning period. Most courses also use alternate versions of the GR to preclude inadvertent honor incidents.

A typical semester includes 21 courses being taught to over 1500 students. A wide variety of research is being conducted by 34 officers. The Department has made several significant contributions for DIA and the State Department in support of AIDS research and drug interdiction.

Colonel **Robert Lochry** retired in 1985 after 15 years as the Department Head. Colonel **Daniel Litwhiler** is the current Head.