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On the cover: Simulation of colliding black holes and the resulting gravitational wave emission. Image courtesy of Max Planck Institute for Gravitational Physics (Albert Einstein Institute). Visualization by W. Berger (Zuse Institute Berlin/AEI). Inset images (left to right): A model of a two-dimensional finite universe without edges. Image courtesy of Key Curriculum Press; Artist's conception of the Interplanetary Superhighway, courtesy of Dr. Martin Lo, NASA/JPL, Caltech, artist Cic Koenig; Artist's rendition of the Cassini spacecraft approaching Saturn, courtesy of NASA/JPL, Caltech; LIGO gravitational wave detector, photo courtesy of LIGO Laboratory.

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

April is Mathematics Awareness Month

The theme for this year's Mathematics Awareness Month is *Mathematics and the Cosmos.* As the main statement of the theme says, "mathematics is at the core of our attempts to understand the cosmos at every level: Riemannian geometry and topology furnish models of the universe, numerical simulations help us to understand large-scale dynamics, celestial mechanics provides a key to comprehending the solar system, and a wide variety of mathematical tools are needed for actual exploration of the space around us." Many institutions across the nation will organize special events during April with the goal of highlighting the value, usefulness, and beauty of mathematics.

Mathematics Awareness Month happens in April of each year under the auspices of the *Joint Policy Board for Mathematics* (JPBM), which is composed of the MAA, the American Mathematical Society, the Society for Industrial and Applied Mathematics, and the American Statistical Association. Math Awareness Week was first celebrated in 1986 with a proclamation by President Reagan; the event was expanded to a full month in 1999. The original week included mostly activities at the national level (at the Smithsonian, for example), but since then the emphasis has shifted to local and regional activities intended to highlight the importance of mathematics. The MAM web site provides a wide range of resources to help individuals and institutions organize activities during the month.

More information on Mathematics Awareness Month, theme essays (on the shape of space, celestial mechanics, and the design of space missions), tips on how to contact the media and get coverage for local events, and many other resources can be found at the new Math Awareness Month website at http://www.mathaware.org.

HRUMC XII

The 12th annual Hudson River Undergraduate Mathematics Conference will be held at Williams College in Williamstown, Massachusetts on April 30, 2005. The conference includes presentations on mathematics by both faculty and students, and both are encouraged to participate. Conference sessions are designed so that some presentations are accessible to undergraduates in their first years of study, and others are accessible to third or fourth year undergraduate mathematics majors.

The keynote speaker for this year will be Ken Ribet, Professor of Mathematics at the Univeristy of California at Berkeley. You can find out more about HRUMC by visiting the conference website http://www.skidmore.edu/academics/mcs/hrumc.htm. Those wishing to make a presentation at the conference should submit an abstract via the website by March 4th, 2005. We would like to thank Williams College and the MAA for their support of HRUMC XII.

Project NExT: Call for Applications

Project NExT is looking for applications from young mathematics faculty who would like to become next year's NExT Fellows. The application deadline is April 15, 2005.

Project NExT (New Experiences in Teaching) is the MAA's professional development program for new and recent Ph.D.s in the mathematical sciences; including pure and applied mathematics, statistics, operations research, and mathematics education. It addresses all aspects of an academic career: improving the teaching and learning of mathematics, engaging in research and scholarship, and participating in professional activities. It also provides the participants with a network of peers and mentors as they assume these responsibilities. Each year, about sixty faculty members from colleges and universities throughout the country are selected to participate in a workshop preceding the MAA summer meeting, in activities during the summer MAA meetings and the Joint Mathematics Meetings in January, and in an electronic discussion network. Faculty for whom the 2005-2006 academic year will be the first or second year of full-time teaching (post-Ph.D.) at the college or university level are invited to apply to become Project NExT Fellows.

For more information, including application forms, visit the Project NExT web site http://archives.math.utk.edu/projnext. Project NExT is a program of the MAA that receives major funding from the ExxonMobil Foundation, with additional funding from the Dolciani-Halloran Foundation, the American Mathematical Society, the Educational Advancement Foundation, the American Statistical Association, the National Council of Teachers of Mathematics, Texas Instruments, the Association of Mathematics Teacher Educators, the Association for Symbolic Logic, and the Greater MAA Fund.

Conference on the Mathematics Curriculum

The Center for the Study of Mathematics Curriculum is hosting its First International Mathematics Curriculum Conference, November 11-13, 2005 at the University of Chicago. The conference will focus on the design and development of K-12 mathematics curricula in the Asian Pacific Rim countries. It will feature ministry officials and textbook authors from China, Japan, Korea and Singapore, as well as reactors from the United States. There will be panels and other opportunities for attendees to interact with speakers. Registration for the Conference is limited. Detailed information about registration is available at http://www.mathcurriculumcenter.org/InternationalConference.

Mathematical Experiences in Business, Industry and Government

By Phil Gustafson

Applications of mathematics to projects in business, industry, and government (BIG) offer a wealth of exciting problems for mathematicians. A wonderful sampling of BIG topics was presented at the MAA Contributed Paper session entitled "Mathematical Experiences in Business, Industry, and Government," during the Joint MAA–AMS meetings in Atlanta. This article discusses highlights of the BIG projects presented at the session. The paper session was sponsored by the Business, Industry and Government Special Interest Group of the MAA (BIG SIGMAA), and was organized by Phil Gustafson of Mesa State College and Michael Monticino of the University of North Texas.

The United States Military Entrance Processing Command (MEPCOM) recently conducted an A-Z Business Practice Review to improve the efficiency of the organization. Tyge Rugenstein and Darrall Henderson of the US Military Academy have worked with the Military Entrance Processing Station (MEPS) Location Optimization Study (MLOS). This study attempts to find the optimal distribution of MEPS to support the needs of the thousands of recruiters for the four military services, Coast Guard, and the FBI. At the US Military Academy, math and operations research majors addressed a reduced version of this problem with a simple but robust 0-1 integer programming model. Since the students completed the project, MEPCOM has prepared the model for full implementation by obtaining the endorsement of all the services, confirming the minimizing function and constraints. The partnership between MEPCOM and USMA continues to grow and provide an excellent venue for both faculty and students to study and solve relevant problems.

Supply chain groups are often faced with questions such as how much inventory should be stocked, what happens to manufacturing capacity if actual sales exceed predictions, or how much product x is expected to sell next month to customer y. The mathematics that is used to get these answers is embedded in a variety of systems running on laptops, desktops, and servers. Charlie Stevens of General Electric discussed some of the specific mathematical tools used daily within the GE Plastics Materials Management group that addresses several of the above questions. Three specific tools discussed were: (1) Manugistics — a tool used to forecast sales demand using Fourier and Lewandowski methods, (2) SAILS — an optimization engine system that allows us to determine the minimum distribution costs that can be achieved in a supply chain distribution network of plants, warehouses and customer locations and (3) Crystal Ball — a Monte Carlo simulation tool that allows us to study the impact to customer service based on a variety of probability distributions for demand and manufacturing capabilities.

Greg Coxson of Lockheed Martin Maritime Systems and Sensors discussed Costas arrays, which originated in sonar waveform studies. Costas arrays are permutation matrices with the property that any nontrivial translation in rows and columns, with no wrap-around, results in no more than one 1 on top of another 1. There appear to be two types of arrays — those formed by a set of generators, and "spurious" ones requiring an exhaustive search to find. Greg was part of a small industry-university team consisting of NJIT Mount Laurel students and Lockheed Martin engineers who sought to advance the array orders for which the full set is known. When the work began, full sets of Costas Arrays were known up to order 23. The team achieved its initial goal of finding the full list for order 24, and then continued on to order 25; it is well on the way to compiling the full list for order 26. The trend in number of Costas arrays as a function of order, based on exhaustive search, indicates a steep drop to zero by order 30, yet arrays can be generated in large numbers for arbitrarily high orders using number-theoretic generators. The team exploited array symmetries, and the use of sophisticated computing methods, including the formation of a "virtual cluster" by networking individual computers and the optimization of low-level computations.

Marcus Pendergrass of Convergent Corporation presented a channel model for short-range ultrawideband (UWB) radio channels. Development of UWB devices for consumer electronics, tracking, positioning, automobile collision avoidance, and a host of other applications, is expected to lead to products that will appear on the market in 2005. The model Marcus discussed was developed through an industrial/academic collaboration under the auspices of the IEEE 802.15.3a standards task group, for the purpose of aiding in the development of a standard for UWB wireless personal area networks. The model is based upon the well-known Saleh-Valenzuela model, but with fading statistics modified to more accurately represent the phenomenology associated with ultrawideband signals. Marcus gave an overview of UWB technology and the associated standards, and then presented the mathematical channel model. He also discussed the process of tuning the channel model to fit several sets of measurement data that were collected as part of the model development process.

Gregory Battle of Morehouse College presented a Markov model to structure the trafficking of tasks in a given governmental office with three components. The Fleet Support Office of the Naval Personnel Research and Development Center was used as a typical case. The probabilities of predicted office states are represented from the matrix equation $Q(k) = Q(0)P^k$ for a given period k using an empirically constructed transition matrix P. A long range prediction of various office states will be computed using a mean passage of time matrix M. Once the cost of these long-range predicted states (given as a probability of occurrence) are calculated per unit time (e.g.

daily, or weekly), then a cost equation can be formulated. The model allows managers to assign tasks to a particular office component that predicts functional office states at acceptable productivity rates with more efficient use of manpower resources resulting in an optimization of costs per time interval of budgeting.

Abbe Herzig of the University of Albany, State University of New York, discussed some of the statistical challenges she faced as a statistician in the product-testing division of *Consumer Reports*. *Consumer Reports* is one of the largest-circulation magazines in the U.S. It reports on consumer products and services, based on extensive research from a staff of engineers, scientists, survey researchers, statisticians, and journalists. Each product category tested for *Consumer Reports* presents a unique set of statistical requirements, involving a broad range of statistical design, data analysis, and presentation tools. Herzig presented some specific examples of product tests, including nutritional quality of breakfast cereals (cluster analysis) and food sensory tests (incomplete block designs and linear models). One popular food sensory example presented was a test of beer quality.

Jim Pomfret of Bloomsburg University described a recent project he and Youmin Lu conducted for an aluminum products manufacturer. This project estimated the effect on output of modifying the process flow in a chemical bathing and anodizing line. Jim described the input data provided by the company, the breakthrough in writing a Java simulation, and the analysis of results. Follow-up data from the company showed that actual operations agreed well with predictions.

Katharine Gurski of George Washington University spoke on "The Effect of the Rayleigh Instability on Anisotropic Crystalline Rods," a project she conducted along with G.B. McFadden at the National Institute of Standards and Technology and M.J. Miksis of Northwestern University. Properties of strength, toughness, ductility, and hardness of materials are greatly influenced by the conditions of solidification. Katharine studied the effect of anisotropic surface energy on the stability of a solidifying crystalline rod, both free-standing and on a surface. The study was partially motivated by the apparent stability of elongated nanowires in a bridge configuration or grown epitaxially on a heterogeneous surface. The rod was assumed to be smooth with a uniform cross-section given by a two-dimensional equilibrium shape. The investigators applied the analysis to examples with uniaxial or cubic anisotropy and showed that the anisotropic surface energy played a significant role in establishing the stability of the free standing rod or rod on a surface.

Nick Coult of Augsburg College discussed how the seismic exploration industry has need for sophisticated mathematical methods. As is often the case in industrial settings, the problems are not always clearly understood or explained at the outset of a project, and often the requirements and goals are fluid as the project proceeds. Nick described a particular project, travel-time data compression, in which some significant aspects of the problem were not known at the start. In particular, though travel-time data is relatively smooth and thus highly compressible using wavelet algorithms, it also often contains "holes" or regions of missing data, which present a major obstacle for compression. Thus, the project evolved to include a significant new aspect — developing a robust, efficient algorithm for smoothly filling in missing data to increase its compressibility using wavelet methods.

Tracy Bibelnieks of Augsburg College spoke on applications of linear, non-linear and integer programming, combined with statistical approaches, to analysis of customer behavior in direct mail and retail markets. Tracy explained how Fingerhut Corporation used basic linear programming methods to optimize the allocation of marketing/advertising dollars across segments of the customer database as well as integer programming to make catalog mailing decisions on a individual customer basis. This approach was a significant component of a larger project, which ultimately changed the way the company viewed and practiced campaign management for direct mail marketing. The method is now being used with other direct mail industries and in applications within the financial and e-commerce sectors. Tracy credits the IBM and Fingerhut teams for allowing the presentation of the applications.

In this article we have seen many exciting applications of mathematics to projects in business, industry, and government. In a variety of settings, mathematics is a key component to many important projects in the world around us. Who uses math? The answer includes many of the mathematicians, scientists, and engineers whose projects and products help improve the quality of our everyday lives.

Acknowledgement: The author gratefully appreciates the input 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.

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A Catchy Name for a Great 21st Century Idea: SIGMAA Benefits Really Add Up

By Steve Carlson

What do the following scenarios have in common?

A mathematician in industry posts a note concerning combinatorial searching on an MAA ListServ, and the posting generates responses involving topics such as Clifford algebras and the mod 9 Fibonacci sequence.

An MAA member attends a session at a national meeting to hear a presentation on Zeno's paradox and hangs around for the rest of the session, listening to fascinating talks on mathematics and the human mind, on feminist mathematics, and on mathematics and transcendental meditation.

An MAA student member clicks on the web page of a newly formed mathematical organization she has considered joining and gains a whole new perspective on summing geometric series with complex ratio.

The answer is easy if you know that a key word in the title describes a fairly recently established MAA program that makes such experiences routine. Each scenario occurred within an activity of a SIGMAA — a Special Interest Group of the MAA. SIGMAAs have existed for five years, and there are now nine such groups available for any MAA member to join. These groups provide opportunities for individuals with a common mathematical interest to share and discuss ideas during sessions hosted at national meetings and — much more frequently — through easily accessed electronic resources, and they also offer interested members a chance to take on professional leadership positions within a SIGMAA of their choice.

It has been my privilege to be involved with the SIGMAAs program since its inception, as a member of the initial task force charged with developing a plan for establishing a system of special interest groups within the MAA, continuing as a member of the MAA Committee on SIGMAAs, and — most satisfying — as a member of several SIGMAAs myself. The establishment of the SIGMAAs program succeeded because of hard work by many individuals and groups at a crucial time for review and renewal for the Association. In this article, I would like to summarize the history of the SIGMAAs movement and also offer readers a sense of how this program offers a new and special MAA membership benefit.

A New Agenda for the 21st Century

At its January 1999 meeting, the MAA Board of Governors initiated a review of the status of the Association with respect to changes in mode of communication, demographics, modern technologies, and member attitudes and expectations and appointed a planning group to prepare a set of recommendations to guide the MAA into the new millennium. The results of this work were summarized in the spring of 1999 in *A New Agenda for the 21st Century*, a document that listed five priority action recommendations, one of which was "Facilitate the Formation of Special Interest Groups."

Subsequently, the MAA Executive and Finance Committees endorsed, in principle, formation of a special interest groups program and, in late spring of 1999 they established the MAA Task Force on Special Interest Groups charged with formulating guidelines for the formation, organizational structure, and operating procedures of such groups. The Task Force's resolution, approved by the MAA Board of Governors in August of 1999, officially named the newly established groups "SIGMAAs" — Special Interest Groups of the MAA — and the new SIGMAAs program was announced to the membership in "MAA Adding SIGMAAs to its Membership Benefits," an article published in the December 1999 issue of FOCUS.

SIGMAAs become a reality

The first proposal to form a SIGMAA came in early December of 1999 from the Association for Research in Undergraduate Mathematics Education (ARUME). ARUME's proposal was reviewed by the Task Force and approved by the MAA Executive Committee just prior to the Joint Mathematics Meetings held in Washington, DC in January of 2000. The announcement that ARUME, now renamed as SIGMAA RUME, had become the first Special Interest Group of the MAA was received with applause from a large group attending the SIGMAA Reception on the afternoon of January 19, 2000 in the Washington Omni Shoreham Hotel.

The approval of the SIGMAA RUME charter and good publicity work quickly attracted more applications to form SIGMAAs. During 2000 and 2001 charters were approved for the SIGMAA on Statistics Education (SIGMAA STATED), which was an outgrowth of the Isolated Teachers of Statistics group, and the SIGMAA on Business, Industry, and Government (BIG SIGMAA), which was formed by a group interested in the mathematical needs of members working in, and students intending to work in, non-academic employment.

With three SIGMAAs in place, the Task Force disbanded and a new standing committee of the MAA, the Committee on SIGMAAs, was established. Upon being formed, the Committee already had a number of applications on its agenda, and within its first year forwarded three recommendations that were approved by the Executive Committee. Thus, the SIGMAAs on the History of Mathematics (HOM SIGMAA), Environmental Mathematics (SIGMAA EM), and the Philosophy of Mathematics (POM SIGMAA) came into existence. During the last two years, approved status has been attained for the SIGMAAs on Mathematics Instruction Using the Web (WEB SIGMAA), Quantitative Literacy (SIGMAA QL), and Teaching Advanced High School Mathematics (SIGMAA TAHSM). Thus, there are currently nine active SIGMAAs represent-

ing a wide range of special interests within the MAA membership.

What's in it for you?

The SIGMAA program provides a relatively new, individually focused membership benefit that takes advantage of modern-day technologies and that, for a very minimal (currently $10) dues supplement, can be available to you. You can follow ListServ discussions among your colleagues, and — with only a few mouse clicks — you can be part of the discussion. As a SIGMAA member, you can propose topics for contributed paper sessions or panel discussions focused on your interest for inclusion in section or national meeting programs. You might even consider the possibility of volunteering for a leadership position as a SIGMAA officer.

The nine individual SIGMAAs would not exist today without the voluntary effort of their founders and officers who have strived to provide valuable member benefits. But, ultimately, it is the members that make their SIGMAA succeed — by paying dues, by attending and participating in sessions at meetings, by taking advantage of electronic communication to discuss ideas and solve problems, and most importantly by sharing a special mathematical interest with colleagues.

Take a look at the accompanying list that describes the nine SIGMAAs to see if one — or several — appeal to you, and consider joining! Or, if you and some colleagues share a mathematical special interest that is not represented by any of the existing groups, consider the possibility of forming a new SIGMAA.

Oh, and now that you are familiar with the SIGMAAs, can you match one with each of the three scenarios given at the beginning of this article? If you need help (or even if you don't), browse the SIGMAA web pages, which can be found at http://www.maa.org/SIGMAA/SIGMAA.html.

The author teaches at Rose-Hulman Institute of Technology and serves as the current chair of the MAA Committee on SIGMAAs. While on sabbatical leave during the 2004-2005 academic year, he is working as a Visiting Mathematician with the MAA Headquarters Office

MAA SIGMAAs

SIGMAA ON RUME *(Research in Undergraduate Mathematics Education)* RUME's mission is to foster research on learning and teaching undergraduate mathematics and to provide a support network for those who are involved in this area of study. RUME also welcomes those who teach secondary mathematics and/or are interested in the findings in research of undergraduate mathematics education.

BIG SIGMAA *(Business, Industry, and Government)* BIG SIGMAA serves as a unifying link between business, industry and government mathematicians, academic mathematicians, and mathematics students. The SIGMAA provides resources and a forum for MAA members who share an interest in mathematics used in business, industry, and government, aids in professional development, helps build partnerships between industry and academics, and increases awareness of opportunities for mathematicians in business, industry, and government.

SIGMAA Stat-Ed *(Statistics Education)* The mission of the SIGMAA on Statistics Education is to provide a forum for those who are interested in statistics education to meet, interact, offer support, and foster increased awareness of statistics education.

HOM SIGMAA *(History of Mathematics)* The mission of HOM SIGMAA is to provide a forum through which those interested in the history of mathematics can meet, interact, exchange ideas, provide support for one another, and foster increased awareness of the historical background of mathematics.

POM SIGMAA *(Philosophy of Mathematics)* The mission of POM SIGMAA is to stimulate interest in the philosophy of mathematics in the wider mathematical community; to inform this community of concepts, issues and recent developments in the philosophy of mathematics; and to encourage research in the philosophy of mathematics.

SIGMAA EM *(Environmental Mathematics)* The mission of SIGMAA EM is to provide a forum for those interested in solving problems arising from environmental sources. SIGMAA EM also promotes awareness of environmental issues and especially the role that mathematics plays in analyzing such issues.

SIGMAA QL *(Quantitative Literacy)* SIGMAA QL aims to provide a structure within the mathematics community to identify the prerequisite mathematical skills for quantitative literacy (QL) and find innovative ways of developing and implementing QL curricula. We also intend to assist colleagues in other disciplines to infuse appropriate QL experiences into their courses and hope to stimulate the general national dialogue concerning QL.

WEB SIGMAA *(Mathematics Instruction Using the Web)* The mission of WEB SIGMAA is to educate its members about the use of the Web for instruction in mathematics, encourage and facilitate project members using the Web for mathematics instruction, create an interactive community of MAA members interested in using the Web for mathematics instruction, and act as a resource for all MAA members seeking to use the Web for undergraduate instruction.

SIGMAA TAHSM (*Teaching Advanced High School Mathematics*) The mission of SIGMAA TAHSM is to support MAA members who share an interest in issues related to post-precalculus mathematics at the secondary school level by providing a forum for exchanging ideas, fostering increased understanding of these issues within the MAA, increasing the dialogue between the MAA and high school teachers, and utilizing expertise of the members in guiding and improving mathematical opportunities for advanced high school students.

Is Mathematics Needed for the Workplace?

By Dale Hathaway

Do students really need to take mathematics courses? Well of course my answer, and probably yours too, would be a resounding yes. But we are probably a bit biased. If we asked a group of chemistry teachers whether students need to take chemistry I'm sure they would provide us with an enthusiastic yes. What is needed is an unbiased answer. At least that is what others would require of us: evidence to support our position beyond our personal opinion. I have collected some evidence that I'd like to share.

Over the last few years our local newspaper has been running a column on careers. I started collecting and saving these articles. I was happily surprised by the classes they recommend that students take to prepare for the different professions. Mathematics is the subject mentioned most often as a necessary course, for careers ranging from accounting to welding. The column, entitled "Focus on Careers," is published in *The Daily Journal* in Kankakee, Illinois. It takes up a full page and includes information on the career, future job opportunities, where to get training, available jobs in the field (including possible salaries), a profile of a specific local person in that career, and lastly, but most pertinent to this article, a listing of classes that an individual interested in that career should take. The classes appear to be mostly high school classes, but I believe they also speak to the importance of mathematics at the college level.

I have collected 92 articles, from December 5, 2000 until the most recent on May 4, 2004. During this run English was mentioned 77 times, while mathematics (or math) was mentioned 68 times; the next highest specific subject, chemistry, was mentioned 32 times. Now that might appear to give English an edge over mathematics, but some articles, instead of simply saying mathematics, listed specific courses (algebra, algebra I, business math, calculus, geometry, probability and statistics, shop math, statistics, or trigonometry). When these sub-fields are counted, mathematical subjects are mentioned 110 times over the 92 articles. When English sub-fields (creative writing, English and language arts, English composition, English literature, reading, technical writing, and writing) are counted, English subjects are mentioned 90 times. The next closest general category is computer science with 61 appearances.

Still another way to examine this data is to consider how many articles mentioned any form of English or any form of mathematics. English subjects were mentioned in 82 of the 92 articles, or 89%, while mathematics subjects were mentioned in 86 articles, 93%. The careers for which the article did *not* mention mathematics were the following: physical therapy, feature editor, advertising/PR, death care industry, bilingual careers, and security guards. There were also 19 careers (20.7%) that mentioned multiple mathematics courses, such as mathematics and calculus or geometry and trigonometry.

You may wonder about my comparison of English with mathematics. The reason is quite simple: everyone seems to know of the importance of English. Many colleges and universities, including my own, require of all students a full year of English plus a literature course, while not all schools require a mathematics course of all students. English is certainly crucial, but mathematics is right up there in terms of what professionals need in career preparation. Evidence of this type has helped our department convince the rest of the faculty at our institution that every one of our students should be required to take at least one college level mathematics course. Starting in the fall of 2005, all our students will be required to take such a course.

I doubt that the careers represented in this column are truly a random sample of possible careers. Given the selection of both blue and white collar jobs, it seems clear that an attempt was made to get a wide variety of careers. It does appear that the sample was somewhat conditioned by convenience: at least three of the individuals featured work for the newspaper (editor, feature editor, and graphic designer). Nursing was also somewhat over-represented with 5 careers having nursing in the title. I don't think this significantly diminishes the significance of the results. Anecdotal evidence of the importance of mathematics and of the importance that people on the job place on mathematics classes is nevertheless compelling evidence of the crucial role that mathematics plays in many careers.

*Dale Hathaway (*Hathaway@olivet.edu*) is a professor of mathematics at Olivet Nazarene University and is interested in the birthday problem and puzzles. His collection of the latter consists of over 1000 different puzzles. He would be happy to send the* Excel *file tabulating his results to anyone who is interested.*

The First United States Conference on Teaching Statistics Aims to Build Connections for Statistics Teachers from All Disciplines

By Deb Rumsey

Would you like some new ideas about what to do with your introductory statistics course? How about some interesting data sets, examples, or in-class activities to get you and your students more involved? Want to try out the latest methods and research that are used in the introductory statistics classroom? Then plan to join us for the first *United States Conference on Teaching Statistics* (USCOTS) at Ohio State University, May 19-21, 2005.

Some of the scheduled speakers at the Plenary Sessions at USCOTS.

The goals of USCOTS are: to hold a national conference that focuses on undergraduate level statistics education (including AP Statistics); to share ideas, methods, and research results regarding what teachers want to know about teaching statistics; to help teachers incorporate new ideas, methods, and resources into their existing courses and programs; and to promote connections among teachers of undergraduate level statistics.

The conference will include Plenary Sessions on curriculum, pedagogy, resources, and research by national leaders in undergraduate and AP statistics education and Spotlight Sessions offering the opportunity to exchange ideas on teaching and learning statistics. Hands-on breakout sessions with leaders in statistics education from all types of institutions and disciplines will help participants incorporate new ideas into their courses. The conference will also offer many opportunities to meet other statistics teachers from a wide range of institutions and disciplines.

In addition to all the resources and the new connections participants will make at USCOTS, we want to know what's unique about your statistics teaching experience. You can contribute to USCOTS by participating in one of our Spotlight Sessions.

What is a Spotlight Session? A Spotlight Session is a "booths, posters, and beyond" session that provides a forum for conference participants to display, demonstrate, test drive, and discuss their favorite examples, activities, exercises, methods, labs, to share their experiences and thoughts on statistics teaching and learning, and get others engaged in idea exchange and discussion. Anyone who is going to the conference is encouraged to contribute to a Spotlight Session. Contributors will be acknowledged in the conference program, and information from the sessions will be included in the USCOTS Resource Notebook, to be given to all conference participants. We will also be having a "People's Choice Award" for the best contribution to each Spotlight Session.

USCOTS will feature 3 different Spotlight Sessions. *Spotlight on Curriculum* looks at answers to the question: "What's on Your Statistics Syllabus, What's Not, and Why?" Choose one or more topics on the introductory or second course syllabus, or discuss a whole course in general. *Spotlight on Pedagogy* focuses on how we teach: "What's Your Approach to Teaching Statistics, and Why?" For example, how do you get students involved? What resources do you use beyond your textbook? How do you handle the central limit theorem? *Spotlight on Research* will allow participants to "Share Your Research on Teaching and Learning Statistics." What research have you applied or carried out in your classroom to assess the teaching and learning process to make improvements in your class?

The goal of a Spotlight Session is to build connections with other teachers, to share ideas, get people involved, and to have fun. Here are some possible things to do:

Tell us about your favorite in-class examples and your students' reaction to them.

Bring in examples of projects that your students have worked on and how you evaluated them. Have conference participants play games that you use to teach probability.

Send us on a statistics scavenger hunt.

Tell us about your best day of teaching statistics, and what made it that way.

Test out a new activity for teaching sampling distributions that you are considering.

Show a video of your class involved in an in-class activity that involved teamwork.

Share your best statistics cartoons, sayings, top 10 lists, etc that you have shared with your class.

To register online for USCOTS, visit http://www.causeweb.org/uscots. On the registration form you can sign up for a Spotlight Session. For more information, contact Deb Rumsey, Organizer and Program Chair: rumsey@stat.ohio-state.edu. USCOTS is hosted by CAUSE, the Consortium for the Advancement of Undergraduate Statistics Education (http://www.causeweb.org).

Cabbages and Kings
A Philosophy of Teaching

By Larry Bouldin

In the Cold War climate of the late 1970s, in a graduate-level statistics class at the University of Tennessee, my instructor was asked what his teaching philosophy was. He replied, "I use the Russian method. I teach the best and shoot the rest," and gave a diabolical grin. The full class was not full at the next class meeting. He was actually an excellent teacher, despite his rather warped sense of humor. At the end of the year, we were grateful that we had experienced his classes.

Each of us has a philosophy of teaching, whether or not we have formalized it as a statement. In truth, we probably teach like someone that we liked — or the opposite of someone we did not. I have always wanted to teach. At one time, I thought it would be history; but then, as a twelve year old freshman in high school in Middle Tennessee, I was fortunate to be a student of Audrey Goldfinch. Her husband was on the faculty at Sewanee and she, with her degree from some prestigious university, was teaching algebra at rural Grundy County High School. This little, quirky, classy woman who wore chemise dresses, parted her black hair in the middle, and wore an emerald ring, *loved* mathematics (and very little else). And we loved her. She called us "people," not kids, nor students. Sometimes she would call us by our last names. "Mr. Bouldin, would you please put problem #4 on the board?" I would feel both honored and terrified, so I always worked all the problems in advance so that I would be prepared, not wanting to disappoint her.

Near Christmas break, she took me aside and told me that I was in the wrong class. I was in second period, and all her talented students were in first. "Would you be willing to work through two chapters of the book in order to join us after Christmas?" she asked. So I spent my Christmas break at the dining room table doing algebra problems, carried them all back to her in January, joined the first period class and there was no looking back. I was on my way. I came in third at the Tennessee Math Teachers Association regional contest in the spring, the first GCHS student to place in years. When Mrs. Goldfinch shook my hand with pleasure and pride, I decided then and there I wanted to do what she had done: take a scrawny kid and help him see his potential.

I had Mrs. Henninger for the rest of my high school mathematics. I liked her too, but in a different way. I did well for her, but she intimidated me, and I never knew how I stood with her. She was no Mrs. Goldfinch, but Mrs. Henninger taught me to love tulips in the spring; to arrange flowers and appreciate the simple designs of that art; to love dates stuffed with cream cheese at Christmas; and how to appreciate little elegant gestures. She wore beautiful clothes and dyed her hair red and had a wicked laugh. Math was important to her, but not her whole existence. I still wanted to teach, but realized that math could coexist with other things too. Henninger challenged me, and I needed that. With her, I always felt a pang of incompleteness — that I was somehow just not good enough but could some day perhaps join her circle of "really good students." The way to achieve that, she told me, was to go to a "good college" and major in math. After I had graduated from college, she called me to her home and told me that I had always been one of her favorites, but that I needed that uncertainty to give me an edge. When she died many years later, I sat and wept for an hour. I still plant tulips every year, try to do little elegant things at Christmas, and fondly remember Mary Henninger.

When I got to Lipscomb University in Nashville, I had Dr. Earl Dennis and Dr. Bob Kerce for my mathematics courses. Earl became my Goldfinch, and Kerce, my Henninger. I worked so hard not to disappoint Earl. He never had to ask us twice to do anything. We wanted to please him, because he loved mathematics and we knew he liked us. He taught us about proof and what made it "elegant" versus "just so-so." He wanted us to succeed and we did everything we could to make that happen. Dr. Kerce, on the other hand, was distant and demanding and unfathomable. We never knew where we stood and always felt somewhat inferior to previous star students he would sometimes extol. Years later, I would again come to feel towards Dr. Kerce as I had toward Mrs. Henninger. I appreciated all he had done for me in pushing me and holding out just beyond my reach another goal to achieve; when he mentioned graduate school to me, I took his advice and went.

When I got to Middle Tennessee State University, I encountered Dr. George Beers and Dr. Harold Spraker, and once again the Goldfinch/Henninger relationship. Beers and I loved abstract algebra and I became one of his prized pupils; Spraker and I enjoyed talking about farms and cattle and geometry, but a line remained drawn that I dared not cross. Then one day, Dr. Spraker called me to his office and informed me that I should apply to UT-Knoxville grad school and go for the doctorate. "You can do this," he said, and I believed him. When I finally finished, he sent me congratulations. I correspond with him still. (The doctorate was more like a job, and I did not enjoy Goldfinch/Henninger connections with anyone there — but perhaps I did not need to.)

So what does all this have to do with my philosophy of teaching? "We are a part of all we have met," the writer O. S. Marden said, and I am no exception. I love playing Goldfinch to that insecure, but talented student, encouraging him or her to see the potential for achievement. Just today I talked with the mother of one of my calculus students who is the light of my class. "He wasn't a very good student in high school," she related, "but now he comes home and does calculus

homework every night and tries to show me what he is doing and he is so happy." Needless to say, I am thrilled. However, next semester in Calculus II, I'll be his Henninger; I will push him, and he will wonder. I will eventually try to convert him from being an engineering major to a math major, and we'll start talking about graduate schools. He will not like me as well then, but years later I think he will. Even if he remains an engineering major, he will go to graduate school.

We can discuss technology, the Harvard project, the new and leaner calculus, "the student as customer," accountability, remediation, group learning, the Web, and whatever else is currently on the minds and tongues of the experts in education. At the end of the day, though, it still boils down to relationships between the teacher and the student. Some we connect with; others… well, it's another story. We who teach must know and continue to learn, be enthusiastic, and love mathematics. We must encourage, respect, and honor our students. We should let them know when we are proud of them and take the time to let them know we believe in them. We must have standards and mercy. We must push and demand and hold out in front of them goals and aspirations and always try to leave them wanting "just a bit more, sir." Some days they will not like us, but hopefully some day they will appreciate us. We should help them see a larger world, and take time to talk about tulips and elegance and cabbages and kings; teach them to differentiate well, not only functions, but between the good and the better. Take time to sing mathematical Christmas carols and tutor a kid who needs help with geometry. Some days we can be Audrey Goldfinch; some days, we can be Mary Henninger.

Larry Bouldin is Dean of Math and Science and Professor of Mathematics at Roane State Community College in, Harriman, TN

FOCUS Online — Columns, Back Issues, and Other Goodies

By Fernando Q. Gouvêa

FOCUS Online is the name for the portion of the MAA web site that is the online counterpart to the print version of FOCUS. But they are not identical. Here's what you can find on FOL:

Headlines: The MAA's home page includes several headlines about recent news, opportunities, and other items we feel will be of interest to MAA members.

News and Features: Every news item that appears in FOCUS also appears online, and usually earlier. Many of the longer items in FOCUS also appear as Featured Articles online, but some of the Featured Articles are online only. Both news and features can be found at http://www.maa.org/news/news.html, which also contains links to some useful MAA resources.

Columns: Five columnists contribute to MAA Online regularly. Ivars Peterson's *MathTrek* is a weekly column about recent and interesting mathematics. Keith Devlin's *Devlin's Angle* is more reflective and opinionated. Ed Pegg, Jr., contributes *Math Games*, which appears approximately every two weeks and covers all sorts of "recreational" mathematics. Both Devlin and Pegg recently wrote about the new *NUMB3RS* show on CBS, for example.

Ed Sandifer's monthly column, *How Euler Did It*, is more specialized, but not too much more. His stories deal with Euler's mathematics, and that covers quite a lot of ground. Colm Mulcahy is our newest columnist. His *Card Colm*, about mathematical card tricks, appears roughly every two months.

None of the online columns appears in FOCUS, so make sure you visit them online. The columns are listed on the home page and at http://www.maa.org/news/columns.html, from which you can also access the archived back issues and two other features on current mathematics, *Math Muse* and *Math News*, both from *Science News* magazine.

Teaching and Learning: At http://www.maa.org/t_and_l/index.html you can find two occasional columns. *Research Sampler* is a series of reports on recent research on mathematics education. *Innovative Teaching Exchange* is a forum for ideas about teaching.

Read This! is our book review column, soon to be linked up to the new *MAA Reviews*. We currently try to post new reviews about three times a month. Over the years, we have accumulated more than 500 reviews.

Back Issues: You can also access back issues of FOCUS, from January 2003 to one month ago. For the latest three issues, go to http://www.maa.org/pubs/focus.html for the latest three issues; click on "past issues" to go further back. This page also has information on how to get advertising into FOCUS, how to write for FOCUS, and on how to contact the editor.

Archives of American Mathematics Spotlight: The R. H. Bing Papers

By Kristy Sorensen, from material compiled by Frederic F. Burchsted

A highlight of the holdings at the Archives of American Mathematics (AAM) is the collection of papers of former MAA president R. H. Bing.

Bing was born in Oakwood, Texas, on October 20, l914. He graduated from Southwest Texas State Teachers College, San Marcos, in 1935 and, after several years as a high school mathematics teacher, began his graduate study at the University of Texas at Austin under R. L. Moore, receiving his doctorate in 1945. In 1947 he accepted a position at the University of Wisconsin, Madison, where he remained until returning to the University of Texas in 1973. Bing was elected to the National Academy of Sciences in 1965 (council member, 1970-1980), and was a member of the National Science Board (1968-1974) and of the National Research Council governing board (1977-1980). He was active in several mathematical organizations, including the Mathematical Association of America (president, 1963-1964), the American Mathematical Society (president, 1977-1978), the Council Board for the Mathematical Sciences (chairman, 1965-1966), the Mathematical Sciences Section of the National Academy of Sciences (chairman, 1970-1973), and the Division of Mathematical Sciences of the National Research Council (1967-1969). In 1974 he received the Mathematical Association of America Award for Distinguished Service to Mathematics.

Bing's research concentrated on the geometric topology of 3-manifolds, particularly their pathology. His side approximation theorem for 2-spheres in Euclidean 3-space and his "Bing shrinking" procedure have been generalized to higher dimensional manifolds. Bing summarized the field in his *The Geometric Topology of 3-Manifolds* (1983).

The Bing papers at the AAM primarily contain material from his years at the University of Texas at Austin (1973-

R.H. Bing lecturing to a group of mathematicians, undated. From the R.H. Bing Papers, Archives of American Mathematics, Center for American History, The University of Texas at Austin.

R.H. Bing with Lyndon B. Johnson, undated. From the R.H. Bing Papers, Archives of American Mathematics, Center for American History, The University of Texas at Austin.

R.H. Bing and his wife, Mary, at the Southwest Texas State (now Texas State University) Distinguished Alumni exhibit, 1984. From the R.H. Bing Papers, Archives of American Mathematics, Center for American History, The University of Texas at Austin.

R.H. Bing as a young man, taken by Brack's Studio, San Marcos, Texas, undated. From the R.H. Bing Papers, Archives of American Mathematics, Center for American History, The University of Texas at Austin.

1986), including Bing's work in preserving the papers of R. L. Moore, records of the formation of the Archives of American Mathematics, and the preparation of an unpublished Moore memorial volume. Bing's services to the scientific and mathematical communities are documented by records of his work for the National Academy of Sciences, the National Research Council, and various topology conferences and institutes. Bing's topological work is chiefly reflected in manuscript material and dittoed preprints (with annotations) of his *The Geometric Topology of 3-Manifolds* (1983). In addition to manuscript material, many photographs are included in this collection.

A portion of R. H. Bing's papers are in the Archives of Texas State University (formerly Southwest Texas State University). The inventory of the R. H. Bing Papers at the Archives for American Mathematics is available online at: http://www.lib.utexas.edu/taro/utcah/00222/cah-00222.html.

The Archives of American Mathematics is located at the Research and Collections division of the Center for American History on the University of Texas at Austin campus. Persons interested in conducting research or donating materials or who have general questions about the Archives of American Mathematics should contact Kristy Sorensen, Archivist, k.sorensen@mail.utexas.edu, (512) 495-4539. The Archives Web page can be accessed at: http://www.cah.utexas.edu/collectioncomponents/math.html.

Mathematical Knowledge for Teaching

The Mathematical Sciences Research Institute (MSRI) will host a workshop focused on Mathematical Knowledge for Teaching from May 25-28, 2005 in Berkeley, California. The conference is designed to bring together K-12 educators, educational researchers, mathematicians, and policy makers to examine what is known about the knowledge needed for teaching mathematics, and how it can be developed and learned. Funding may be available to support workshop attendees. Students, recent Ph.Ds, women, and minorities are particularly encouraged to apply. For more information, visit http://www.msri.org/.

What I Learned from... Going to Greece with the MAA

By Julius Barbanel

The suggestion of a classicist colleague a few years ago that I read Sophocles marked the start of my fascination with ancient Greek culture. I read Sophocles, the other tragedians, Homer, Herodotus, Thucydides, Plato, Aristophanes, and pretty much any ancient Greek literature I could find. I loved it all. It was through Plato, and the co-direction of a Union College student's senior thesis, that I discovered the beauty and excitement of ancient Greek mathematics. This student, who was a joint major in classics and mathematics, wrote her senior thesis on Plato's *Theaetetus*, a dialogue that deals with the theory of knowledge. The particular part of the dialogue on which she focused concerned the existence of what the Greeks called "incommensurable magnitudes," which are equivalent to what we would call "irrational numbers." I found it to be a fascinating project that involved also learning the Pythagorean and then the Eudoxian approaches to proportionality.

After this first project, I supervised a number of additional theses on various subjects in ancient Greek mathematics, such as the Platonic Solids and the Mechanical Method of Archimedes. I was enjoying learning this material and working on student projects immensely (always warning my students in advance that I'm a beginner, but an enthusiastic beginner). However, something was missing, and that was a sense of place, a sense of orientation. Let's see: Thales was from Miletus, Pythagoras from Samos, Plato founded his academy in Athens but traveled to Sicily, Euclid received his training from Plato's students and then founded an academy in Alexandria… Then I heard about the first MAA study tour to Greece, and I knew it was for me.

I had high expectations for the trip, and it exceeded them all. Let me start with my favorite, Delphi. Visiting Delphi, with its Temple of Apollo on towering Mount Parnassus, I thought about the problem of doubling the cube (i.e., for a given cube, construct a cube having double its volume). According to legend, this problem originated when the people of the Greek island of Delos, suffering from a terrible plague, asked the oracle at Delphi what they should do, and the oracle, who was believed to be speaking for the god Apollo, replied that they should build a cubical altar twice the size of their present cubical altar. (Plato's reaction to this was to argue that Apollo did not really want an altar built, but rather wanted to shame the Greeks for their neglect of geometry.)

Then there was our brief visit to the west coast of Turkey, an area that the ancient Greeks had colonized. As we walked past the ancient building, I imagined Thales walking in exactly the same place. Thales started it all. He is considered by most historians to have begun the entire ancient Greek scientific enterprise.

Near Thales' home of Miletus is the Greek island of Samos, where we stayed for a few days in the town of Pythagoria. Not too hard to guess this town's claim to fame. Pythagoras, perhaps as much a guru as a philosopher/mathematician, started a school and attracted many followers. It is fair to say that this school began the study of number theory and also music theory. And here we all were, drinking ouzo and eating baklava in Pythagoria. (My guess is that Pythagoras did neither.)

Also on the island of Samos, we toured the tunnel of Eupalinus, site of an ancient tunnel and a modern mystery. (How did the ancient builders of this tunnel manage to make the two ends of the tunnel meet in the middle of a mountain?)

In Athens, we visited the site of Plato's academy, probably the very first academic institution and toured the Agora where Socrates used to hang out and insist that people clearly define their terms and justify their beliefs.

Throughout the trip, we also heard wonderful lectures by Greek historians of mathematics on such topics as: the contrast between the mathematical philosophies of Plato and Aristotle, the planetary theory of Aristarchus (who described the orbits of the Earth and moon about the sun long before Copernicus), and the burning mirrors of Archimedes (used in the defense of Sicily against the Romans).

Julius Barbanel in front of a statue of Pythagorus in Pythagoreion, Samos.

Of course, we also saw many wonderful sites that did not directly connect with mathematics, such as Olympia (site of the original Olympic games), the Temple of Hera on Samos, and the ancient palace at Mycenae (the possible home of Agamemnon, one of the central characters in Homer's *Iliad*).

I am in the process of developing a course on ancient Greek mathematics for non-math majors. For this reason, Union College helped provide support (through the Hewlett Foundation) for my participation in the MAA study tour. I'm confident that this was money well spent. When I teach this course for the first time next year, I will be able to reinforce the mathematics of ancient Greece with pictures and stories from our trip and with a deeper sense of history and place.

Julius Barbanel is a professor of mathematics at Union College in Schenectady, New York.

*What I Learned from...*Using a Personal Response System

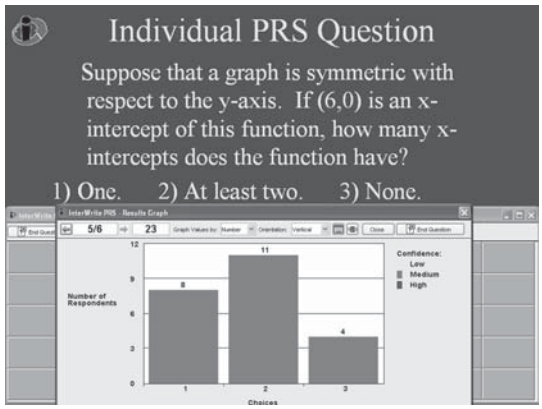
By Melanie Butler

During the summer of 2004, I began working to help mathematics instructors at West Virginia University learn to use a Personal Response System (PRS). As a member of the Institute for Mathematics Learning (IML), within the Mathematics Department, I am particularly interested in finding ways to increase student engagement and success in the below calculus level courses. The Dean's Office had just purchased the system, which allows an instructor to pose a (usually multiple choice) question to a class. The students then use their individual transmitters (basically like a television remote) to answer the question. The computer collects and records these transmissions, and the instructor can choose when to show the results of the classroom poll.

I decided to serve as the contact person for the mathematics department (and later as the contact person for anyone wishing to learn to use the system in one of the classrooms). This position meant that I would help train instructors to use the PRS, help alleviate problems, and just generally try to keep enthusiasm high. It also meant that I would need to be successful using the PRS in my fall 2004 College Algebra classroom of 200 students. Through these processes, I learned some things about students and new technology.

Something will always go wrong!

Learning to use the new PRS was somewhat daunting. The only training provided by the university occurred a mere week before classes started. By learning the system on my own and through contacts with the company, I was able to help the other instructors get a head start. Having someone in the department willing to take on this responsibility made a difference in the learning curve that we all experienced. The departments where someone stepped forward are using the technology, whereas the departments that didn't have a contact are having more trouble getting it off the ground.



A screen shot of the PRS in action.

As the semester began (and we had less time to learn about the PRS than we had hoped), things went wrong. The transmitters wouldn't send a signal. The software wouldn't run on the computer. People were upset. At this point, it was important for one person to remain optimistic and ready to work on the problems. As the semester has progressed, we have had fewer and fewer problems (or at least we have learned to deal with the problems that we encounter in a better way). Giving ourselves time to deal with the new technology, to feel frustrated but to keep working was very important.

The students will do it!

Before the semester began, we were all nervous about how the students would respond to the PRS. Being nervous about using the technology ourselves only made the problem worse. I walked into my college algebra classroom with the attitude that this technology was new, fun, and that we were going to use it faithfully. The students didn't bat an eye. Many of these students have grown up in a time when they are constantly adjusting to new technology. The students took this new aspect of the course as they would any other change (a new text, a new syllabus, etc.).

The PRS questions were factored into the students' attendance grades. A relaxed attitude toward the PRS helped the students to feel comfortable with the new technology on which they would be graded. I didn't get upset if something went wrong, and neither did the students. If the PRS didn't work for whatever reason, I made sure that the students understood that it wouldn't affect their grades.

Students like to have a say!

There is something neat about asking a question to 200 people and being able to see immediately (or in 30 seconds or so) what everyone thinks. Would you like me to do another example like this? Why were the grades on this last test so much better? How do you factor this polynomial? As an instructor and as a student there are so many benefits to seeing what everyone thinks (plus it's just cool).

Moreover, as a student, it is great to have a say on what is going on in the classroom. When the graph of student responses is displayed, every vote is counted. 156 students understand this example, or 122 students need more explanation. Asking the students a question, considering their responses, and adjusting a lecture accordingly does a world of good for showing 200 students that you care about them. With the PRS, I can easily do these steps several times a class. It's too soon to say if the grades will show any effects from PRS use (I had one section with PRS and one section without), but, from an instructor's perspective, classroom engagement was definitely affected.

I plan to use the PRS in a college algebra class in the fall. I also plan to help more people learn the technology and the benefits that it can bring. Members of the IML are currently conducting research into the effects of PRS use. I hope to see more research and resources for PRS use in the future.

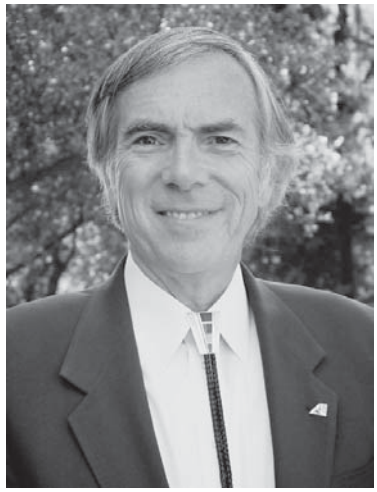
Melanie Butler is a member of the Institute for Mathematics Learning at West Virginia University. Please feel free to contact her at mbutler@math.wvu.edu.

MAA National Elections Coming Up in April

By Martha J. Siegel, Secretary

Joseph A. Gallian

William James (Jim) Lewis



Robert E. Megginson

A new MAA President has just taken office; how can it be time for elections again? The reason is the MAA's system of allowing future Presidents a full year of President-Elect status, during which time they participate in the governance of the Association and get ready for their two years as President. So it's time to elect the person who will serve as President-Elect in 2006 and then as President in 2007 and 2008. It's also time to choose new MAA Vice-Presidents who will serve in 2006 and 2007.

Election booklets and ballots will be mailed by approximately April 1. As in the 2003 national election, members will be able to vote either electronically or using paper ballots.

The Candidates for the MAA National Elections are:

President-Elect: Joseph A. Gallian (University of Minnesota, Duluth), William James (Jim) Lewis (University of Nebraska, Lincoln), and Robert E. Megginson (University of Michigan).

First Vice-President: Amy Cohen (Rutgers University), William Hawkins, Jr. (University of the District of Columbia), and Carl Pomerance (Dartmouth College).

Second Vice-President: Deanna B. Haunsperger (Carleton College), Mario Umberto Martelli (McKenna College), and Janet P. Ray (Seattle Central Community College, ret.)

From the Ballot:

TO ALL MEMBERS OF THE ASSOCIATION: In accordance with Article IV, Sections 1(a) and 2 of the Bylaws of the Association, you are hereby afforded an opportunity to vote for candidates for the offices of President-Elect for a term of one year (who will become President in 2007 for a term of two years), First Vice-President for a term of two years, and Second Vice-President for a term of two years.

The Bylaws provide for approval voting. Thus each voting member of the Association may vote for as many candidates for each office as he or she desires. Since voting for all three of the candidates for an office leads to the same outcome as voting for none of them, you may choose to vote for one or two candidates for each office. For a detailed discussion on approval voting, see the FOCUS article, Volume 7, Number 2, March-April 1987, pp 2, 5.

Members of the Nominating Committee were Thomas F. Banchoff (Chair), David Bressoud, Wade Ellis, Jr., Aparna W. Higgins, and Ann Watkins. 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. The candidate's statements (to appear on the ballots and online) are limited to 250 words for President-Elect, and 150 words for First Vice-President and Second Vice-President. Within their statements, the candidates were asked to submit their MAA activities, other professional activities, and what they think are the main challenges facing the MAA.

NSF Beat

By Sharon Cutler Ross

Profound changes in our understanding and application of the biological sciences have implications for the mathematics used by researchers in the life sciences. Whereas twenty years ago a calculus for biology majors and a statistical methods class might have provided a foundation for a beginning life sciences researcher, today more sophisticated mathematics is required. The Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM) initiative of the NSF addresses this issue by enhancing undergraduate education and training at the intersection of the biological and mathematical sciences. This joint effort of the Education and Human Resources (EHR), Biological Sciences (BIO), and Mathematical and Physical Sciences (MPS) directorates seeks to better prepare biology or mathematics students to pursue graduate study and careers that integrate mathematical and biological sciences. In Fall 2004, eight UBM awards were made. In addition, an NSF Director's Award recognized the collaborative efforts of the UBM management team: S. Scheiner (BIO), E. Teles (EHR), C. Williams (EHR), M. Steuerwalt (MPS), and H. Blount (MPS).

The UBM project at the New Jersey Institute of Technology (A. Bose, PI) will develop a training program in which mathematics and biology are linked at both the curricular and research levels. A primary goal is to enable students to converse in the languages of both mathematicians and biologists. The program will also develop an interdisciplinary curriculum and train students to conduct independent research and demonstrate how mathematics and biology complement one another.

The University of Vermont and State Agricultural College project (L. Stevens, PI) integrates interdisciplinary mathematics and biology courses with multi-year research projects. One activity is a seminar series that examines how biology and mathematics combine in contemporary studies to investigate hypotheses and analyze data. A capstone course will give students the opportunity to analyze and present their research data in a polished paper for presentation.

Research-focused learning communities form the basis of the UBM project at Truman State University (J. Miller, PI). Student-faculty teams will conduct interdisciplinary research and engage in activities designed to foster both intellectual independence and professional and social interaction within the student cohort. Each research project calls upon a wide range of mathematical and quantitative skills, tools, and approaches and advances knowledge in the biological sciences.

At SUNY-Geneseo (A. Macula, PI), a new and revised problem-based curriculum will be combined with research activities that use modern techniques to study complex problems. Jointly mentored biomathematical research projects are the core of the program. Not only do they introduce students to cutting-edge research, these projects also will stimulate faculty development and curricular innovation.

Summer research programs play a key role in the UBM training program at Arizona State University (Y. Kuang, PI). New cross-disciplinary courses will facilitate the earning of a bioscience or mathematics minor by students in the other field. Faculty from mathematics, biology, and biophysics will provide students with experience in cross-disciplinary communication and explorations.

The San Francisco State University project (E. Connor, PI) uses a focus on environmental biology to train students to do research at the interface of the biological and mathematical sciences. The goals of the project will be met through research experiences, close mentoring in research teams, group activities, and careful advising.

At Texas A&M (V. Cassone, PI) groups of biology and mathematics students will be recruited each year from diverse backgrounds to study a new common curriculum that incorporates advanced biological and mathematical tools, attend a quantitative biology seminar, and receive training in a biology research program. A long-term goal is to develop a quantitative biology major and a mathematical biology emphasis in applied mathematics.

The main focus of the William and Mary College project (D. Cristol, PI) is on mentoring with each undergraduate having a mathematician and a biologist mentor. New bio-math courses will be developed and a regional bio-math conference organized. Partnering with a local two-year college will aid in the recruitment of underrepresented populations. Research will focus on the dynamics and viability of animal meta-populations.

Letters to the Editor

My Own Mathematical Tour

I read with interest the brief article by Herbert Kasube about why one should take a mathematical tour, in the December 2004 FOCUS.

Although I have not been on a formal study tour, last August I visited St. Petersburg, Russia for 5 days and made it my business to seek out the house where Euler lived near the Mathematical Institute and Academy of Sciences. I also saw the nearby place where the mathematicians Lyapunov, Markov, Chebyshev, Ostrogradsky, and Steklov worked. Both buildings are on the Leytenant Schmidt Embankment along the Neva River. There are plaques commemorating them at both places. Also I visited Euler's tomb at the Alexander Nevsky Lavra cemetery. I am sure there are many readers who have been there. A study tour to St. Petersburg and region, and maybe to Moscow, would be interesting. Unfortunately, I did not have enough time to meet Andrei Lotkin, Secretary of the St. Petersburg Mathematics Society, who generously had given me the information and directions I needed to visit these sites in an expeditious way.

Donald L. Muench
St. John Fisher College
dmuench@sjfc.edu

Plaque commemorating Leonhard Euler. The text reads: "LEONHARD EULER lived here from 1766 to 1783. He was a member of the Petersburg Academy of Sciences, a highly prominent mathematician, student of mechanics, and physicist.

Euler's house, at #15 Lt. Schmidt Embankment, in St. Petersburg.

Euler's tomb in St. Petersburg. The tombstone reads LEONHARDO EULERO, Academia Petropolitana, MDCCCXXXVII.

Correction on the Putnam Fellows Article

I just wanted to point out an error in the FOCUS article on the Putnam Fellows by Alexanderson. The error is in the Kaplansky quote to the effect that Zariski is the only person to have had two students go on to get Fields Medals (Hironaka and Mumford). Bott also had two, Smale at Michigan and Quillen at Harvard. But if my memory is half as good as Kaplansky's when I'm 87, I'll be happy!

Rob Kirby
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Ten Years with the MAA

My ten year membership certificate from the Mathematical Association of America recently arrived in the mail, and I very much appreciate receiving it.

This event caused me to reflect upon why I have remained a member for ten years. I am not a professional mathematician or educator. However I have and do work in technical industries — computers and pharmaceuticals — that use mathematics especially statistics.

My reasons for remaining a member are

1. I enjoy MAA publications especially the historical articles and published problems. Math problems challenge my reasoning abilities, and I have found better reasoning skills to be of benefit in many areas of life. A good math problem is like a good mystery story — I can't wait to unravel it!

Historical articles expose the context in which mathematics grows and operates. Much of the resistance that I have seen to the use of mathematics comes from a lack of understanding of its goals and purposes, which are best understood by reading the history of the subject.

2. I enjoy discussions of the applications of mathematics because examples and applications enhance mathematical intuition and display the power of mathematics to influence the physical, social, and artistic worlds.

However I do have one criticism — not enough is written about the application of mathematics to the life and social sciences. I would like to see more articles written on mathematical applications to biology, financial engineering, and the design of equitable voting and allocation rules. Game theory, optimization, and probability theory are some of the core mathematical ideas that come to mind in thinking about social issues. Social problems need exact reasoning just as a much as physical problems, and I have faith that mathematics can contribute mightily to the solution of social problems.

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"The heart and soul of understanding calculus"

The title, "Must Calculus Come First?", of Rick Norwood's letter (December 2004) caught my attention. Judging by the many students in my classes who had already taken calculus in high school, I am indeed concerned about the manner calculus is taught in high school. But leaving aside the question of whether replacing calculus by elementary linear algebra might indeed improve matters, I was really surprised to read that "for every epsilon there is a delta" is "the heart and soul of understanding calculus". According to this statement, Newton, Leibniz and all the other early masters of analysis didn't really understand calculus. Surely Rick Norwood must have meant something else, and before we discuss the merits of linear algebra versus calculus we better agree what we should be talking about.

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How to find good math research questions

Jeff Suzuki suggested a method for finding significant but manageable research topics with the clever acronym PEACE (December 2004). In addition to the Suzuki method, in the old days physics inspired many mathematicians, including Newton, Fermat, Bernoulli, Euler, Lagrange, Gauss, Cauchy, Fourier, Laplace, Dirichlet, Riemann, Poincare, Hilbert, Weyl, Cartan, von Neumann, Birkhoff, Kolmogorov, Wiener, Schwartz, Mackey and a litany of others. Today computer science, biology, chemistry, economics, and engineering also provide inspiration for some adventurous mathematicians, including Smale, Mumford, Yau, Nash, Diaconis and others. Moreover, physics continues to be a strong influence on pure math (e.g., Witten, Gromov, Seiberg, Jones, Connes, Novikov, Arnold and Yau).

However, this approach is more difficult than the Suzuki method for young researchers, who are generally not aware of the important open questions raised by modern science and technology. Moreover, this alternative approach is not the easiest road to successful research or tenure for several reasons. First, it is often difficult to transform vague questions from science and technology into precise mathematical theorems. Second, the likelihood of a young mathematician being able to prove such theorems is low, owing to the broad range of tools required, compared with a narrow field of math. Third, the resulting work may not be appreciated by other mathematicians because it often doesn't look or feel like real mathematics. Nevertheless, both mathematics and science would be poorer without continued cross fertilization by an adventurous and determined minority of mathematicians.

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Short Takes

Compiled by Fernando Q. Gouvêa

International Comparisons Generate Reactions

Every so often, studies compare the mathematics achievements of American students with those of students from other nations. The results reliably produce strong reactions. Tony Chan, a mathematician who is Dean of Physical Science at UCLA (and a member of MAA), noted in the *Los Angeles Times* (January 2, 2005) that Americans so undervalue mathematics that "countries we beat in the Olympics defeat us in math." On the next day, an editorial in the *Detroit Free Press* argued that Americans can no longer ignore the fact that our students perform poorly in comparison to the rest of the world. Similar comments appeared in the *Wall Street Journal* and many other papers, several of which worried about the economic impact of this under-performance.

Education Week (January 5, 2005) quoted Cathy Seeley, president of NCTM, who called attention to the results of the Program for International Student Assessment (PISA), on which U. S. students scored below the international average in both problem solving and mathematics literacy. The latest TIMSS (Trends in International Mathematics and Science Study) study, available online at http://timss.bc.edu, confirms that finding: the U.S. ranked 15th out of 45 countries surveyed in 8th-grade math, and 9th in science; of the 25 countries included in the 4th-grade rankings, the U.S. came in 12th in math and 6th in science. Another study, by the Organization for Economic Cooperation and Development (OECD), ranked the United States in 24th place among the 29 industrialized countries in its survey. Finland, Korea, and Japan had the top three slots.

A Truce in the "Math Wars"?

The so-called "Math Wars," i.e., the debate about mathematics curricula for the schools, have generated much bitter argument over the last few years. According to *The Washington Post*, we may be near to a "truce." The newspaper reported in its December 21, 2004 issue that a "peace summit" was held in Washington. Organized by Richard Schaar of Texas Instruments, the meeting brought together five leading mathematicians and mathematics educators: R. James Milgram of Stanford, Jeremy Kilpatrick of the University of Georgia, Wilfried Schmid of Harvard, Deborah Ball of the University of Michigan, and Joan Ferrini-Mundy of Michigan State. According to the *Post*, the group found that they did agree on some basic principles and intend to continue meeting. The hoped-for end result is a consensus report on mathematics education.

More Doctorates

According to the *Chronicle of Higher Education* (January 7, 2005), the number of new PhDs increased by about 2% in 2003, reversing a downward trend over the previous three years. In particular, the number of doctorates awarded to men went up for the first time since 1996. Most of the increase happened in the "physical sciences, engineering, social sciences, and education."

The data comes from the annual Survey of Earned Doctorates, is online at http://www.norc.uchicago.edu/issues/sed-2003.pdf. The report includes data on where the new PhDs got their undergraduate degrees and other interesting information. Of the doctorates surveyed, 19% of those awarded to U.S. citizens were earned by students in "American minority groups." Women received 45% of all doctorates in 2003, but American women earned 51% of those going to U.S. citizens.

March 14 is Pi Day

Math departments or math clubs looking for a convenient vehicle for an outreach event or celebration may be interested in planning for "Pi Day" on March 14 (3/14), using, for example, the activities suggested in MAA member Larry Lesser's article in the current issue of *Texas Mathematics Teacher*, online at http://www.tenet.edu/tctm/downloads/TMT_Fall_04.pdf. Lesser's mathematical lyric "American Pi" appears in the recent book *Pi: A Biography of the World's Most Mysterious Number*, by Alfred S. Posamentier and Ingmar Lehmann (a review of which is forthcoming in the MAA's online book reviews column, *Read This!*).

NRC Publishes Report on Student Learning

The National Research Council has released a report, *How Students Learn*, focusing on mathematics, science, and history. The report synthesizes research on how students learn and highlights three "fundamental and well-established" principles of effective teaching: taking into account and explicitly addressing students' initial understanding and preconceptions; developing competence by helping students accumulate factual knowledge and incorporate that knowledge into a useful conceptual framework which allows for easy retrieval of information; and using "metacognitive" teaching strategies that help students take control of their learning by setting their own goals and assessing their progress. The volume includes specific recommendations and examples. The report can be ordered or read online at http://www.nap.edu/books/0309074339/html. A review will appear soon on MAA Online.

Mathematician's Coins Help Local Church and College

On January 17, 2005, the *Observer-Dispatch* of Utica, NY reported on the legacy of Wayne Palmer, who taught mathematics at Utica College for many years before his death in February, 2004. Palmer had made arrangements to donate his coin collection to Utica College and the First Church of Christ Scientist Utica-New Hartford, where he was a member. The collection was auctioned off for $1.2 million, divided equally between the two institutions.

According to the newspaper, "In his 74 years, Wayne Palmer never saw a quality coin he didn't like — or collect." His collection contained rare coins from all over the world, especially the British Commonwealth. The auctioneers described

the collection as "absolutely fabulous." Palmer also collected cans and bottles, and that collection provided $50,000 for a scholarship fund.

Salary Gap Gets Smaller

Much has been written about the salary gap between those who have a college education and those with only a high school diploma. College graduates earn about 45% more, on average, but according to an article in *The New York Times* (January 13, 2005) the gap has decreased in the last few years after rising sharply throughout the 1980s. The article attributes the change to supply and demand: tight labor markets increased the demand for less-educated workers and the number of immigrants with advanced degrees grew significantly. The article quotes economist David Autor, who says that the demand for workers with "very strong cognitive, managerial, and communications skills" is strong and rising, but notes that not all college graduates fall into that category.

"Math Set Him Free"

The January 15 *Des Moines Register* tells the story of William White, who was sentenced to 50 years in prison when he was 14 and who has just, at age 33, graduated with a major in computer science and a minor in mathematics from Drake University. The article highlights the lack of intellectual stimulation in White's environment as a child, and tells of how he discovered mathematics while in prison. Against all odds, he completed his high school degree, and eventually got a work release and went to Drake University. You can read the story online at http://desmoinesregister.com/apps/pbcs.dll/article?AID=/20050116/NEWS02/501160303/1004.

Colleges Reevaluate AP Credit

It was a while ago, but we have just realized that National Public Radio ran a story on November 8, 2004 discussing the decision of several colleges to modify the way they give credit for AP mathematics courses. The story was in NPR's *All Things Considered* program and was reported by Robert Frederick. NPR's blurb says that "Colleges are making it more difficult for incoming students to get credit for advanced placement calculus, and some high schools are changing the way they teach calculus as a result." The report is online at the *All Things Considered* archives, and can be found at http://www.npr.org/templates/story/story.php?storyId=4159468. Several prominent mathematics educators are interviewed in the piece, which also highlights the conflict between the expectations of leading colleges and the expectations of American colleges as a whole.

Sources

International Comparisons: NASSMC Briefing Service, http://nbs.nassmc.org. *Peace Summit*: NASSMC Briefing Service, The Washington Post, http://www.washingtonpost.com/wp-dyn/articles/A15026-2004Dec20.html. *Doctorates*: Chronicle of Higher Education (January 7, 2005). *Pi Day*: email communication from Larry Lesser. *NRC Report*: Education Week (January 12, 2005), National Academies web site. *Coin collection*: email communication, Utica Observer-Dispatch. *Salary gap*: NASSMC Briefing Service, *The New York Times*. *William White*: NASSMC Briefing Service, Des Moines Register.

In Memoriam

Frank Harary, died at 83 in Las Cruces, NM, on January 4, 2005 after a brief illness. Dr. Harary was widely recognized as the "father" of modern graph theory, a discipline of mathematics he helped found, popularize, and revitalize. His book *Graph Theory*, written in 1969, had an important role in attracting people to the subject and demonstrating its importance; it is still in print. Haray was educated at Brooklyn College and the University of California at Berkeley, and taught for many years at the University of Michigan before moving to New Mexico State University at Las Cruces. He was a member of the MAA for 58 years.

Henry Thomassen, an economist and a longtime member of the American Statistical Association and of the Mathematical Association of America, passed away suddenly May 27, 2004. Most recently, Thomassen was serving as economic advisor to the Georgia governor; a role he fulfilled for more than three decades, spanning the administrations of eight governors. Earlier Dr. T (as he was known to friends and associates) had been a faculty member at Georgia State University, Emory University, the University of British Columbia and the University of Nebraska. Before his years as a university professor, Thomassen, who was born in Calgary, had played hockey professionally and served with the Canadian army in the Korean War. He is survived by Helen Thomassen, his wife of more than 40 years, and their five children. He was a member of the MAA for 28 years.

Infinite Possibilities

Spelman College is proud to host the *Infinite Possibilities Conference*, to be held April 1–2, 2005. This unique gathering will assemble women mathematicians from underrepresented minority groups from all over the country for a stimulating 2-day mathematics conference.

The Infinite Possibilities Conference will host professionals, undergraduates, and graduate students, from the various fields of mathematics. Highlights of conference activities include panel discussion on graduate studies in mathematics, research talks given by professionals, student poster sessions, discussions on experiences with mathematics, and a banquet and award ceremony for special achievement in mathematics in honor of the late Dr. Etta Z. Falconer.

For more information visit http://www.ipc2005.com.

Employment Opportunities

KENTUCKY

Western Kentucky
UniversityApplications are invited for the position of Head of the Department of Mathematics starting July 1, 2005.

Applicant must have a doctorate in mathematics or a mathematical science with appropriate credentials for a tenured appointment at the rank of professor. We are seeking a dedicated and effective leader who can help promote and strengthen the department's academic, research, and service programs. Qualified candidates must have a commitment to recognizing and encouraging excellence in teaching, have a familiarity with current issues involving the mathematics curriculum, and technology, and have an established record of research/scholarly activity and a commitment to encouraging such activity, and have a history of significant professional service. Evidence of additional administrative expertise is also desired.

Mathematics is one of the nine departments in the College of Science and Engineering. With 34 full-time positions (23 tenured/tenure-track), the department offers baccalaureate and masters programs in mathematics. In addition, mathematics is included in the university general education requirements for all undergraduate degrees.

Western Kentucky University enrolls approximately 18,000 undergraduate and graduate students, including more than 1300 minority and 500 international students, and has a strong commitment to achieving diversity among faculty, staff, and administration. The university is in Bowling Green, between Nashville, TN and Louisville.

Review of applications will begin February 1, 2005 and will continue until the position is filled. Please send a letter of application, vita, a statement of administrative leadership philosophy, and at least three letters of recommendation to:

Dr. Frank Conley, Interim Chair,
Search Committee
Department of Mathematics
Western Kentucky University
1 Big Red Way
Bowling Green, KY 42101
e-mail: frank.conley@wku.edu

For more information about the Department of Mathematics at Western Kentucky University, visit our web page at www.wku.edu/math

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Mathematics & Computer Science: The **Mathematics & Computer Science** Department of Bronx Community College, City University of New York, seeks to fill out six tenure-track positions in the ranks of Lecturer/Assistant/Associate Professor.

LECTURER/ASSISTANT PROFESSOR

Description and Duties: Full-time tenure-track faculty position to teach developmental and upper level Mathematics and Computer Science courses. Evening, Saturday, and Sunday teaching required.

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Salary Range:

Lecturer: $32,997 - $53,113 Assistant Professor: $35,031 - $56,014

ASSISTANT/ASSOCIATE PROFESSOR

Position Description and Duties: Full-time tenure-track faculty position teaching mathematics courses, participating in interdisciplinary course development; commitment to improving student's writing and thinking skills; student recruitment; student advisement; research in mathematics education; and service to the college and community. Evening, Saturday, and Sunday teaching required.

Qualification Requirements: Ph.D. or Ed.D. in Mathematics or Mathematics Education, with a research agenda in Mathematics Education. Candidates with experience in teacher preparation for secondary school mathematics instruction will be given special consideration.

Salary Range:

Assistant Professor: $41,974 - $61,111 Associate Professor: $45,651 - $73,028

Send cover letter and resume, listing current salary and three letters of reference by 04/08/05 to: **Ms. Shelley B. Levy, Director of Human Resources, Office of Human Resources, Bronx Community College, University Avenue & West 181st Street, Bronx, NY 10453.**

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Balloon rides in Albuquerque are a major attraction and available daily. For more information on balloon rides and tours, check the special April meetings issue of FOCUS.

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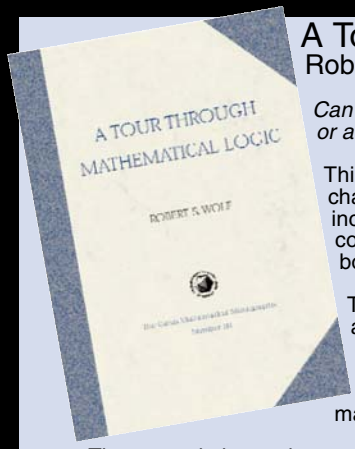

A Tour Through Mathematical Logic

Robert S. Wolf

Can be used as a text in a course in mathematical logic or set theory, or as supplemental reading in these or a course in recursion theory, model theory, or nonstandard analysis.

This book provides a tour through the main branches of the foundations of mathematics. It contains chapters covering elementary logic, basic set theory, recursion theory, Gödel's (and others') incompleteness theorems, model theory, independence results in set theory, nonstandard analysis, and constructive mathematics. In addition, this monograph discusses several topics not normally found in books of this type, such as fuzzy logic, nonmonotonic logic, and complexity theory.

The word "tour" in the title deserves some explanation. This word is meant to emphasize that this is not a textbook in the strict sense. It lacks many of the details and proofs that one normally expects in a mathematics text. However, in almost all such cases there are references to more detailed treatments and the omitted proofs. Therefore, this book is actually quite suitable for use as a text at the university level (undergraduate or graduate), provided that the instructor is, willing to provide supplementary material from time to time.

The most obvious advantage of this omission of detail is that this monograph is able to cover a lot more material than if it were a standard textbook of the same size, This de-emphasis on detail is also intended to help the reader concentrate on the big picture, the essential ideas of the subject, without getting bogged down in minutiae. The goal of this book is: to provide an introduction to the foundations of mathematics that is substantial and stimulating, and at the same time a pleasure to read. It is designed so that any interested reader with some post-calculus experience in mathematics should be able to read it, enjoy it, and learn about it.

Catalog Code: CAM-30 • 408 pp., Hardbound, 2005 • ISBN: 0-88385-036-2 • List Price: $52.95 • MAA Member Price: $42.95

Fourier Series

Rajendra Bhatia

Suitable as a text in a course in analysis, mathematical methods, or mathematical physics.

This concise introduction to Fourier series covers history, major themes, theorems, examples and applications. It can be used to learn the subject and also to supplement, enhance and embellish undergraduate courses on mathematical analysis.

The book begins with a brief summary of the rich history of the subject over three centuries. The subject is presented in a way that enables the reader to appreciate how a mathematical theory develops in stages from a practical problem (such as conduction of heat) to an abstract theory dealing with concepts such as sets, functions, infinity, and convergence. The abstract theory will provide unforeseen applications in diverse areas.

The book begins with a description of the problem that led Fourier to introduce his famous theory. The mathematical problems this leads to are discussed rigorously. Examples, exercises and directions for further reading and research are provided, along with a chapter that provides material at a more advanced level suitable for graduate students. The author demonstrates applications of the theory as well as a broad range of problems.

Exercises of varying levels of difficulty are scattered throughout the book. These will help readers test their understanding of the material.

Catalog Code: FSE • 140 pp., Hardbound, 2005 • ISBN: 0-88385-740-5 • List Price: $46.50 • MAA Member Price: $36.50

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