FOCUS

May/June 2003

Volume 23, Issue 5

FOCUS is published by the Mathematical Association of America in January, February, March, April, May/June, August/September, October, November, and December.

Editor: Fernando Gouvêa, Colby College; fqgouvea@colby.edu

Managing Editor: Carol Baxter, MAA cbaxter@maa.org

Senior Writer: Harry Waldman, MAA hwaldman@maa.org

Please address advertising inquiries to: Carol Baxter, MAA; cbaxter@maa.org

Letters to the editor should be addressed to Fernando Gouvêa, Colby College, Dept. of Mathematics, Waterville, ME 04901, or by email to fqgouvea@colby.edu.

Subscription and membership questions should be directed to the MAA Customer Service Center, 800-331-1622; e-mail: maahq@maa.org; (301) 617-7800 (outside U.S. and Canada); fax: (301) 206-9789.

Periodicals postage paid at Washington, DC and additional mailing offices. **Postmaster:** Send address changes to FOCUS, Mathematical Association of America, P.O. Box 90973, Washington, DC 20090-0973.

ISSN: 0731-2040; Printed in the United States of America.

FOCUS Deadlines

	August/September	October	November
Editorial Copy	July 8		September 16
Display Ads	July 10	August 20	September 24
Employment Ads	June 11	August 13	September 10

MAA Online Offers New Services and Easier Access

If you've visited MAA Online lately, you have already seen the new look of the front page featured on the cover of this issue. Staff at MAA headquarters, and especially Rich Hamilton, our webmaster, spent months planning the roll-out of the new front page. The new design is not just another pretty face, but represents one phase of a project to revamp our entire website to add new services for MAA members.

One new service already available is the online bookstore. You can now order books directly through MAA Online. By using your MAA customer number (found just above your name on the top left of any mailing label from FOCUS or another MAA journal), you can log on to the bookstore to get member pricing. Once logged on, you will also be able to review your member profile and, if needed, update your street and email addresses. You can even renew your membership online. (It is not yet possible to change your journal subscriptions through the web, but that service will be in place soon.)

Of course, another goal of the reorganization is making navigation of the site easier, so that you will be able to quickly find the information you seek. By using drop-down menus (activated by positioning your mouse pointer on one of the main categories listed on the left side of the front page), most areas of MAA Online are just one or two clicks away. The menus allow many more items to be "close" to the front page than the static buttons they replace. With the explosion of information available through our site, this structure provides much easier access, and as we continue to refine and improve the site, we hope that you'll agree that MAA Online should be your first step for math on the World Wide Web. ■

From the Editor

OK, enough already! No article we have published so far produced as many letters to the editor (and even article submissions) as Reuben Hersh's "A Nifty Derivation of Heron's Area Formula by 11th Grade Algebra," which appeared in our November issue. Thanks for all your letters and comments, folks, but let's not make this the *Heron's Formula Newsletter.*

It's good to know, of course, that many of you enjoyed that article. This issue includes an article in a similar spirit: Robert Weinstock's account of his discovery of the quadratic formula. Occasional articles of this kind are welcome, but keep in mind that you're writing for FOCUS, not an academic journal. We prefer to publish short, informal articles that combine news, mathematical content, new ideas, practical tips for working mathematicians and mathematics teachers, and even a bit of entertainment. The articles in this issue reflect that wide range. I hope you enjoy them and find them useful.

I'd like to invite contributions to a new series of articles, entitled'"What's the Best Textbook?" This is the topic of many informal conversations among mathematicians, and I'd like to challenge you to put your opinions down on paper. Some parameters: (a) articles should discuss a range of textbooks in one subject, preferably one that is taught to upper-level mathematics undergraduates; (b) authors should provide short but cogent reasons for their preferences; (c) a high level of civility will be expected; and (d) authors should avoid harangues about how the world is going to the dogs and we should all revert to 19th century textbooks. Aim for about 900 words of text. Please feel free to contact me with any questions. The best way to send articles is by email, either as text files or as attachments.

I hope I don't provoke another mail storm!

FOCUS is always looking for news, cover images, and articles (we prefer, of course, cover images that tie in with news items or articles). Letters to the editor are also always welcome. I can be reached by email at focus@maa.org.

Fernando Q. Gouvêa

Correction

The dates for the PMET Workshop: *Preparing Eementary Teachers* was incorrectly listed in the April issue of FOCUS. The correct dates are August 5-13, 2003. For more information on these workshops please go to http://www.maa.org/pmet.

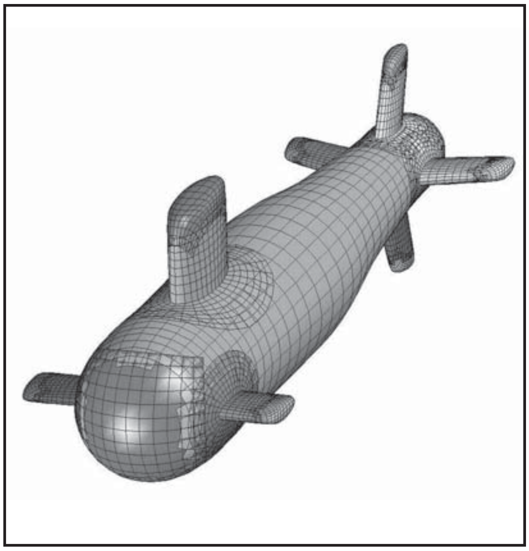
How to Pack Lunch for a Mars Mission, and other BIG Math Projects

By Phil Gustafson

Applications of mathematics to projects in business, industry and government offer a wealth of exciting problems for mathematicians. However, the question "who uses calculus?" is one that we hear often. This question was addressed at the MAA Contributed Paper Session, entitled "Mathematics Experiences in Business, Industry and Government," during the Joint MAA-AMS meetings this past January in Baltimore. This article discusses highlights of the BIG math projects presented at the paper session, and offers some partial answers to the calculus question. The presenters demonstrated that those who have calculus in their background can model food system planning for a Mars mission; detect, track and pre-empt terrorists; explain the images your digital camera takes; use graph theory in designing a car; discuss the linear systems used in groundwater models; and develop a genetic algorithm model for the investment plan to pay for all of this. The paper session was sponsored by the Business, Industry and Government Special Interest Group of the MAA (BIG SIGMAA).

If you are planning a trip to Mars, John Cruthirds can help pack your lunchbox. He presented an outline of his mathematical model of the food system planned for a possible manned NASA mission to Mars. Cruthirds, a mathematics professor at North Georgia College and State University has spent two summers working as a Summer Faculty researcher at NASA's Johnson Space Center, and part of his task was to develop a mathematical model for the food system for long-term space missions, including a possible 3-year trip to Mars. To understand some of the challenges, imagine living inside a bus for 3 years, very rarely getting off the bus and eating the same food the whole time, without many of the little things that make eating a pleasure. His model incorporates many variables, including food quality, nutritional value, palatability, diet cycle length (how long until food repeats), and psychological factors related to a fresh food supply. His model also considers a measure of the energy (power) and mass required to store and prepare the food, and crew time required to maintain the system.

Tom Mifflin of Metron helps solve problems of national interest. Metron is a small scientific, consulting firm that employs mathematicians and applies mathematics to problems in government and industry. Recently they worked on several projects concerning detecting, tracking and pre-empting terrorist operations. In his talk, he described how they apply non-linear filtering, random graph theory, information theory, and stochastic optimization to this problem. Other applications include tracking submarines and developing a search plan for a 19th-century shipwreck.



Submarine image courtesy of Lawrence Livermore National Laboratory.

Peter Stanek of Lockheed Martin spoke on the mathematics of digital photography. He defined a digital image as an array of pixels given by charge-coupled devices or similar technology. Three imaging topics that are completely dependent on mathematics were discussed. The first topic was image compression. Digital images represent very large data files that easily exhaust the capacity of floppy disks, CDs and hard drives. Thus data compression is vital for storage and communication of imagery. Both JPEG and JPEG 2000 compression are based on mathematical techniques such as Fourier and wavelet analysis. Second, Stanek pointed out that analyzing the content of a digital image and identifying objects in a picture uses a variety of mathematics. For example, picture-taking maps our 3-dimensional world onto a plane, and objects can be identified by their projective invariants (such as the cross-ratio of four points on a line). Next, Stanek discussed how images can be explored by measuring the spectral content of a scene. For example, NASA's Airborne Visible and InfraRed Imaging System (AVIRIS) collects images in 224 bands, each 10 nm wide for wavelengths between 400 and 2500 nm. Because a typical AVIRIS image is 140 MB, opportunities for mathematical applications abound. An AVIRIS scene is a subspace of a 224-dimensional vector space of all possible scenes. What is its subspace dimension? How can it be compressed? Carefully processing spectral information reveals scenery details unnoticed in conventional photographs. Examples were also presented from NASA programs, the Hubble Space Telescope and LandSat.

Pete DeLong of Raytheon expected probability theory to be useful as he began his career in industry, but the importance of discrete math, especially directed graph theory, caught him by surprise. His talk discussed applications of graph theory to systems engineering. A system can be represented as a graph, where vertices represent system processes and edges represent interactions. For example, in an automobile system, the function of a car might be decomposed into vertices titled "move vehicle", "interface with users", and "protect users", with directed edges representing interactions among the processes. To fully describe the system, the system engineer recursively decomposes vertices into new graphs, and edges into new edges. In this way the engineer makes sure the system is complete, seeks design efficiency, and estimates costs. One related problem is to estimate invariants of such recursively defined graphs. DeLong then discussed sensor fusion systems, where the edges represent flow of data from sensors, and vertices represent processes that label sensor data derived from a fixed target. He pointed out that data pertaining to the target can be represented as a graph that satisfies Kirchhoff's voltage law, and that the set partition of the sensor data can be represented as a structured forest. The structure of the set partition is based on a template that is a tree, and the template determines the proper architecture of the sensor fusion system.

Tim Chartier of the University of Washington discussed the ubiquitous matrix problem $Ax = b$. With the continual improvements in computer capability, the use of simulations and modeling plays an increasing role in the modern scientific laboratory. Chartier cited examples of math modeling problems from Lawrence Livermore National Laboratory that include groundwater clean-up and submarine design. Due to the complexity of such models, numerical solutions are desired. The domain of interest is discretized, translating the partial differential equation model into a linear system of the form $Ax = b$. Due to the refinement needed in such grids and to the fact that each grid point correlates to at least one unknown and one equation, these linear systems are often very large (for example, the $n \times n$ matrix A may have $n = 10^6$ or 10^9). Such large systems put a heavy demand on the computers used to solve the systems, as Gaussian elimination is known to require $O(n^3)$ operations. Instead, iteration is used to numerically solve such systems. An iterative method can begin with an initial guess to the solution vector x, and with a matrix M that in some sense approximates A. Viewing the solution in $x = A^{-1}b$ form, the search for a linear process that represents M^{-1} is a topic of current research. Some approaches include the conjugate gradient method, incomplete LU decomposition, and multigrid methods. Tim Chartier collaborates with researchers at Lawrence Livermore National Laboratory in the area of multigrid methods, in which a coarse grid is initially used to reduce the cost of solving the system, then the solution to this coarse grid model is used to help obtain a solution to a finer grid model.

Edwin (Jed) Herman of the University of Wisconsin, Stevens Point, asked the familiar question, "Who Really Uses Calculus Anyway?" Jed went in search of the answer by sending out questionnaires and tracking down BIG people for interviews. He found that accountants, web designers, stockbrokers, and bankers generally do not use calculus in their jobs. Computer programmers, computer analysts, and doctors may or may not use calculus; and actuaries, chemists, physicists, engineers, and geologists may use calculus in their jobs. Whether or not they use calculus on an everyday basis depends on their specific tasks. Actuaries, for example, use calculus-based statistics in their work, and while software handles the computations, they still need to understand calculus in order to understand what the software is doing. Doctors may value the way of thinking that is cultivated in math courses. Physicists working in radiation oncology use calculus to maximize the amount of radiation on a tumor while minimizing it on surrounding tissue. This is a substantial optimization problem, involving radiation levels and proper alignment of equipment using angles, with up to 2000 simultaneous variables. A civil engineer did not use calculus everyday, but calculus was involved in his software for modeling storm water run-off. The model incorporated such factors as soil absorption and elevation, as well as difference equations. Overall, the people who were most likely to use calculus in their jobs were scientists and engineers (especially those with advanced degrees) and actuaries. Jed planned to continue his study to include statisticians, economists, and other occupations that might well use calculus on a daily basis.

Robert Tardiff of Salisbury University spoke on joint work with Harry Suber of TrendLogic Associates on using genetic algorithms to select financial instruments for inclusion in an investment portfolio. A way to describe such a portfolio is to specify the proportion each financial instrument is of the entire portfolio. A genetic algorithm is used to find a mix of financial instruments that maximize return while minimizing risk. Genetic algorithms are models for the evolution of a population of individuals: Individuals are selected for reproduction according to their fitness (natural selection), these individuals reproduce, some of their offspring undergo mutation, and finally the next generation or population is produced. Generally speaking, the fittest individual in a given generation is at least as fit as any individual in any previous generation (cloning would guarantee this). Populations are allowed to evolve until the fitness of the fittest individual does not change appreciably. In portfolio design, individuals are vectors whose i^{th} component is the proportion the i^{th} financial instrument is of the portfolio. The fitness of one of these vectors is the ratio of return to maximum drawdown (risk) for the corresponding portfolio during a particular period of time. Some practical financial issues to control are overweighting a few financial instruments, unreasonable precision, and total money at risk. While the genetic algorithm model requires minimal assumptions, it yields good solutions.

This article reviews several exciting applications of mathematics to projects in business, industry and government. We have seen that in a variety of settings, from industrial to financial, from close to home to outer space, overseas, underseas and underground, mathematics is a key component to many important projects in the world around us. Who uses calculus? The answer includes many of the mathematicians, scientists and engineers whose products help improve our everyday lives.

Acknowledgement: The author is grateful for the assistance provided by the speakers for the content appearing in this article, and for their participation in the paper session. ■

Phil Gustafson is Associate Professor of Mathematics at Mesa State College in Grand Junction, CO, and is Vice Chair for Programs for BIG SIGMAA.

The Four As: Accountability, Accreditation, Assessment, and Articulation

By Peter Ewell and Lynn Arthur Steen

Most MAA members understandably devote their primary professional energies to teaching and research. Indeed, support of education and scholarship in the mathematical sciences ("especially in the collegiate field") is central to the mission of the Association. It used to be that the primary pressures on college and university mathematicians came from their peers and partners — from the practitioners and users of mathematics. But as higher education has become more important, more prevalent, and more costly, those who pay the bills — administrators, trustees, legislators, parents — are beginning to ask for evidence of value. Mathematics, the argument goes, is too important to be left to mathematicians.

Recognizing that most mathematics departments have little experience in answering the evidentiary questions that public agencies tend to ask (e.g., What mathematics do all students learn? Why aren't more students preparing to be mathematics teachers?), MAA sought and received a $500,000 grant from the National Science Foundation for the project "SAUM: Supporting Assessment in Undergraduate Mathematics." (See sidebar for details.) Discussions at section meetings and SAUM workshops confirm that most MAA members are still focused on *mathematics* teaching and scholarship without being fully aware of significant changes underway in the ecosystem in which mathematics departments operate. Thus our topic: the four As.

Accountability. "No Child Left Behind," the signature legislation that George Bush used to inaugurate his presidency, imposes unprecedented federal requirements on the K-12 system to use regularly-administered standardized tests to document annual improvements in all student ethnic and socioeconomic subpopulations. Many feel that higher education's turn is next.

During this session Congress must reauthorize the Higher Education Act (the source of student loans, among other things). Opening discussions have been more vigorous than in previous years as the administration seems to be suggesting that the logic of "No Child Left Behind" — annual improvements in every subpopulation — should apply to higher education just as it does to K-12. However, since no one appears to know how to measure learning outcomes in higher education, the leading proposal is to focus on graduation rates. Many state legislatures are moving in the same direction. Mathematics will be in the crosshairs of this movement since one of the leading reasons for students not graduating is failure to pass required mathematics courses.

Accreditation. Unique among nations, the United States relies on private associations of schools and colleges —rather

Supporting Assessment of Undergraduate Mathematics (SAUM)

An MAA project supported by a $500,000 grant from the National Science Foundation, SAUM is designed to help departments effectively assess one or more goals common to undergraduate mathematics departments, especially (a) the mathematics major, (b) preparation of future teachers; (c) college placement programs; (d) mathematics in mathematics-intensive programs, and (e) general education courses, including those aimed at quantitative literacy. The project is directed by Bernard L. Madison, Professor of Mathematics and former Dean of the College of Arts and Sciences at the University of Arkansas.

The central activity of the SAUM project has been a series of workshops for teams of faculty who work with each other, with other teams, and with project leaders to develop plans to implement on their own campuses. Each team is preparing a case study documenting the assessment issue they were trying to resolve, and reporting on progress or results over the 2-3 years of the project activity. These case studies, and others, will be assembled into a report together with syntheses of common issues that will be distributed to every department of mathematics in the United States.

MAA's leadership in assessment has a relatively long history— especially compared with other disciplines. In 1990 CUPM established a subcommittee on assessment, chaired by Bernard Madison. In 1995 this committee published guidelines for departments to use in establishing a cycle of assessment aimed at program improvement. Subsequently, in 1999, MAA published *Assessment Practices in Undergraduate Mathematics* (MAA Notes #49). This volume contains over seventy case studies of assessment at institutions across the US; the CUPM subcommittee's 1995 report is reprinted as an appendix. SAUM extends MAA's history of energetic assessment support one step further, concluding with a new volume of case studies to help departments identify models they may wish to adapt (as well as mistakes they may wish to avoid).

In addition to project director Bernard L. Madison, other senior SAUM personnel are Bonnie Gold (Monmouth University), William E. Haver (Virginia Commonwealth University), William A. Marion, Jr. (Valparaiso University), and Lynn A. Steen (St. Olaf College). Peter Ewell (NCHEMS) serves as Project Evaluator and Michael Pearson (MAA Associate Director for Programs) manages the project at the MAA's Washington office. Further information can be found on the SAUM website at http://www.maa.org/saum.

Team members from different colleges discuss assessment issues at a recent SAUM workshop at Towson University.

than a government agency — to validate a college's standing as a destination of government-funded student aid. Most academic members of the MAA can recall periodic episodes of special reports associated with visits of accreditors to their campuses. In 1992 defaults on student loans were politically hot, so that year in the Reauthorization of the Higher Education Act Congress required accreditors to validate key financial and socioeconomic indicators associated with loan defaults. Knowledgeable observers believe that this time Congress will further tighten the rules for accreditation by imposing specific learning, retention, or graduation criteria.

Accreditors were first mandated to look at learning outcomes as a condition of recognition in Department of Education rules established in 1989, but these directives were not very specific. Now they are at the top of the list of things Congress is grilling accreditors about. Consistent with the logic of "No Child Left Behind," moreover, accreditors are increasingly being asked not just about whether they examine student learning outcomes in the light of institutional mission, but also why they don't establish and enforce common standards of learning that all must meet. In this way the "mathematics for all" movement that has swept K-12 is likely to take root in higher education.

The potential federal stick is to disenfranchise accreditors from their gatekeeping role. Indeed, a bill to decouple accreditation from gatekeeping has already been drafted and may be deployed. So while Reauthorization is unlikely to bring higher education a federally-mandated, test-based, accountability "solution" as in K-12 (largely because of lack of money and expected fierce resistance), the attempt may very well be to achieve this goal indirectly by leaning much more heavily on accreditors to enforce standards of learning.

Assessment. "Standards of learning" brings us to the central focus of SAUM: assessment. How do mathematics departments know whether students are achieving the goals they have in mind and the standards they set? Not only Congress but even more so state legislatures and boards of trustees are now focused on evidence of outcomes. Reports like *Measuring Up* [1] highlight what seem to many policymakers to be an appalling lack of information about results of higher education. One consequence is the prominence of K-16 rhetoric that appears to call for a test-based response, at least through grade 14. Funding schemes based on measurable performance statistics are increasingly popular with state legislatures. These create a problem of particular significance to mathematics, namely, the lack of alignment between newly mandated high-school exit tests, college entrance exams, and college placement tests.

Assessment that is persuasive and helpful requires actual evidence of student learning. Not only do external stakeholders increasingly require such evidence, but it is vitally important internally for educational improvement. Too often assessment practices reveal only "compliance behavior" where assessment is seen as "for" somebody else. That posture ensures that the results of assessment remain unconnected to decisions that matter. Moreover, it suggests to those responsible for students' overall education — deans, provosts, trustees — that academics don't see the educational revolution taking place in front of them.

Articulation. Underlying all these educational and political factors are significant changes in the way people are going to school. A majority of students now attend two or more institutions to complete programs (and almost a fifth attend three or more). [2] Rapid increases in technology-based or distance education raise new issues of quality and confound standard methods of academic accounting (courses and credits). Especially noticeable and problematic in mathematics is the increasing overlap between high school and college illustrated by remedial courses in college, advanced placement courses in high school, and dual enrollment courses in both. [3]

Because these new enrollment patterns are educationally non-traditional, they resist accounting that relies on traditional time-based course credits. And since they are also attractively economical, they increase budget managers' attention to certified outcomes and end-product assessment. Articulation is thus moving from friendly agreements among neighboring mathematics departments who wish to ensure transfer of credits to a hot button state-wide issue that leads to some kind of legislatively enforced outcomes-based accountability "solution."

Mathematicians tend to see their discipline as uncompromisingly hierarchical, so they focus considerable attention on setting prerequisites for courses and planning curricula to ensure that students who enter courses are "prepared." But the increased "swirling" of students among different institutions renders many of these careful articulation plans ineffective if not meaningless.

We are in a new era that demands new approaches. Fortunately, as the accompanying box illustrates, the MAA has a distinctive track record of leadership on these issues that is well recognized outside the bounds of the mathematical community. Members and departments who may only now be awakening to the seriousness of the four A's should not hesitate to build on the work that has already been done.

[1]National Center for Public Policy and Higher Education. *Measuring Up 2002: The State-by-State Report Card for Higher Education.* Available Online at: http://measuringup.highereducation.org/2002/reporthome.htm.

[2]Adelman, Clifford. 1999. *Answers in the Tool Box: Academic Intensity, Attendance Patterns and Bachelor's Degree Attainment.* Washington D.C.: U.S. Department of Education, Office of Educational Research and Improvement.

[3]Clark, Richard W. *Dual Credit: A Report of Programs and Policies that Offer High School Students College Credit*, Pew Charitable Trusts, 2001. ■

Peter Ewell is a Senior Associate at the National Center for Higher Education Management Systems (NCHEMS). Lynn Arthur Steen is Professor of Mathematics at St. Olaf College and a former president of the MAA. Both are members of the SAUM Steering Committee.

CNSF Makes the Case for Science Funding

CNSF, the Coalition for National Science Funding, recently produced a brochure for members of Congress explaining the role and importance of science funding in general and of the National Science Foundation in particular. The MAA is a member of CNSF and participated in the preparation of the brochure. On June 17, CNSF will sponsor its yearly exhibition and reception showcasing research made possible by the National Science Foundation. Over 30 booths will display a wide range of scientific research and education projects. University researchers and educators will be on hand to describe their work to interested Members of Congress and their staffs. Each year, the event draws about 100 Congressional staff, Members of Congress, and White House leaders. To see the CNSF brochure and more information about CNSF activities, visit their web page, http://www.cnsfweb.org.

SIGMAA on RUME Research Conference

As part of its ongoing activities to foster research in undergraduate mathematics education and the dissemination of such research, the Special Interest Group of the MAA on Research in Undergraduate Mathematics Education (SIGMAA on RUME) will hold its seventh Conference on Research in Undergraduate Mathematics Education in Scottsdale, Arizona, October 23–26, 2003. The program will include plenary addresses, interactive plenary panels, contributed paper sessions, and preliminary report sessions. For current information on the program and the call for papers, visit the conference web page at http://www.cs.gsu.edu/~matdnv/rume2003/rume2003.html.

New NSF Program Supports Undergraduate Math/Bio Training

The Directorate for Biological Sciences (BIO), the Directorate for Education and Human Resources (EHR), and the Division of Mathematical Sciences (DMS) in the Directorate for Mathematics and Physical Sciences (MPS) at the National Science Foundation (NSF) are making available opportunities for the scientific community to enhance interdisciplinary education and training for undergraduates at the intersection of the biological and mathematical sciences. The goal is to stimulate development of a future workforce, including teachers and researchers, that is prepared to work in the increasingly many areas where these two disciplines connect. Proposals for this year's cycle are due by June 2. For further details, see the Dear Colleague letter, nsf03037, linked through the New Documents page http://www.nsf.gov/pubsys/newdoc.cfm.

The *Curriculum Foundations* Workshop on Mathematics Preparation for the Major

By Herbert E. Kasube

When it comes to mathematics majors, what mathematical concepts must students master in their first two years of college? What problem solving skills? What broad mathematical topics must students encounter in their first two years? What priorities exist between these topics? These and other questions confronted mathematicians gathered at the Mathematical Sciences Research Institute in Berkeley February 9–11, 2001. As part of the *Curriculum Foundations* Workshop Project, this conference looked specifically at the mathematics major and its needs in the first two years.

The principal conclusion was that the most important task of the first two years is to move students from a procedural/computational understanding of mathematics to a broad understanding encompassing logical reasoning, generalization, abstraction, and formal proof. The emphasis was on the belief that this transition should begin as early as possible in the student's undergraduate career.

Students in the first two years should have the opportunity to sample a wide variety of mathematics. In the past, calculus and linear algebra formed the mathematical foundation during these first two years. Nobody was suggesting the elimination of these "bricks" in the foundation. Rather, alternatives should be available as well. Suggested possibilities include discrete mathematics, number theory, geometry and knot theory. With many students entering our colleges and universities with Advanced Placement credit in calculus offering these alternatives seems even more appropriate.

Workshop participants recognized that mathematics students are headed in many directions. Some (a relatively small number) are headed to graduate school in mathematics, others are planning a career in the secondary school classroom, while others are headed to jobs in industry. Academic advising takes on a very important role and must be approached thoughtfully. A one-size curriculum does not fit all!

Essential themes should be threaded through different courses. One such theme is the nature of mathematical language and knowledge, which includes basic logic, the role of definitions, statement versus converse, and the nature of proof. Other themes are more specific — the concept of function, approximation, algorithm, linearity, and dimension.

The group also compiled a list of skills with which students should gain proficiency during these first two years. These skills include (but are not restricted to) standard computations, visualization, geometric skills, translating mathematics into words (and vice-versa), recognizing incorrect statements or answers, and communicating mathematics both orally and in writing.

It is important that there be a balance between computational skills, conceptual understanding, theoretical reasoning, and applications. This balance can help ease the transition to subsequent courses.

The role of technology was discussed and it was noted that students should have experience with "appropriate" use of technology. This may involve the use of graphing calculators, but is not restricted to such usage. In particular, students should have some experience with computer algebra systems during the first two years.

Many mathematics departments across the country have recently noticed a decline in the number of mathematics majors. Where do these majors start? They start in the courses during the first two years. Workshop participants agreed that recruitment and retention of mathematics majors is an important concern. A well-designed mathematics curriculum in the first two years can draw in and keep prospective mathematics majors. Suggestions included actively pursuing students who perform well in these early mathematics courses, encouraging them to consider a major in mathematics. Specific recruitment suggestions included presenting topics and activities in these courses that will attract students to mathematics, enriching these courses with a wide variety of applications, and including students in the "life" of the mathematics department. This last suggestion could involve formation of an active math club, possibly a student chapter of MAA or a Pi Mu Epsilon chapter. Anything that would help a student "identify" with the mathematics department will help with retention. This must be done seriously and early in the student's college experience.

This workshop was just a part of a part of a massive effort by MAA's Committee on Curriculum Renewal Across the First Two Years (CRAFTY) to determine the interests of partner disciplines. To see all of the reports generated by the *Curriculum Foundations* Workshops watch for the upcoming MAA Report entitled *A Collective Vision: Voices of the Partner Disciplines*, edited by William Barker and Susan Ganter. ■

Herbert Kasube was a participant in the CF Workshop on Mathematics Preparation for the Major at MSRI and is a member of both CRAFTY and CUPM. He teaches at Bradley University.

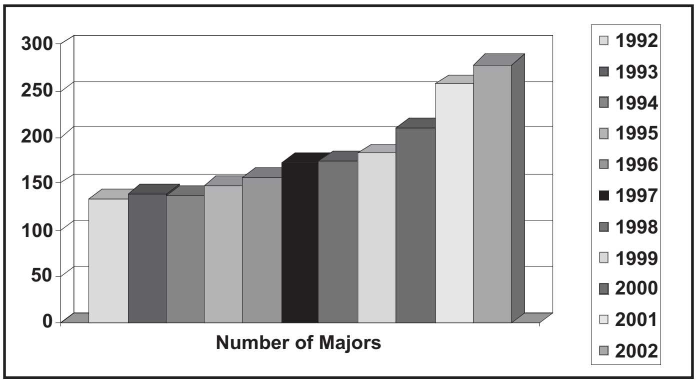
Other *Curriculum Foundations* Articles in FOCUS

- Biology–March 2003
- Chemistry–August/September 2002
- Computer Science–May/June 2002
- Engineering–December 2002
- Interdisciplinary Core Mathematics –August/September 2002
- Mathematics for Health and Life Sciences–November 2002
- Physics–March 2001
- Statistics–December 2002
- Technical Programs in Two-Year Colleges–November 2002

One School's Success in Recruiting Mathematics and Computer Science Majors

By Curt Jones, Lisa Lister, and John Polhill

While the overall enrollment of students in college has been increasing nationwide, the number of mathematics majors has been decreasing since 1990. The Mathematical Association of America's Committee on the Undergraduate Program in Mathematics (CUPM) has developed the draft of a curriculum guide that discusses this issue, among others, in undergraduate mathematics (online at http://www.maa.org/cupm/). The draft notes that there are some exceptions to this downward trend. The Department of Mathematics, Computer Science, and Statistics at Bloomsburg University has been successfully growing in terms of majors since 1994. Recruitment has been a university-wide goal since 1999 and, in particular, the goal set for mathematics and computer science is to achieve a 5% increase in the number of majors from 1999 to 2004. Our Department has far surpassed this mark by implementing a variety of initiatives.



Bloomsburg University is a four-year state college in Pennsylvania, with about 7500 students. Nearly all of our students come from Pennsylvania, New York, and New Jersey, with 90 percent from Pennsylvania. Due to this fact, it makes sense for us to have outreach programs for area high school students.

High School Contests

One of the primary recruitment tools is our high school programming and math contests. These contests not only recruit participants, they also show our Department and the university in a positive light. Teachers who bring teams to compete see that Bloomsburg University is a place where students get a quality education, and enjoy personal interaction with their professors.

Members of our student chapter of the Association for Computing Machinery (ACM) suggested a high school programming contest as a method of introducing Bloomsburg University to prospective students. We face the challenge that Bloomsburg is in a rural area of Pennsylvania and there are few local high schools to attract to the contest. We must ensure that the participants enjoy their day on our campus and feel successful during the competition, since we want them to speak positively of the contest and our university to fellow students at their school. We also want the advisors to convince their administrators of the educational value of our contest and encourage other high schools to attend in future years.

In order to ensure that the participants enjoy our event, we deviate from some normal contest methods. First, each team brings their own equipment and uses their own software. This way, we need not worry about equipment failures during the contest and high school students need not learn new systems on our campus. Second, teams consist of four students. This allows the students to work in pairs so that no team member feels isolated. Third, we have the students solve ten problems that are structured in difficulty so that most teams will solve at least four to six problems during the three-hour contest. The top teams typically solve all ten, while every team solves two to three problems. Our student volunteers help struggling teams with words of encouragement, and if a submitted solution is not correct the team is told what is wrong.

Our efforts have been rewarded. We started the contest in 1995 with 20 teams and now host 45 to 50 teams from 25 different schools each year. Some of these teams travel over two hours to attend our contest. Each year new schools request to be included in the contest and our feedback has been very positive. In order to accommodate so many teams, we have roughly 10 faculty and 25 students help with the contest each year.

With the success of the Programming Contest, we decided to develop a Math Contest. We started five years ago with about 75 students and advisors from five to ten area high schools and now draw 200 attendees. We allow schools to bring at most four teams of four students each to compete in a daylong competition.

The Math contest consists of three parts: Quiz Bowl, Game of 24 Points, and Brainteasers. During the morning we have the Quiz Bowl and Brainteasers. The Quiz Bowl is a fast paced Jeopardy type contest with questions from algebra, trigonometry, geometry, basic statistics, and logic. Teams compete in pairs, with the 16 highest scoring teams advancing to the next round. After the first round, the winners of each match advance to subsequent rounds. While teams are waiting for their turn to compete in the Quiz Bowl, or if they have been eliminated, they work on the Brainteasers. Brainteasers is a written exam of 25 to 35 weighted mathematics problems and logic puzzles. The teasers are graded as either right or wrong and the highest score wins.

In the afternoon we play the Game of 24 Points. This is a version of a well-known card game in which four cards are dealt from a standard deck with the face cards removed. Using addition, subtraction, multiplication, and division, students must try to get the number 24. This is a simple game that the students enjoy, but it does have the flaw that, when practiced, patterns can be memorized. To even the playing field, we change the number they need to obtain during different rounds of the competition. Any number from 22 to 26 has a high probability of being obtainable from a random selection of four cards.

For both contests we do charge a nominal entry fee for each team. This is supplemented with university funds. Each student gets a tee-shirt, a certificate of participation, and lunch, while the advisors also receive a tee-shirt and lunch. The members of the top team are each offered a Bloomsburg University scholarship, provided by the Bloomsburg University Foundation. In the programming contest, the top six teams are given a plaque and the top six schools get to pick prizes from a collection of awards ranging from new computers and scanners to graphing calculators and books. In the math contest, the top three teams for each of the competitions receive a plaque, and a prize such as a student-version of Mathematica.

Visits from High Schools

Throughout the academic year, area high school math classes visit our Department. Typically, 20-30 juniors come to the campus for a day in which students engage in some fun mathematical activities. At the same time, the accompanying high school teachers get to know our faculty and campus in a positive and enjoyable environment. When the high schools visit, the students and advisors see that the professors in our Department are very interested in education and will go out of our way to help students learn.

The campus visits begin with a tour of the campus and our facilities. This tour allows the students to get a better feel for the University. For some of the kids, it is the first time they have been out of their hometown and the trip to Bloomsburg is quite a big experience for them. We have one or two of our majors give the tour so students can ask them questions about being students in the Department and at the University.

After the tour, students participate in three hands-on technology lessons. These lessons have been traditionally an introduction to Geometer's Sketchpad, the TI-92 Calculator, and Mathematica. The activities are meant to show students how technology can be used in applications of mathematics and introduce the advisors to some of the technology that is available. For example, in the TI-92 presentation, students are given a brief introduction to the calculator and then work on an activity, which uses Newton's Law of Cooling to solve a murder mystery. In the Mathematica presentation, students were looking to optimize volume of different objects. These activities are to show students that math can be fun and useful.

Visits to High Schools

Department faculty members have two opportunities to visit area high schools. The first is through a statewide project known as CETP-PA, which stands for Collaborative for Excellence in Teacher Preparation in Pennsylvania. With this program, professors in mathematics and the natural sciences have the opportunity to co-supervise student teachers with education faculty. The goal is to have faculty from the student's primary subject area attend two classes taught by each student teacher during the course of the semester.

The other program is a high school speakers program, which is our own initiative. With this project, our professors visit high schools in order to present information on some interesting topic in mathematics or computer science. Such topics have included math and sports, game theory, and cryptology.

With both programs, a major benefit to the Department is the opportunity to interact with area high school students and teachers. They can see firsthand that our faculty members care about giving students a quality education, and teach mathematics enthusiastically.

Open Houses

Every semester, the university has an open house. Seniors from area high schools have the opportunity to visit the Bloomsburg campus and meet with faculty from various departments. Our Department has a representative professor from both mathematics and computer science, and student representatives as well. During our presentations, we give each student a packet of information describing the attributes of our Department. We also take students on a tour of our facilities, including our new computer lab. This is yet another opportunity for high school students to see that our Department has an open door policy for students.

The rewards of our efforts include an increased recognition of our Department, the recruitment of new students, and the increased satisfaction of our current students. Our ability to run these programs is dependent on the fact that nearly all of the professors in our Department contribute to the effort in some way. In fact, many are involved with more than one of these programs.

Our efforts have been extremely successful. As shown in the chart on page 10, we have more than doubled the number of majors in our Department since 1992. In fact, in a time when many universities are losing majors, our numbers have grown from 210 in 2000 to over 275 majors in 2002. We will continue to actively recruit students to our Department and University while we make efforts to keep those students that we already have.

We strongly encourage anyone considering the problem of student recruitment and retention in mathematics to have fun doing so. Small initiatives can make a difference. For more ideas, you are welcome to contact us or check out the CUPM draft on the MAA web site. ■

The authors teach at the Department of Mathematics, Computer Science and Statistics at Bloomsburg University of Pennsylvania. All three authors can be reached by email: cjones@bloomu.edu, llister@bloomu.edu, *and jpolhill@bloomu.edu.*

An Unintentional Discovery of the Quadratic Formula

By Robert Weinstock

Sixty-seven years ago, pupils in Philadelphia schools (and probably elsewhere) didn't normally face quadratic equations until eleventh or twelfth grade. The initial encounter involved readily factorable quadratic polynomials ("quadratics") with integral coefficients and real rational roots. The aim, of course, was to determine these roots. Next learned was a procedure that some of the pupils found rather exciting: determination of (real) roots by means of graphs: Plot the polynomial on graph paper; locate the x-values at which the graph crosses the horizontal axis — and there you are. (Introduction of the "quadratic formula" for root determination lay ahead; and the possibility of non-real roots remained a secret kept from the pupils for at least one class after the formula had arrived.)

After solving several quadratics via graphing, one lad happened to notice that all the solutions conformed to a uniform pattern:

1) Most obvious in it was the symmetric location of the two roots with respect to the value of x at which the graph's lowest point was seen. (Each of the quadratics he had been given to graph had positive x^2 coefficient.)

2) The value of x at which each graph's lowest point appeared could be calculated as minus the coefficient of x divided by twice the coefficient of x^2— that is, as ($-b/2a$) for the quadratic $ax^2 + bx + c$.

3) The horizontal distance between the x-value achieving the minimum and each of the points at which the graph crossed the x-axis could be evaluated in two steps: (i) by dividing of the vertical distance of the graph's lowest point from the x-axis by the coefficient of x^2, and (ii) by taking the square root of this quotient.

Thus the two roots were determined as

$$x = -\frac{b}{2a} \pm \sqrt{\frac{(\text{vertical distance from } x\text{ - axis to graph' s lowest point})}{a}}$$

or, equivalently, as

$$x = \pm\frac{b}{2a} \pm \sqrt{\frac{(\text{minus value of quadratic at } x = \pm b/2a)}{a}}.$$

However, the observant youth, while still in high school, never expressed his observation in writing. He confined his presentation of it to oral delivery only, usually with a finger pointing at the graph of a quadratic held in hand. To his disappointment, no one he showed it to was much interested.

Directly after his discovery the youngster behaved scientifically: he tested it on several additional examples. It always worked, of course. He became convinced that he had discovered a new way to solve quadratic equations. He was rather pleased with himself.

But soon the class learned of the possibility of non-real roots and about complex numbers in general. It was in this context that the class was introduced to solution by means of the "quadratic formula":

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

It was obvious, of course, that the graphical method is useless for solution of quadratics having non-real roots; the graph nowhere crosses (or even touches) the x-axis! So there went the "new way" of solving quadratic equations — out the window. It worked only for real roots.

But the youngster of real-root empirical success, having used the solution formula to obtain the non-real roots of a particular quadratic, constructed the graph of that quadratic, and eventually emerged with the following pertinent observations:

1') The real part of both solutions was the value of x at which the graph exhibited its lowest point. (All of a, b, and c in the example were real, of course; moreover, $a > 0$.)

2') The value of x at which the graph's lowest point resided was ($-b/2a$), the same as in the real-roots case.

3') The coefficients of "i" in the previously obtained roots were, respectively, plus and minus the quantity obtained in two steps: (i') division of the vertical distance from the x-axis to the graph's lowest point by the coefficient of x^2, and (ii') taking the square root of this quotient. (He must have been guided to this recognition by the success of step 3) in the real-roots case.)

Thus the two roots were determined as

$$x = -\frac{b}{2a} \pm \sqrt{\frac{(\text{vertical distance from } x\text{ - axis to graph' s lowest point})}{a}}$$

or, equivalently, as

$$x = \pm\frac{b}{2a} \pm i\sqrt{\frac{(\text{value of quadratic at } x = \pm b/2a)}{a}}.$$

Furthermore, since $i^2 = -1$, it took little time for the lad to rewrite this last result:

$$x = -\frac{b}{2a} \pm \sqrt{\frac{(\text{minus value of quadratic at } x = -b/2a)}{a}}$$

— the very formula that worked when the quadratic had real roots only! Perhaps he had after all discovered a new way to solve quadratic equations.

Next, of course, came the routine tests: comparing use of the young scientist's formula with what came out of the textbook's "quadratic formula," applied to several quadratic equations. And, of course, the results always coincided, whether the quadratic's roots were real or non-real. He had, he was again convinced, discovered a new method of solving quadratic equations.

It wasn't until after high school graduation that he came upon the notation

$$f(x) = ax^2 + bx + c$$

for quadratics and, analogously, for functions in general. He was thus able to write his empirically established result as

$$x = \pm\frac{b}{2a} \pm \sqrt{\frac{\pm f(\pm b/2a)}{a}}.$$

And not long afterward he computed

$$f(-b/2a) = a(-b/2a)^2 + b(-b/2a) + c = -\left(b^2/4a\right) + c$$

so that his "new" formula read

$$x = \pm\frac{b}{2a} \pm \sqrt{\frac{\left(b^2/4a\right) \pm c}{a}} = \pm\frac{b}{2a} \pm \sqrt{\frac{\left(b^2 \pm 4ac\right)}{4a^2}}$$

$$= \frac{\pm b \pm \sqrt{b^2 \pm 4ac}}{2a}.$$

Yikes! Exactly the same as the long-established quadratic formula. The young man had *not* found a new way to solve quadratic equations. On making *this* discovery he stopped mentioning to others his earlier supposed achievement. He kept his chagrin to himself.

It wasn't until many years later that — no longer a youth, a septuagenarian in fact — he embarked on serious thought about his early quadratic experience, with the eventual realization that it had not been so trivial an exercise as he had once concluded. He had, after all, accomplished an—*empirical* discovery of the general formula for solving the quadratic equation. Today, no longer a septuagenarian, he of course wonders: Has any one else ever done it? ■

Robert Weinstock is Emeritus Professor of Physics and Astronomy at Oberlin College. He can be reached by email at zweinsto@oberlin.net.

Meeting the Challenges: Education Across the Biological, Mathematical, and Computer Sciences

By Victor Katz

Are the mathematics and biology communities "meeting the challenges"? That was the basic question for the conference of that title held in Bethesda, MD from February 27 to March 1, organized by the MAA, in conjunction with the American Association for the Advancement of Science and the American Society for Microbiology, and with support from the National Science Foundation and the National Institute of General Medical Sciences. As we know, mathematics is becoming increasingly important in biological and biomedical research, but the education of biologists frequently contains little mathematics, while mathematicians, who usually know little biology, have a difficult time incorporating biological examples into mathematics courses. The "challenges", then, are the difficulties inherent in integrating biology, mathematics, statistics and computer science more effectively in undergraduate curricula.

The MAA Committee on the Undergraduate Program's Subcommittee for Curriculum Reform Across the First Two Years (CRAFTY) held one of its *Curriculum Foundations* Conferences on the Mathematical Curriculum for Health and Life Sciences Students in May, 2000 and shortly thereafter issued a report that addressed this issue. (A summary of this report appeared in the November 2002 issue of *FOCUS.*) In particular, agreement was reached that core topics for biology students should include the basic notions of calculus, probability, approximation, logic and mathematical thinking, and deductive reasoning, as well as some work with statistics and computers. Courses containing these topics should put special emphasis on the use of models, both as a way of organizing information about and providing intuition into systems that are too complex to understand otherwise.

From the biology side, the Committee on Undergraduate Biology Education to Prepare Research Scientists for the 21st Century, organized by the National Research Council, issued a report entitled *BIO2010: Transforming Undergraduate Education for Future Research Biologists.* It suggested even more mathematics, including aspects of probability, statistics, discrete models, linear algebra, calculus and differential equations, modeling and programming. And in computer science, although many universities now offer courses on the computational techniques needed to deal with the data generated by current biological research, the challenge is to convince biology majors to enroll.

One of the purposes of the "Meeting the Challenges" conference was to bring together mathematicians, biologists, statisticians, and computer scientists to try to come up with models for the mathematical education of biologists for the twenty-first century. In addition, the participants were charged with proposing solutions to the twin problems of biology faculty without strong mathematics backgrounds and mathematics faculty without strong biology backgrounds. Finally, they were to look at methods for attracting more students into the biological sciences, students who would become the researchers of the future.

One solution to the last challenge was described by Michael Summers, of the University of Maryland Baltimore County in the opening plenary address of the conference. Summers described the Meyerhoff Scholars program of UMBC, in which bright high school students, mostly from minority backgrounds, are recruited to come to the University, major in a scientific field, and commit to going on for a Ph.D. These young men and women are mentored on a continuing basis throughout their undergraduate years to make sure that they succeed, beginning with a summer bridge program before their freshman year. They also participate fully in on-going research problems with senior faculty. This program has had great success since its founding in 1988, with a very large percentage of those accepted either having completed a Ph.D. or being actively at work toward the degree.

Although most universities and colleges will not have grants from the Meyerhoff Foundation, they generally have little trouble in attracting and retaining biology majors. What is difficult, however, is retaining minority students and insuring that biology students, whether at UMBC or elsewhere, understand and act on the need for more mathematics in their courses. Thus UMBC's method of involving students early in research projects was discussed frequently at the conference, with the additional suggestion that these projects themselves use mathematics. There are many aspects of introductory biology courses that lend themselves to such projects, so faculty, whether in biology or in mathematics, will need to inform themselves of the possibilities available for student support. Another frequent suggestion was that, because numerous job opportunities in mathematical biology are becoming available, students whose interests are in mathematics should be introduced early to the applications of mathematics in biology. Also, even at the high school level, faculty making recruiting visits should use the occasion to introduce students to these new career opportunities. In particular, it is important to show students contemplating medical school that there are amazing opportunities in biomedical research to solve some of the basic questions about the nature of life, questions that will lead to new methods of eliminating diseases that affect so many. But these opportunities are only available with a sufficient knowledge of mathematics.

Participants in the conference considered carefully the issues of faculty development. After all, how can mathematics faculty be enthusiastic about opportunities in biology unless they are themselves conversant with the subject? How can they introduce biological examples in mathematics classes if they are not comfortable with the biology? Thus it is imperative to introduce programs to educate mathematicians about biology. The MAA is already attempting this, through some of its professional development workshops under the PREP program. But there is certainly room for much more. The important ingredient for success in faculty development, it was agreed, was to bring biologists and mathematicians together to discuss their subjects. Summer institutes are useful for this purpose, but so are joint mathematics-biology colloquia, especially if they are held regularly. Perhaps we need also to look at the IFRICS model of the 1970s, the Institutes for Retraining in Computer Science. At that time, there was a shortage of computer scientists to meet the demand for computer science courses, so many mathematicians participated in these institutes to learn how to teach computer science. This program helped bridge the gap until the supply caught up with the demand. Today, given the shortage of biologically trained mathematicians ready and able to teach biological applications in mathematics course, it may be worthwhile reviving that model for the next decade or so.

Of course, not only must mathematicians better understand biology, but also biologists must better understand mathematics. Many current biology faculty had very little mathematics in their own education, and sometimes even claim that mathematics is unnecessary in their particular biological specialty. But what is becoming increasingly clear is that virtually every area of modern biology requires mathematics, and the level of the mathematics required is increasing rapidly. A glance through biology journals will confirm this. Thus biologists need to participate in the same institutes as the mathematicians, where ideas can be shared in both directions and even where new ideas for joint research projects can be developed.

A point that was made consistently throughout the discussions at the conference was that biology courses need to incorporate the mathematics that we insist that biology students learn. Too many introductory biology texts today, and the courses that depend on them, leave out the mathematics, or discuss it only peripherally. To help students understand the relevance of mathematics to their future careers in biology, it is necessary to incorporate mathematics at even the earliest level of biology. If the textbooks do not do so, then it is imperative that faculty supplement their texts with some of the modules that have been developed for just this purpose. (See http://www.bioquest.org for examples of modules and other educational materials.) An ideal situation, of course, would be to have mathematicians and biologists teach some of these courses jointly. As we know, however, interdisciplinary courses are frequently difficult to implement. Yet they have had success in some universities, and if faculty push hard enough for them, they can be taught.

Interdisciplinary courses, of course, reflect the model of much current research, namely that it is done in teams. Thus, it is not necessary for everyone in a course or in a research project to know all the mathematics or all the biology. As long as the participants can communicate with one another, a mathematics-biology research project can be accomplished with each participant using his or her own knowledge and skills. Thus, another major suggestion made consistently was that faculty should take every opportunity to participate in joint biology-mathematics projects. And as these take place, the participants will learn enough about each others' subjects to be able to communicate effectively with students in their own discipline.

The discussions that consumed the most time at the conference revolved around curriculum. What mathematics must be taught to future biologists and biomedical researchers? As already noted, CRAFTY has made its own suggestions and the BIO2010 report has made others. Numerous colleges already have revamped the mathematics courses required by biology majors to incorporate some of these suggestions. Lou Gross, of the University of Tennessee, Knoxville, one of the plenary speakers at the conference, described the successes at his own school with a new mathematics course as well as the inclusion of more mathematics in biology courses.

The incorporation of mathematics into biology over the next decades may eventually convince enough students and their universities that biology in the twenty-first century is analogous to physics in the twentieth. Thus programs for biology majors will involve heavy doses of mathematics, and many prospective biologists, like their physics counterparts, will even have a minor in mathematics, taking courses in differential equations, advanced calculus, and abstract algebra.

At present, however, the majority of universities will not ask biology majors to take more than two or three mathematics courses. So if these students are to learn at least some of the mathematics they will need in the future, it appears that mathematics faculty must develop specially designed courses appropriate for biology majors. A three-semester sequence of courses is probably the most that the great majority of biology major can include, but from various models at colleges and universities around the country, it appears that one can accomplish quite a bit in that time frame. In order to do this, as CRAFTY suggests, mathematical modeling must be at the heart of the course. We must carefully choose biology problems that can be modeled by increasingly sophisticated mathematics as one works one's way through the courses. Early on, one might be satisfied with the elements of probability and statistics and with the notion of drawing and interpreting graphs of various types of functions. Later, one needs to develop the ideas of calculus as well as more sophisticated statistics which would enable students to work with the huge data sets so common in biology. Finally, one has to develop the basic ideas of linear algebra as well as differential equations and dynamical systems.

The Meeting the Challenges conference was a unique opportunity for faculty from mathematics, biology, and computer science, as well as representatives from industry and the professional organizations, to meet and learn about each other's concerns. There were five plenary speakers. Besides Summers and Gross, they included Mary Clutter, the Assistant Director of the Biological Sciences Division at the NSF, Judith Ramaley, the Assistant Director of the Division of Education and Human Resources at the NSF, and James Cassatt, the Director of the Division of Cell Biology and Biophysics at the NIGMS. Each of these speakers emphasized the increasingly interdisciplinary nature of science and urged faculty to overcome disciplinary boundaries in designing new programs. Ramaley, in particular, noted that our job is to prepare people who will do Good Work, in the words of the authors of a new book by Howard Gardner, Michaly Csikzentmihalyi, and William Damon. And good work requires greater expectations, which can only be met through our students' mastery of the knowledge and skills necessary to study the natural world, mastery that must be enhanced by a strong responsibility for personal actions. (For more on the Great Expectations project of the American Association of Colleges and Universities see http://www.aacu.org/gex/index.cfm.)

The major work of the conference took place in cross-disciplinary working groups that discussed issues of curriculum, faculty, and students. The participants then met in disciplinary groups to review the recommendations. The report to come out of the conference will be written by the group leaders and recorders, among others, and will be edited by Lynn Steen, of St. Olaf College. It will include numerous examples of mathematics and computer science in biology, examples designed to make the point to the nation's stakeholders that it is crucial for the future to develop biology researchers better trained in mathematics and computer science. The report is expected to be available at the 2004 Joint Mathematics Meetings. But even before the issuance of the report, it is important that mathematics departments take seriously the CRAFTY recommendations and begin thinking about the needs of biology students. It is imperative that we as mathematicians "meet the challenges" of educating the biology students of the twenty-first century, so that their research into the nature of life itself can benefit all of us. (See http://www.maa.org/mtc/welcome.html for more information on the conference and for related reports and articles.) ■

Victor Katz is Professor of Mathematics at the University of the District of Columbia.

NAM and MAA Together

Dr. Cheryl Peters, Academic Dean, Houston Community College System (HCCS) – Central College, attended the MAA Winter meeting for the first time. Prof. Wade Ellis, who will be the presenter of a MAA Prep workshop at HCCS-Central in May 2003, is pictured with Dr. Peters during the NAM banquet. HCCS is the second largest two-year college in the United States. The National Association of Mathematicians (NAM) has as its goals "the promotion of excellence in the mathematical sciences and the promotion of the mathematical development of under-represented American minorities."

MAA Past-President Ann Watkins at the NAM banquet in Baltimore, flanked by Dr. Johnny Houston, Dr. Frank Hawkins, Dr. Irvin Vance, Dr. Leon Woodson, and Dr. A. Shabazz. Visit NAM on the web at http://www.caam.rice.edu/~nated/orgs/nam/ or http://www.math.buffalo.edu/mad/NAM/index.html. (Photos by J. B. Giles, used by permission.)

Bridging the Gap: A Mathematician's Challenge

By Laurie Burton

Given the shortage of mathematics educators and the MET document's call for expanded and enhanced course offerings, it is inevitable that mathematicians will be asked to teach some of the mathematics courses for future K–8 teachers. However, designing and managing successful courses for future K–8 teachers is more complex than a mathematician might, at first, imagine.

Training non-mathematics majors to have a deep understanding of the K–8 mathematics curriculum is not simply a matter of teaching new mathematics content. Instead, the goal is to train future teachers to understand the structure, procedures and nuances of elementary mathematics. When I was introduced to the curriculum of K–8 mathematics education courses, I found myself facing new challenges and adjusting to a new set of teaching and learning objectives. I would like to share what I learned with mathematicians who wish to add the mathematical preparation of K–8 teachers to their teaching repertoire.

My Background

After I graduated from the University of Oregon with a Ph.D. in mathematics, I spent four years as a typical enthusiastic junior faculty member at a public undergraduate institution. I embraced reform methods, engaged my students in collaborative learning and was an active member of Project NExT. My interaction with education majors consisted of working with the future high school teachers in my classes and teaching summer graduate courses for in-service high school teachers. I enjoyed working with these teachers and found myself increasingly interested in the mathematical education of all future K–12 teachers.

I eventually had the opportunity to join the mathematics faculty at Western Oregon University and work in their "already exceeds the MET recommendations" teacher preparation program (we have twelve mathematics education courses designed specifically for K–8 teachers). As part of my new position, I became an OCEPT Fellow and was asked to update the curriculum for several of our K–8 mathematics education courses.

The recommendations that follow are based on my own experience teaching mathematics education courses. They are not meant to be exhaustive. They are simply ideas that a mathematician working with future teachers developed with the advice of practiced mathematics educators and quite a bit of trial and error.

Professional Development

Recommendation: Seek formal professional development opportunities.
As a first step, I attended conferences and workshops designed to facilitate effective teaching for teacher education courses. This intensive exposure to curriculum topics and presentation approaches opened my eyes to many of the instructional methods I would need to integrate into my own mathematics education courses. Professional development is now widely available to mathematicians interested in teacher education. The MAA, for example, is increasing their offerings of workshops for the development of teacher training skills in their PREP and PMET programs.

Recommendation: Seek the advice of experts.
I sought out and talked to noted mathematics educators at local universities. These colleagues were very helpful. They recommended curriculum and assessment sources and shared ideas about effective classroom design for future K–8 teachers. One colleague, for example, introduced me to an application of modular arithmetic appropriate for use with future K–8 teachers. This helped me to understand the level at which I should approach these students and piqued my interest as an algebraist.

Recommendation: Collaborate with your colleagues in the education department and join them in K–8 classrooms.
At my university I was able to find like-minded colleagues in the education department. We scheduled time together and coordinated the syllabi and the structure of the mathematics education content courses taught in the mathematics department with the mathematics pedagogy courses taught in the education department. Additionally, we occasionally visit local classrooms together, which provides me with a critical awareness of the mathematics my students will be expected to master and teach.

The Classroom and the Students

Recommendation: Use appropriate classroom models.
I first attempted to implement new teaching and learning strategies by presenting "mini-lectures" followed by collaborative group work. This did not work well. Merely presenting basic information to students who already know the details of elementary algorithms does not generate the critical thinking that leads to the lasting foundation of mathematical understanding these students need. With the help of experienced educators, I kept changing my instructional methods and procedures until I found a more successful approach. My current model for mathematics education class design is roughly as follows:

- To set the stage, I quickly target the main ideas of the lesson for the students.
- To encourage focused and active deliberation on the material, I supply in-depth, hands-on, visually supported collaborative activities. These explorations include questions about how the mathematics works and how one explains the mathematical topic under consideration. The students work in groups, often with manipulatives, and my

role is to constantly circulate, listen, answer questions, and solicit explanations.

- To follow up the group work, I use discussion and frequent (student) presentations of problem solving approaches. Future teachers see that a variety of solution paths often lead to the same conclusion and this helps to create flexible teachers. This also fosters verbal fluency in the explanation of mathematics concepts.

The goal of this class model is to allow the students to understand the content intuitively, to bridge to algorithmic approaches, to practice explaining mathematics and to create long-lasting meaning out of their course curriculum. Students in this type of course use their in-class work as a resource, successfully work out and explain problems, and demonstrate knowledge retention and in-depth understanding on exams.

Recommendation: Use appropriate curriculum materials.
There are many fine texts and corresponding activity books available for the first year of mathematics education courses for future K–8 teachers. See http://www.wou.edu/~burtonl/ for a list of curriculum resources for more advanced courses.

Recommendation: Use appropriate assessment techniques.
Standard assessment practices (homework and exams graded on procedure and success at achieving the correct answer) are not appropriate for mathematics education courses. In most of my mathematics education courses, *I assume my students can already solve the mathematical problems we are considering.* My goal is usually not to teach them new mathematical skills, but to help students thoroughly understand how known algorithms work. Some assessment techniques that I currently implement are:

- Requiring careful written explanations in the homework assignments. Students learn by explaining and illustrating how elementary mathematics works.

- Assigning book and teaching journal reports. This helps the students gain perspective on how the mathematics they are learning is connected to their future classrooms and introduces them to valuable resources.

- Asking students to do term projects involving the design of simple lesson plans and student activities for the elementary or middle school classroom. These projects relate the current course topics to the topics my students will eventually be teaching.

- Assigning small-group final presentations (games, lesson plans, etc.). This encourages cooperative work outside of the classroom as well as inside and helps students learn to work as an effective team.

- Using in-class, take-home, and oral exams. Students are asked to explain their procedures and to sketch out or show visual models that demonstrate their understanding of the topic.

I try to use assessment procedures that examine the students' knowledge at a variety of levels, introducing them to techniques they might use in their own classrooms and allowing for a variety of learning styles. Mathematics education students generally embrace these goals and feel much less intimidated by these evaluative procedures than by the usual kinds of mathematics assessment. This helps me create a positive learning atmosphere but permits effective evaluation of students' knowledge.

Recommendation: Expect motivated and successful students.
Students interested in careers as teachers are frequently the most enthusiastic and responsible of students. They will be training the next generation of students and deserve respect, support, and an opportunity for genuine mathematical advancement. Many K–8 teachers have not taken and will never take higher level mathematics (calculus and beyond). Some K–8 teachers, like many other people, feel that studying mathematics is cause for anxiety and that success in mathematics is beyond their reach. It is critically important that all future teachers, particularly those with misconceptions about their ability to succeed in basic mathematics, be allowed to develop their mathematical power in a friendly and helpful classroom.

Two Typical Students

Linda is energetic, extremely bright and has never taken any "pure" mathematics courses beyond high school. She plans to teach mathematics at the middle school level and is required to successfully complete eleven 3-quarter hour mathematics education courses. Linda turns in highly detailed work, which is full of insightful comments. Linda is often in my office, she wants to know everything and she is intensely intellectually curious. Her intellectual skills, her constant desire to learn and her drive to succeed ensure that she will be a dynamic middle school mathematics teacher.

Dianne has also never taken any "pure" mathematics courses beyond high school. She plans to teach at the fourth or fifth grade level and, with her focus in mathematics at the elementary school level, is taking eight 3-quarter hour mathematics education courses. Dianne is a quiet, somewhat shy student who frequently struggles with the mathematical concepts in my advanced mathematics education courses, especially at the beginning of the term. However, Dianne has a remarkable work ethic and an intense desire to learn. In several classes, Dianne submitted almost unbelievably outstanding final projects. Given the appropriate time and support, she was able to develop, on her own, detailed lesson plans and activities that elementary school children would love. Furthermore, these lessons demonstrated her deep grasp of the exact mathematical points emphasized in the course. Additionally her projects are some of the most creative term projects I have ever seen. Dianne creates her own success and will clearly be an asset to her future students.

These two students are particularly noteworthy, but in fact are surprisingly representative of mathematics education students at WOU. Their skills are built over time and flourish in an atmosphere emphasizing knowing and understanding elementary mathematics. In large part they are successful because they have had the opportunity to participate in a wide variety of mathematics education courses designed specifically for K–8 teachers. This is clear evidence that creating appropriate training opportunities for future teachers is an effective and worthwhile endeavor.

I believe it is no longer appropriate for mathematicians to consider themselves a separate community from mathematics educators. The need for quality education of our future teachers is just too great. Furthermore, entire departments should commit to, value and encourage participation in teacher education. Who will take the first steps in your department to enhance the mathematical education of teachers in your community? Will it be you?

Acknowledgement: Thanks to the collegial writing support through WRITE ON!, an OCEPT writing retreat to help make this article possible (DUE-9653250). ■

Laurie Burton (burtonl@wou.edu) is a Mathematics Education Specialist at Western Oregon University and will be co-directing a PREP workshop about K–8 teacher education this summer (http://www.wou.edu/~burtonl/).

NSF Beat May 2003

By Sharon Cutler Ross

How do people learn mathematics? How do we best teach mathematics? The NSF's Research on Learning and Education (ROLE) program has made an initial round of awards for research into these and other questions about learning. The mathematics-related awards are summarized below. ROLE supports research related to human learning in the areas of brain research, behavioral, cognitive, affective, and social aspects of learning, and the learning of mathematics, science, engineering, and technology in informal or formal settings and in complex educational systems.

At Carnegie-Mellon (J. Anderson, PI), research is underway to improve tools for tracking how students solve mathematical problems. Both eye-movement scanning and fMRI imaging are being used to find improvements for a cognitive tutor that is being adapted for use in middle schools.

Improvement in the preparation of African-American students for algebra and higher mathematics is the goal of the ROLE project coordinated by Lesley College (F. Davis, PI). Schools in three urban settings form the research ground for identifying successful practices that increase the proportion of minority students who successfully complete algebra and enter college preparation tracks in high school.

An exploration of the interactions among diverse, connected classroom technologies is the prime activity of the project at University of Massachusetts-Dartmouth (J. Kaput, PI). Three areas of impact are considered – assessment, learning structures, and teaching. The goals are to inform iterative improvement of technological practices that support learning and of teacher development and support structures.

At Boston College (M. Martin, PI), rethinking and reconceptualizing the fifth international study of mathematics and science is supported by a ROLE award. Based on experience with previous assessments, such as TIMSS, frameworks for assessments in mathematics and science will be developed.

Ways to nurture and cultivate mathematical imagination are being investigated at TERC, Inc. (R. Nemirovsky, PI). A series of studies with teachers seeks to confirm that cultivating mathematical imagination is related to effective learning of mathematics.

The University of Colorado-Boulder (A. Perissini, PI) is continuing a study of two reform-based teacher education programs by following a group of pre-service teachers through their second year of teaching. Of particular interest is how teacher education impacts their learning and development as teachers.

The ROLE project at MIT (E. Spelke, PI) seeks to shed light on the teaching and learning of mathematics through a series of studies involving monkeys, infants, children, and adults. The goal is to investigate the sources of mathematical thinking throughout the developmental spectrum. ■

Sharon Cutler Ross is a member of the FOCUS and MAA Online editorial board. Her NSF Beat *column appears regularly in FOCUS. Past columns are archived on MAA Online.*

The United States Military Academy: Strength in Diversity

By Amy Shell-Gellasch

As I started my last year of graduate school at the University of Illinois at Chicago in 1999, I faced the daunting task of finding a job, and asked the age-old question, "Where do I start!?" I sought help from members of the email distribution list for the NSF sponsored *Institute for the History of Mathematics and its Use in Teaching*. I had attended the Institute, organized by Fred Rickey and Victor Katz, the previous two summers, and had made many connections. Something was sure to pan out – I hoped. When I got an immediate reply from Fred Rickey, encouraging me to consider The United States Military Academy (USMA) at West Point, New York, I was amazed, to say the least. I was working on a Doctor of Arts in the history of mathematics in the hopes of pursuing a nice collegiate career at a small liberal arts college, where I could commune with faculty and students. Teaching at the premier Military Academy of the United States, arguably the best in the world, was not what I had envisioned for myself. But almost immediately something deep inside me said, "It's West Point!"

The position was a three-year teaching post doc. After talking with Fred and meeting members of the faculty at that winter's Joint Meetings of the AMS and the MAA, West Point was the only place I wanted to be. What impressed me so much was that the Academy is completely committed to giving its students and faculty every available opportunity to grow and learn. As I enter my third and final year as an Assistant Professor at West Point, my view of the Academy as a progressive and forward looking institution has only increased.

West Point is so named for its location on a high bluff jutting out of the west bank of the Hudson River, about fifty miles north of New York City. This commanding location, and its fort, originally named Fort Arnold, were key to the defense of the Colonies during the American Revolution. The Hudson River split New England (the hotbed of the revolution) from the rest of the American Colonies, and whoever controlled the river controlled access to the interior. In fact, General Benedict Arnold's ignominy came about when he tried to sell the plans for West Point to the British. As the new United States of America organized itself, George Washington stressed the need for a military academy. However, such an academy was not founded until the presidency of Thomas Jefferson in 1802. The revolutionary war fort at West Point was chosen as the location of the new academy. The focus of the Academy was to train engineers, not only for the Army, but for the new nation. Much of the infrastructure of the early nation— roadways, railroads, canals, bridges, water systems, and government buildings—was designed and built by West Point graduates.

The early Academy had few students, and no set curriculum or graduation requirements. When Sylvanus Thayer took over the Superintendency of the Academy in 1817, he revamped everything from military training to the curriculum. The year before taking command, Thayer went to France to gather books and ideas for the Academy, which he modeled after the …Ecole Polytechnique. The one thousand plus books that he brought back make up the treasured Thayer collection of the Academy library.

Being the first engineering school in the United States, West Point had and continues to have a highly mathematics-based curriculum. From Thayer's time on, classes have been small (limited to 18). Cadets are expected to demonstrate their knowledge on a daily basis. To facilitate this, blackboards cover every wall of the classrooms. It is believed that the Academy is the location of the first blackboard use in the new world. Every cadet, whether math major or history major, is required to take four semesters of mathematics. These four courses are Discrete Dynamical Systems, Calculus, Differential Equations and Probability and Statistics. The academic program at West Point, as the core math curriculum may indicate, is intense. Every year we have several Rhodes and Marshall scholars. In 2001, three Rhodes and three Marshall scholarships were awarded to West Pointers. Only Harvard and Princeton had more Rhodes scholars that year.

The heavy math requirement and the small class size explain why we have such a large faculty for a relatively small student population. Currently the Corps of Cadets at West Point number just over 4000 (this number is set by Congress) and we have sixty-seven full time faculty. Of that, twenty or more faculty members are sent to the Joint Meetings every year.

Traditionally, the faculty at West Point has been military. The earliest Professors were civilians or former officers, and most were Academy graduates. However, by the mid-nineteenth century, the faculty was solely military officers, all Academy graduates. This meant that none had any graduate training. In fact, the first head of the Department of Mathematical Sciences with a doctorial degree (in Engineering) was not until 1974. The first head with a doctorate in mathematics was Chris Arney, department head from 1995 to 2000.

Currently, the faculty, both military and civilian, is much different. In 1977, Isaac Schoenberg became the first visiting civilian professor. Since then we have had distinguished visiting faculty members every year. In 1991, The Department of Mathematical Sciences brought in its first permanent senior civilian faculty member, Donald Small. In addition to Don Small, Brian Winkel, Fred Rickey, and Frank Wattenberg are our current senior civilians. In 1992 the first group of five Title X civilian faculty members joined the department. These are three-year Assistant Professor positions, designed as teaching post-docs. Then in 1996 we hired two Davies Fellows, again for three-year terms as Academy faculty and Army Research Laboratory (ARL) researchers.

Each fellow teaches one semester a year at the Academy, and then conducts research through the ARL the rest of the year. These civilian positions, combined with one or two visiting positions per year, make for a very diverse and dynamic civilian faculty.

The majority of the mathematical faculty (77 percent at present) are army officers. The head and deputy head of the department are called Professors of the United States Military Academy (PUSMAs). These are Colonels that are appointed by Congress to hold this special position. The PUSMAs, as well as about half a dozen military professors, are permanent faculty members with Ph.D.s. The bulk of our teaching is done by rotating military faculty members. The Army selects successful officers from the field to get a master's degree from civilian universities across the country. They then come to West Point to teach for three years in our core math program. They then return to "the regular army" to continue their army career in one of the specialties such as the infantry, engineers, medical service corps. Of these, a select few are chosen to get a Ph.D. and then return for another tour of duty. The U.S. service academies (Army, Navy, and Air Force) also trade instructors. Currently we have two Air Force officers teaching in the department. And though the Department of Mathematical Sciences does not have any Foreign instructors, the Department of Foreign Language currently has exchange officers from the German, Mexican, and Brazilian militaries to teach languages.

Between permanent and rotating, military and civilian, we have an incredibly lively faculty. Not only is this wonderful for the cadets, it is wonderful for us. We all come from such different backgrounds with different mathematical and educational interests that there is never a dull moment or want of ideas. The cadets get a strong mathematical background due to the diversity of their instructors. Their many military instructors, who have been out in the army and will return to the Army after West Point, provide them with role models for their future career. On a side note, this is one of the wonderful things about teaching at one of the service academies; you know exactly what each of your students is going to do upon graduation, allowing you to spark their interest through the examples you chose.

Though USMA is not a research institution (we have no graduate programs), we do a lot of research. As mentioned above, the Army Research Lab conducts research into all branches of mathematics, both pure and applied. Not only do the Davies Fellows conduct research through ARL, many of our rotating instructors and a few Title X civilians, pick up research projects through this organization. The Academy is very supportive of research and conference presentations. Everything from my historical research with Fred Rickey and Don Small's research into effective methods of teaching algebra, to research in operations research and differential equations is encouraged and supported. All faculty members are encouraged to share their research with the department or to present their research at meetings.

Along with tremendous academic support, the Academy also provides moral support. This grows out of the Army's system of teamwork, acknowledgement, and encouragement. Whether you help out with an athletic team (every cadet must participate in two sports a year) or direct a course, you are recognized. When I started at West Point, several friends and colleagues asked if I felt isolated or ignored since I had no military background. To the contrary, the civilians, who make up the majority of our Ph.D.s, are highly respected and deferred to by the military for their expertise. Since many of the civilians have wider mathematical and teaching backgrounds, the department often looks to them for ideas and guidance. Again the Academy is the most progressive place I have taught. Though rooted in history, the academic, or "Dean's side of the house", is always looking to see what new ideas we can try, what new technology we can implement, who we can bring in to talk to the Cadets or the faculty. Along these lines, new faculty members spend six weeks in the summer they arrive learning West Point's curriculum, teaching philosophy, and style. These faculty development seminars continue throughout the year for the whole faculty, with talks and workshops. Most events are at the departmental level, but many are Academy wide. The support system also extends to our teaching. Within each course, instructors are grouped into small teams to share ideas. Each course has a course director and assistant course director that develop the curriculum for the course. Finally, a senior faculty member is chosen program director to oversee the whole process. This helps explain the close-knit atmosphere at the Academy.

After West Point, the rotating military return to the Army, to do the job that they were originally trained for, but with an experience in academia and mathematics one would not expect of Army officers. And the civilians go on to traditional academics or industry positions, but with the experience of having taught at one of the most historic and progressive institutions in the world: A special place with a diversity of talent and an important mission unlike any other. I am proud to have been a part of two hundred years of West Point tradition. ■

Amy Shell-Gellasch is in her third and final year as an Assistant Professor at the United States Military Academy. This June she and her husband Christopher, an officer in the U.S. Army, move to Grafenwoehr, Germany, for a three year tour of duty, where she will become a freelance math historian.

Found Math

"It is like studies that show 90 percent of people think they are better-than-average drivers. Forty percent of them are wrong."

Seen on CNN.com, January 2003, by Colm Mulcahy.

Graduate Students and the Joint Mathematics Meetings: a Report

By David E. Zitarelli

The e-mail invitation was innocent enough. "One of the traditional events at the joint mathematics meetings is the Graduate Student Reception. At this informal social gathering, co-sponsored by the MAA and AMS, graduate students have the chance to talk informally to mathematicians representing a wide range of interests. It is our opportunity to welcome graduate students into the mathematics community. We would like very much to have you join us."

Never having attended the affair, I accepted at once and penciled the date January 15 onto my calendar. I wondered what my own department did to prepare graduate students for their first annual meeting. After some inquiries I drew the conclusion that these students were supposed to learn on their own, perhaps from the experiences of those who had preceded them, without any official institutional advice, support, or encouragement.

But my philosophy is different. I believe in nurturing talent, so I sent an e-mail to our graduate students asking if any intended to attend the meeting in Baltimore and what they knew about such meetings. The replies revealed that three would attend to interview for jobs and several others would be interested in participating, but none had an inkling of what transpired there.

So in mid-December I offered a one-hour overview at a weekly seminar held for graduate students at Temple University called the Candidates Seminar. Ten students attended. Given my interest in history, I began my remarks by recalling some AMS history. These early 21st-century students seemed impressed that three of their late 19th-century counterparts were responsible for founding the AMS and organizing the first meetings. I noted that the first three annual meetings were held to conduct business, whereas monthly meetings were devoted to lectures on mathematics. But in the fourth year, 1892, one paper was read and before long lectures themselves — ranging from 10-minute contributed talks to 20-minute invited lectures to one-hour plenary addresses — became the chief attraction for the general membership.

Next I exhibited program booklets from the last few meetings, officially called Joint Mathematics Meetings (JMM). The booklet from the 2002 JMM in San Diego showed that 1380 abstracts had been submitted. The numerous special sessions (each with abstruse jargon) and the cardinality of speakers appeared daunting, but they provided me with an opportunity to present a birds-eye view of mathematics and living mathematicians. I hoped this would prevent these neophytes from being too overwhelmed when they actually showed up at the Convention Center in Baltimore. Next came a discussion of the Employment Center, which might have seemed germane only to the three students who expected to finish their dissertations this year and had arranged interviews there but — perhaps not too surprisingly — the other seven scribbled frantic notes. (Incidentally, the year 2003 marked the 50th anniversary of the Employment Center, which was commemorated by a special historical exhibit.) I ended with advice for presenting a 10-minute paper at the meeting, and the necessity of practicing for what I regard as the hardest kind of talk to give.

The Graduate Student Reception grew out of MathChats, which began at the San Antonio JMM in 1993 as a place where well-known mathematicians representing a wide range of disciplines would join graduate students on an informal basis. This year's Reception was organized by Betty Mayfield (Hood College) and Shawnee McMurran (California State University at San Bernardino). It was held at 5 p.m. on Wednesday, the opening day of the JMM, so the students had already experienced one day of the meeting. We got together outside the room ten minutes before the Reception began. This enabled us to enter the room together, thus easing the fear that might otherwise have prevented some from attending.

The reception was a glorious one-hour affair whose major attraction appeared to be the free food. Clearly the organizers had put a lot of work into the reception. In addition to buffet tables set up around the room, servers offered additional delicacies that provided a tasteful introduction to the social world of mathematics. After about 10 minutes three representatives from the AMS and MAA offered brief introductions that turned out to be the only interruption in the affair. One said something like, "When I was a graduate student a professor told me that people I would meet at the JMM would become friends for the rest of my professional career, and this indeed turned out to be true." I do not know if this piece of advice applies today to a much bigger community of mathematicians but I hope so. In any event, the 200 or so students spent the rest of the hour munching and enjoying the good (perhaps mathematical) camaraderie.

I was happy to see that the Temple subset soon broke away into smaller groups. Three in our group renewed acquaintance with aspiring mathematicians they hadn't seen in years and did not know were pursuing the subject. One post-doc, who joined our group because he was interviewing for a tenure-track position, met with another graduate student whom he had not seen since they attended the same high school in Argentina 15 years ago. Another encountered one of his undergraduate instructors from Ethiopia 10 years ago. And a third met a friend whom he hadn't seen in seven years; neither knew the other was in a Ph.D. program. What serendipity!

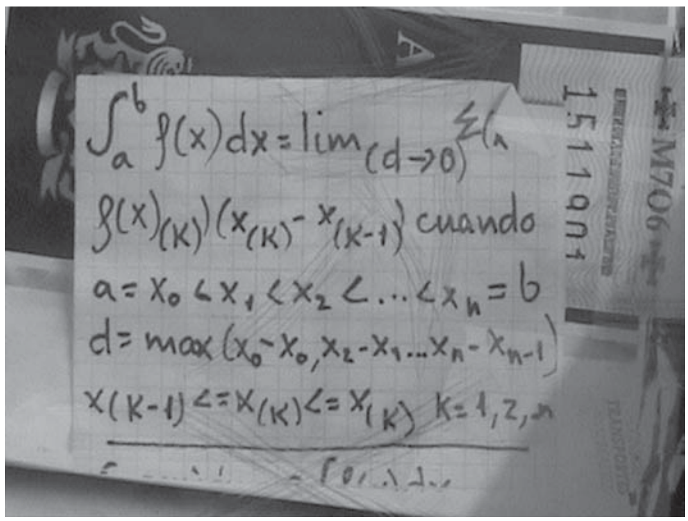
While the assembled students were munching, mingling, and generally enjoying themselves in the Hyatt Regency, the Convention Center was taken over by the governor-elect of Maryland, Robert Ehrlich, who toasted the future of his state. For me, however, the real future of the country lies with the students assembled at the reception. While the Maryland Republicans were decked out in tuxedos, our graduate students wore a mix of coat-and-tie attire and typical graduate-student garb (jeans). This distinction in dress separated those who had just spent a day interviewing for their first professional positions from those who came to enjoy the scene.

I saw all the Temple students several times over the remaining three days of the JMM but because I was an organizer for a session that ran two days I did not get an opportunity to engage in any discussions about their experiences and reflections. So upon my return to campus I sent them e-mails asking several questions. Four responded. The one who had interviewed was impressed with the Employment Center's organization. "I am optimistic I will get a job," he concluded. However, another surveyed the proceedings from afar and concluded, "It looked pretty intimidating and the interviewees seemed pretty nervous."

All of the respondents liked the Graduate Student Reception but two noted that shyness prevented them from mingling beyond our group. Since this trait seems to characterize many in our profession, perhaps future organizers can find a way to help overcome this hurdle.

Although Temple's graduate students generally enjoyed their first JMM, they found it exhausting. Good — so do I. One student was encouraged by the number of sessions devoted to teaching mathematics, "Since we never really get much advice about teaching before we are shoved into it at Temple." Another was discouraged by the quality of many 10-minute talks. Her advice to future speakers is to "practice, practice, practice." Overall, however, they felt they had benefited personally and professionally, and they looked forward to attending next year's Reception at the JMM in Phoenix. ■

David Zitarelli teaches at Temple University. His research interests are in the history of mathematics and algebraic semigroups.



The ad pictured on the left for Fortuna cigarettes was seen in Madrid in February 2003. The title at the top of the ad says "Memory Expansion." Note the slip of paper inserted into the wrapper. A close-up shows what is written on the slip of paper. It seems someone needed to remember the definition of the Riemann integral! (Thanks to Colm Mulcahy.)

Motions to Change the Bylaws of the Association

By Martha Siegel, MAA Secretary

At the Business Meeting at the Boulder MathFest, the membership will be asked to approve the following changes to the Bylaws of the Mathematical Association of America. I have included a short rationale for each change. The Board of Governors has already voted approval for all of them. In every case, the bold italicized words are to be added to the Bylaws and the words marked with a strikeout will be deleted. You may find the current MAA Bylaws online at http://www.maa.org/aboutmaa/bylaws00.html.

I bring to your attention the Regulations for changes to the Bylaws.

Article XI—Amendments to the Articles of the Association and Bylaws

1. Changes in the Articles of Association or amendments to the Bylaws may be made at any annual business meeting of the Association, or at any adjourned session thereof, or at any special meeting of the Association called for such purpose, by a two-third (2/3) vote of those present and entitled to vote, provided that due notice concerning such amendment shall have been mailed to each member at least one (1) month before the date of such meeting. The Secretary shall give such due notice when so instructed by a vote of the Board of Governors or when so petitioned by at least one hundred members of the Association.

2. No changes in the Articles of Association or amendments to these Bylaws shall have a legal effect until a certificate thereof, verified by oath of the President and under the Seal of the Association, attested by the Secretary, shall be recorded in the office of the Recorder of Deeds for Cook County, Illinois.

Proposed Bylaws Changes

Membership as a Requirement for Serving as Governor

We had a peculiar situation this year [one that has occurred rarely, actually] in which a candidate for Governor of a Section was not a member of the MAA. Most Section bylaws state that in order to be a member of the Section, you must be a member of the national MAA. However, nowhere in our national bylaws or in most Section bylaws is it stipulated that an officer must be a member of the MAA.

Article III. 2. There shall be a Board of Governors (herein called "the Board") to consist of the officers, the ex-presidents for terms of six years after the expiration of their respective presidential terms, the Associate Secretary, the Editor of each of its three publications entitled *The American Mathematical Monthly, The College Mathematics Journal,* and *Mathematics Magazine,* the members of the Executive Committee (see article III. 3), the chair of the Committee on Sections, and additional elected members (herein called "Governors"). ***All members of the Board must be individual members of the Association in good standing.*** It shall be the function of the Board to supervise, administer, and control all programmatic and financial activities of the Association.

Substitutions for Governors at National Meetings

We have had spirited discussions at Board meetings relating to policies on substitutions for governors who have to be absent from meetings. Wayne Roberts, Parliamentarian, headed an *ad hoc* committee charged with bringing a Bylaws change to the Board that would allow designated substitutes to be seated and to have the right to vote. We ask for approval of the following Bylaws change:

Article III. 6. Notice of all meetings of the Board shall be given by the Secretary to each member of the Board at least fifteen (15) days prior to the date set therefore. ***A Governor who is elected from a Section or who is elected as a Governor-at-Large may, in anticipation of missing a Board meeting, appoint a past governor of the section or a past governor-at-large for that constituency as a substitute for that meeting. The Governor shall notify the Secretary of the impending absence and give the name of the substitute, who then comes with full voting rights at the meeting.***

Electronic Voting

The State of Illinois, in which we are incorporated, has ruled that electronic voting may replace mail ballots. In order to be sure that there is no confusion in the Bylaws, the Board of Governors approved several small changes. The motion is to make the following changes:

Article III. 8. The Board may refer a matter to a referendum ~~mail~~ vote of the entire membership and shall make such reference if a referendum is requested, prior to the final action by the Board, by three hundred or more members. The taking of a referendum shall act as a stay upon Board action until the votes have been canvassed, and thereafter no action may be taken by the Board except in accordance with a plurality of the votes cast in the referendum.Article IV. 2 (b). For the general election the Nominating Committee shall prepare ~~printed~~ ballots with three or more nominees for each office to be filled by the members. ~~Blank spaces on the ballot shall provide for write in votes.~~ Each voting member of the Association may vote for as many candidates for each office as he or she desires. This ballot shall be ~~mailed~~ delivered to the membership by April 1 of an election year, returned ballots must be ~~postmarked~~ dated prior to June 1 ***by an approved method of certifying that votes have been cast by the announced final date***. For each office, the Nominating Committee shall declare elected the person having received the most votes and been determined by the Nominating Committee to be willing and able to serve. In the case of ties, the Nominating Committee shall make the selection from among those tied.

Retired Members

Retired people who qualify may retain membership at no cost, receiving *FOCUS* and member privileges such as reduced rates for meetings registrations and book discounts. Such Retired Members may subscribe to a journal by paying a fee. The Board of Governors has approved a Bylaws change to the effect that the journal fees charged to Retired Members should not be stipulated in the Bylaws of the Association. Currently the Board approves the Dues Matrix each year and if this bylaw change passes, the Board would also be empowered to set the journal fees for Retired Members.

Article VIII. 3. Any individual member who because of age is no longer in active service, who is in good standing at the time of retirement, and who has been a member of the Association for twenty years, may upon notifying the central office of said retirement, be exempt from the payment of dues, while retaining all of the privileges of membership except receipt of journals. ~~Such a member may elect to receive one or more journals at an annual cost of one half of the dues paid by a regular individual member receiving the same journal.~~ ***Such a member may elect to receive one or more journals at an annual cost to be determined by the Board of Governors.*** ■

MAA Contributed Paper Sessions Phoenix Joint Mathematics Meeting, January 7-10, 2004

PRELIMINARY ANNOUNCEMENT

The organizers listed below solicit contributed papers pertinent to their sessions. Presentations are generally limited to ten minutes, but selected participants may extend their contribution up to twenty minutes. Please note that the dates and times scheduled for these sessions remain tentative. See the end of this announcement for specific submission procedures and other details. Each session room contains an overhead projector and screen; black boards will not be available. Persons needing additional equipment should contact, as soon as possible, but prior to September 9, 2003: the session organizer whose name is followed by an asterisk(*).

MAA CP A1 Teaching a History of Mathematics Course
Wednesday morning
Joel Haack(*), University of Northern Iowa
Joel.Haack@uni.edu
Amy Shell-Gellasch, United States Military Academy

This contributed papers session solicits papers on the teaching of history of mathematics courses. Papers can address courses at all levels and types, from general history courses for educators to topic specific courses for majors. Special consideration will be given to papers that present ideas on how to organize and develop history of mathematics courses. Other topics such as ideas for units or web usage will be considered.

MAA CP B1 Teaching Operations Research in the Undergraduate Classroom
Wednesday morning
Dipa Choudhury(*), Loyola College in Md, dsc@loyola.edu
Steven M. Hetzler, Salisbury University

This session seeks to highlight innovative teaching strategies in operations research in the undergraduate classroom. These strategies could include the construction of new teaching materials or creative use of existing materials. Submissions should provide specific learning objectives addressed by the use of these materials. In addition, provide some of the following information: (1) the syllabus of the course you teach, (2) a personal philosophy (with examples) of technology integration in the classroom, (3) interesting case studies, or (4) suggestions on textbooks and/or software.

MAA CP C1 Uses of the WWW that Enrich and Promote Learning
Wednesday and Saturday afternoons
Marcelle Bessman(*), Jacksonville University, mbessma@ju.edu
Marcia Birken, Rochester Institute of Technology
Mary L. Platt, Salem State College
Brian E. Smith, McGill University

This session seeks to highlight uses of the web and its tools that engage students in the learning process. Tools such as course management systems, digital resources, tutorial systems, and hybrids that combine these functions on the web can make a difference in student engagement, understanding, and performance. Talks should demonstrate how these technologies are being integrated into the learning process. The session is sponsored by the MAA Committee on Computers in Mathematics Education (CCIME).

MAA CP D1 Mathematical Experiences for Students Outside the Classroom
Wednesday morning
Laura L. Kelleher(*), Massachusetts Maritime Academy
lkelleher@mma.mass.edu
Mary S. Hawkins, Prairie View A & M University

Mathematics “happens” outside the classroom and, in fact, many mathematics majors are drawn to the subject through an event sponsored by a Student Chapter or Math Club. This session seeks presentations by academic, industrial, business, or student mathematicians so that the audience will be encouraged to organize and run events for their students. Descriptions of non-classroom activities could include, but are not limited to, special lectures, workshops for students, Math Days, Math Fairs, research projects for students, Career Days, recreational mathematics, problem solving activities and student consultants. This session is organized by: MAA Committee on Undergraduate Student Activities and Chapters.

MAA CP E1 Courses Below Calculus: A New Focus
Wednesday afternoon and Thursday morning
Mary Robinson(*), University of New Mexico
Valencia Campus
maryrobn@unm.edu
Florence S. Gordon, New York Institute of Technology
Arlene Kleinstein, SUNY at Farmingdale
Norma Agras, Miami Dade Community College
Laurette Foster, Prairie View A&M University
Linda Martin, Albuquerque T-VI

An unprecedented collaborative effort is currently being developed among members of MAA, AMATYC, and NCTM to launch a national initiative to refocus the courses below calculus to better serve the majority of students taking these courses. The goal of the initiative is to encourage courses that place much greater emphasis on conceptual understanding and realistic applications via mathematical modeling than traditional courses that too often are designed to develop algebraic skills needed for calculus. For this session, we specifically seek to address all of the college level courses below calculus, with particular emphasis on offerings in college algebra and pre-calculus. We seek presentations that present new visions for such courses, discuss implementation issues (such as faculty training, placement tests, introduction of alternative tracks for different groups of students, transferability problems, etc) related to offering such courses, present results of studies on student performance and tracking data in both traditional and new versions of these courses and in follow-up courses, discuss the needs of other disciplines and the workplace from courses at this level discuss connections to the changing school curricula and implications for teacher education. This session is co-sponsored by the CRAFTY, the Committee on Two Year Colleges, and the Committee on Articulation and Placement.

MAA CP F1 Getting Students to Discuss and Write about Mathematics
Wednesday afternoon
Sarah L. Mabrouk(*), Framingham State College
smabrouk@frc.mass.edu

This session invites papers about assignments and projects that require students to communicate mathematics through in-class oral presentations that they make or in-class discussions that they must lead and motivate and through written assignments and/or papers. These assignments can include analysis and applications of mathematics, presentations of and analysis of proofs, presentations about famous mathematicians and the mathematics that they studied, and assignments/projects that utilize creative writing. Each presenter is encouraged to discuss how the use of the assignment/project helped students to improve their understanding of mathematics and their ability to communicate mathematics. Of particular interest is the effect of such projects/assignments/presentations throughout the course on the students' understanding of mathematics, their communication of mathematics, and their attitude toward mathematics.

MAA CP G1 The Effective Use of Computer Algebra Systems in the Teaching of Mathematics
Wednesday afternoon
L. Carl Leinbach(*), Gettysburg College
leinbach@gettysburg.edu
Edward A. Connors, University of Massachusetts

Computer Algebra Systems (CAS) create an environment for the learning and teaching of mathematics. They can be used to encourage mathematical explorations, and affect the way in which we teach and what material we emphasize. Papers for this session are to discuss one of the following topics: classroom uses of CAS; student projects that use the CAS in a significant way; testing practices that allow the students to use a CAS; or evaluations of the overall use of CAS at a particular institution. It is expected that each presentation, in addition to explaining the use of the CAS, will address the effectiveness of this use in the teaching and learning of mathematics. While proposals for papers dealing with the use of a CAS in any mathematics course are welcome, preference will be given to papers dealing with the use of a CAS in courses other than the calculus sequence. In particular, papers on the use of the CAS in courses such as Applied Statistics, College Algebra, Quantitative Methods, and the Mathematics Preparation of Teachers are particularly welcome. Note that this session is focused on the use of a CAS, not technology in general. However, the choice of a platform (computer or handheld device) or CAS (Derive, Maple, Mathematica, or other CAS) is that of the presenter.

MAA CP H1 Placement Strategies
Thursday morning
Janet P. Ray(*), Seattle Central Community College
janray@sccd.ctc.edu
Susan Forman, Bronx Community College, CUNY
Patricia R. Wilkinson, Borough of Manhattan Community College, CUNY

Proper placement of students into their first college mathematics class is important to students and faculty alike. This session invites papers that describe placement strategies and instruments that you are using or have used at your institution. Papers might deal with uses of home grown or standardized instruments, non-test based strategies, or innovative, multi-layered approaches. Also invited are papers describing how the success of your placement strategy is measured. How do you know if it is working? Systems in place at any institution type or at any mathematics level are welcome. This session is co-sponsored by the MAA Committee on Two-Year Colleges and the Committee on Articulation and Placement.

MAA CP I1 Chaotic Dynamics and Fractal Geometry
Thursday morning
Denny Gulick(*), University of Maryland, dng@math.md.edu
Jon Scott, Montgomery College

During the past decade and a half, the areas of chaotic dynamics and fractal geometry have emerged as lively subjects not only for research but also in the undergraduate curriculum. One of the wonderful features of these subjects is that they are able to combine many of the fundamental undergraduate topics, among them calculus and analysis, differential equations, linear algebra, geometry, statistics, and computer science. This session invites papers that investigate the impact of these two fields on undergraduate mathematics. The papers, which should have an expository flavor, might include new developments in either chaos or fractals (or both), interesting or novel applications, undergraduate research experiences, or innovative approaches for exploring these topics in undergraduate mathematics.

MAA CP J1 Truth in Using the History of Mathematics in Teaching Mathematics
Thursday morning
Victor J. Katz(*), University of the District of Columbia
vkatz@udc.edu
Eisso Atzema, University of Maine

The history of mathematics has long been accepted as a scholarly activity for its own sake. Increasingly, historical research is called upon by a wide variety of professionals within the mathematical community to serve a broad range of agendas. We seek contributions from mathematicians, mathematics historians and mathematics educators at all levels that address the issue of "truth" in the use of the history of mathematics. In particular, contributions are welcome that consider three particular issues: (1) Whether and/or how myths and legends can be effectively used as such in the mathematics classroom, (2) what role the examination of myths and legends might play in a history of mathematics course, and (3) how the mathematics history community can contribute toward the effective use of history by "consumers" of history. This session is sponsored by HOM SIGMAA.

MAA CP K1 Innovations in Teaching Discrete Mathematics
Thursday afternoon
William E. Fenton(*), Bellarmine University
wfenton@bellarmine.edu
Nancy Hagelgans, Ursinus College

Discrete Mathematics is offered in many mathematics departments, at different levels, for different audiences, and with different expectations. This session seeks presentations on novel approaches to the teaching of discrete mathematics. These could be exploratory activities, application projects, interdisciplinary courses, etc. We particularly encourage presentations on the use of technology, as a teaching tool or as a source of interesting problems and applications. Evaluation of the pedagogy is welcome though not mandatory.

MAA CP L1 Initiating and Sustaining Undergraduate Research Projects and Programs
Thursday afternoon
James A. Davis(*), University of Richmond
jdavis@richmond.edu
Joel Foisy, State University of New York

Papers are requested describing undergraduate research programs. Of particular interest will be descriptions of innovative ways to get administrative support or other support that creates a sustainable program. Also of interest will be papers indicating where to find appropriate problems and how to gauge the right level. This session is sponsored by the CUPM Subcommittee on Undergraduate Research.

MAA CP M1 Mathlets for Teaching and Learning Mathematics
Thursday afternoon
David Strong(*), Pepperdine University
David.Strong@pepperdine.edu
Thomas Leathrum, Jacksonville State University
Joe Yanik, Emporia State University

This session seeks to provide a forum in which presenters may demonstrate mathlets and related materials that they have created or further developed. Mathlets are small computer-based (but ideally platform-independent) interactive tools for teaching math, frequently developed as World Wide Web materials such as scripts or Java applets, but there may be many other innovative variations. Mathlets allow students to experiment with and visualize a variety of mathematical concepts, and they can be easily shared by mathematics instructors around the world. The session is sponsored by the MAA Committee on Computers in Mathematics Education (CCIME).

MAA CP N1 SIGMAA - Statistics Education Discourse on Inference
Friday morning
John D. McKenzie, Jr.(*), Babson College
mckenzie@babson.edu
Carolyn K. Cuff, Westminster College

Since the introductory statistics courses have infused data driven activities into the course, many learning difficulties related to data have been minimized. However, the area of inference, a major topic in the course remains a stumbling block for students. Paper are solicited which demonstrate effective teaching on inference topics including confidence intervals, hypothesis testing, power, and the interpretation of results.

MAA CP O1 Math and the Arts
Friday morning
Ann Robertson(*), Connecticut College, arob@conncoll.edu
John M. Sullivan, University of Illinois, Urbana
Reza Sarhangi, Towson University
Nat Friedman, State University of New York, Albany

The Math and the Arts session seeks interdisciplinary abstracts related to mathematics and one or more of the following disciplines: archeology and related fields, architecture, dance, music, literature, theater, film, and the visual arts. Examples might include but are not limited to *Petroglyphs of North America, Symbols Across Culture (Archeology) Geometry in the Creation of the Santa Maria del Fiore, Fractals in African Architecture and Culture (Architecture) * A Dimensional Analysis of the Geometry of Movement: The Means of Production, Merce Cunningham's Fractions I (Dance) * Representing Bach's Fugues and Canons by Functions and Graphs, Fractal Geometry In Beethoven's Seventh Symphony (Music) * Alice In Wonderland and Logic, Updike's Midpoint, Death and the Compass by Jorge Luis Borges, (Literature) * Stoppard's Arcadia, The Theater of Chaos, the Mathematics of Pi, (Theater / Film) and * Tessellations of the Alhambra, Dynamism and Simultaneous Motion, Optical Geometry as Art, Flatland Paintings, and A Visual Approach to Mathematics Education (Visual Arts). The above list is intended only to be suggestive in nature. Session objectives include: (1) To present topics or new findings relating mathematics to its artistic and aesthetic presentations and (2) To introduce innovative techniques and to demonstrate the use of technology in promoting connections and interdisciplinary work in math and the arts.

MAA CP P1 Applications of Mathematics in Computer Science

Friday morning

William Marion(*), Valparaiso University
Bill.Marion@valpo.edu

This session invites papers which illustrate examples of the application of mathematics or mathematical thinking to topics introduced in an undergraduate computer science curriculum. These examples should be presented in such a way that they can be used as a lecture example, an in-class assignment, a homework assignment or a project by instructors who teach courses in computer science. Examples for use in the following categories of courses will be considered—discrete mathematics courses, CS I and II-type courses and all other computer science courses—and should be of a type which supplements the material in a standard text (or which presents a topic in a novel way). As a follow-up to this session, particularly interesting examples will be given consideration for entry into an on-line repository.

MAA CP Q1 Mathematics Experiences in Business, Industry and Government

Friday morning

Philip E. Gustafson(*), Mesa State College
pgustafs@mesastate.edu
Michael Monticino, University of North Texas.

This contributed paper session will provide a forum for mathematicians with experience in Business, Industry, and Government (BIG) to present papers or discuss projects involving the application of mathematics to BIG problems. BIG mathematicians as well as faculty and students in academia who are interested in learning more about BIG practitioners, projects, and issues, will find this session of interest. This session is sponsored by the MAA Business, Industry and Government Special Interest Group (BIG SIGMAA).

MAA CP R1 SIGMAA on RUME Contributed Research Paper Session

Friday afternoon and Saturday morning

Anne Brown(*), Indiana University South Bend
abrown@iusb.edu
Marilyn Carlson, Arizona State University
Draga Vidakovic, Georgia State University

Research papers that address issues concerning the teaching and learning of undergraduate mathematics are invited. Appropriate for this session are theoretical or empirical investigations conducted within clearly defined theoretical frameworks, using either qualitative or quantitative methodologies. Of highest priority are proposals that report on completed studies which further existing work in the field.

MAA CP S1 MY FAVORITE DEMO-Innovative Strategies for Mathematics Instructors

Friday afternoon and Saturday morning

David R. Hill(*), Temple University, hill@math.temple.edu
Lila F. Roberts, Georgia Southern University

Mathematics instructors use a myriad of innovative techniques for teaching mathematical concepts. Technology readily available in colleges and universities has provided a means to boost creativity and flexibility in lesson design. Tools an instructor utilizes may include specialized computer applications, animations and other multimedia tools, java applets, physical devices, games, etc. This contributed paper session will focus on novel demos that mathematics instructors have successfully used in their classrooms. Rather than focus on projects or student group activities, this contributed paper session will focus on the instructor's activities to facilitate learning. Mathematical content areas will include pre-calculus, calculus, elementary probability, and selected post-calculus topics. This session invites 1) demos that introduce a topic, 2) demos that illustrate how concepts are applicable, 3) demos that tell a story or describe the development of a procedure, and 4) demos that lead to an activity that involves the class. Presenters of demos are encouraged to give the demonstration, if time and equipment allow, and to discuss how to use it in a classroom setting. Proposals should describe how the demo fits into a course, the use of technology or technology requirements, if any, and the effect of the demo on student attitudes toward mathematics.

MAA CP T1 Mathematical Models of the Environment

Friday afternoon

Karen D. Bolinger(*), Clarion University, kbolinge@clarion.edu
W. D. Stone, New Mexico Institute of Mining and Technology
Ahlam E.Tannouri, Morgan State University

We invite presentations that deal with all aspects of using mathematics to model problems of the environment. Presentations are welcome that deal with exposition, pedagogy or elementary modeling and that are suitable for college level mathematics classes. Also welcome are presentations that deal with student research efforts, senior capstone experiences, group projects, and applications of higher mathematics, whether they fit within any course, weave through many mathematics courses, or stretch across departmental boundaries. Talks especially valued are those that make practical suggestions concerning how to establish fruitful communication between mathematicians and applied scientists, and, how to stimulate mathematics students into thinking about real world problems in terms of the mathematics they study. This session is sponsored by the Environmental Mathematics SIGMAA and the MAA Committee for Mathematics and the Environment.

MAA CP U1 Philosophy of Mathematics
Friday afternoon
Roger Simons(*), Rhode Island College, rsimons@ric.edu
Satish C. Bhatnagar, University of Nevada, Las Vegas

This session invites papers on any topic in the philosophy of mathematics except logic and set theory. Possible topics include the nature of mathematics, the nature of mathematical objects, the nature of mathematical knowledge, the relation between mathematics and the physical world, the role of esthetics in the development of mathematics

MAA CP V1 Focus on Integrating Graphic Handhelds into Collegiate Mathematics
Saturday morning
Charles E. Hofmann(*), LaSalle University
hofmann@lasalle.edu
Joseph R. Fiedler, California State University Bakersfield

The appropriate use of technology, graphic calculators, algebra capable calculators, and data collection devices, in the mathematics classroom has been the center of much debate. Few are neutral regarding the use of these devices. The pervasive use by students complicates testing and opens the field to novel and focused assessment activities. This session invites papers about the full range of handheld devices and their classroom uses. Presenters are encouraged not only to share their classroom activities, but also to discuss how these activities fit into the overall structure of their courses and curricula. Papers for this session are to discuss one or more of the following topics: classroom uses of handheld technologies, evaluations of their overall use at a particular institution, strategies for their effective incorporation into large lectures or into service courses, use of handheld technologies in significant ways in student projects and laboratories, and cross-disciplinary collaborations exploiting these technologies.

MAA CP W1 Mathematics and Sports
Saturday morning
Sean Forman(*), Saint Joseph's University, sforman@sju.edu
Doug Drinen, University of the South

When applied to the sporting arena, mathematics can provide both compelling classroom examples and interesting research problems. Baseball has long been mined for interesting statistics examples ranging from regression and probability to the game theoretic aspects of in-game strategy. Recent books on jai alai, football, and a few other sports have studied those sports through a mathematical lens. The economics of sports is now covered by its own journal and the statistics publication *Chance* routinely discusses statistical examples from sporting events. This session invites papers describing interesting classroom examples utilizing examples from sports and papers discussing the application of mathematics to sporting events.

MAA CP X1 Technology in Mathematics Teacher Preparation Courses
Saturday afternoon
Mary Ann Connors(*), Westfield State College
mconnors@foma.wsc.ma.edu
Christine Browning, Western Michigan University, Kalamazoo

Preparing teachers to use technology appropriately is a challenging task for teacher educators. Hand-held computer algebra systems, graphing calculators, spreadsheets and other computer software are popular tools for facilitating numerical investigations, connecting mathematics topics, and incorporating multiple representations of various meaningful problems. Such explorations lead to students' better understanding of mathematical concepts while empowering them to analyze practical problems. This session invites papers presenting ways in which we can prepare pre-service teachers to use and develop meaningful activities that will engage their future students in mathematical thinking facilitated by technological tools. Papers that also present curriculum revisions concentrating on meaningful technology use within courses that focus on mathematical content for pre-service teachers are also encouraged. It is the hope that these curriculum revisions and/or activities will serve as a catalyst for class discussions of issues connected with K -12 curriculum and instruction, national and state standards, sequencing of topics, the role of technology, and assessment.

MAA CP Y1 Strategies that Work to Positively Change Student Attitudes Toward Mathematics
Saturday afternoon
Caren Diefenderfer(*), Hollins University
cdiefenderfer@hollins.edu
Janet Andersen, Hope College
Elizabeth Yanik, Emporia State University

We solicit contributed papers that describe strategies, both in and out of the classroom, which demonstrate a positive impact on student attitudes towards and perceptions of mathematics. These may be strategies incorporated in math courses that general education students are "forced" to take or strategies used in courses designed for majors. In addition, talks may emphasize departmental activities that have helped to create a positive esprit de corps and talks that address encouraging members of under represented groups are particularly welcome. Our concern is that many students (including mathematics majors) leave our programs with negative attitudes toward mathematics. We are also concerned that there are potential majors that we are not reaching because we are not adequately conveying the benefits and satisfaction of doing mathematics. This may be particularly true of under-represented groups. We would like the mathematics community to be aware of successful strategies that can be modified to use in our individual programs that will help students to learn, experience and believe in the joy and magic of mathematics. We are also interested in the question of how to cultivate a mathematically appreciative society. In particular, how can such strategies be used to attract and retain more minority students in mathematics courses?

MAA CP Z1 General Contributed Paper Session
Wednesday, Thursday, and Saturday afternoons
Laura Wallace (*), California State University San Bernardino
wallace@csusb.edu

Papers may be presented on any mathematical topic. Papers that fit into one of the other sessions should be sent to that organizer, not to this session. Any paper that cannot be accommodated in one of the named contributed paper sessions will be diverted automatically to this session; therefore papers should not be sent to more than one session organizer.

Submission Procedures for MAA Contributed Papers

Send a detailed one-page summary of your paper by email directly to the organizer indicated with an asterisk (*) no later than September 9, 2003; concurrently, submit your abstract directly to the AMS (see below for instructions). In order to enable the organizer(s) to evaluate the appropriateness of your paper, include as much detailed information as possible within the one-page summary limitation.

The AMS will publish abstracts for MAA talks. These will be available online about two months before the meeting, and paper copy will be available onsite to registered participants. Abstracts must be submitted on the appropriate AMS form within stated limits, and NO LATER THAN OCTOBER 1. Electronic submission is available via the Internet or email. No technical knowledge of LaTeX is necessary for submission, however, LaTeX and AMS-LaTeX are the only typesetting systems that can be used if display mathematics is used or special formatting is desired. To see descriptions and to view the electronic templates available, visit the abstracts submission page at http://www.ams.org/abstracts/instructions.html, or send email to: abs-submit@ams.org, typing HELP as the subject line.

Completed email templates must be sent to ABS-SUBMIT@AMS.ORG with SUBMISSION as the subject line.

Abstracts submitted electronically are quickly either acknowledged, with a unique abstract number assigned to the presentation, or rejected, with a short message on what information is missing or inappropriate. All questions concerning the submission of abstracts should be addressed to:

abs-coord@ams.org.

Here are the codes you will need: MEETING NUMBER: 993

The EVENT CODE is the seven characters appearing before the title of the sessions shown below, e.g., MAA CP A1

The SUBJECT CODE is the last two-character letter/number combination from the event code list, i.e., A1.

Audiovisual equipment available for MAA talks: Each session room contains an overhead projector and screen; black boards will not be available. Persons needing additional equipment should contact, as soon as possible, and definitely prior to September 9, 2003, to the session organizer whose name is followed by an asterisk (*).

Employment Opportunities

OREGON

UNIVERSITY OF OREGON
Department of Mathematics
Applications are invited for Instructor/Assistant to the Department Head in the Department of Mathematics, beginning August 1, 2003. Minimum qualifications are an M.S. or M.A. in mathematics or closely related field and evidence of higher education instruction ability. Administrative experience desired. Applicants from all parts of the mathematical sciences are encouraged to apply. See: http:darkwing.uoregon.edu/~math/employment.html.