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

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

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

Please address advertising inquiries to: Rebecca Hall RHall@MarketingGeneral.com

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

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Volume 25 Issue 9

Inside

FOCUS Deadlines

	February	March	May/June
Editorial Copy	December 15	January 15	March 15
Display Ads	December 20	January 28	March 28
Employment Ads	December 9	January 15	March 10

Mathematics at the AAAS Meeting, February 2006

By Warren Page

The 2006 Annual Meeting of the American Association for the Advancement of Science, to be held February 16–20, in St. Louis, MO, will feature many outstanding expository talks by prominent mathematicians. The following symposia sponsored by Section A (Mathematics) are part of the special mathematical event "Beyond Pi: Grand Challenges in the Mathematical Sciences."

Paradise Lost? The Changing Nature of Mathematical Proof (organized by Keith Devlin)

Million-Dollar Mathematics: Challenge Problems in the 21st Century (organized by John Ewing and James Carlson)

NUMB3RS and the Challenge of Changing Public Perception of Mathematics (organized by Robert Osserman and Tony Chan)

Astrodynamics, Space Missions, and Chaos (organized by Edward Belbruno)

Tsunamis: Their Hydronamics and Impact on People (organized by Walter Craig, Jerry Bona, and John Mutter)

How Insects Fly (organized by Jane Wang)
Arches: Gateways From Science to Culture (organized by Kim Williams)

Other symposia that will be of interest to the mathematical community include: *Physics of Virtual Worlds, Frontiers in Biological Imaging: From Cells to Humans, Imaging Dynamical Diseases in the Brain, Refining Einstein: The Search for Relativity Violations, Science and Engineering Challenges and Opportunities in Homeland Security, Overcoming Gender Stereotypes: Girls in Science, Engineering, and Technology, Computer Science Behind Your Science, Expanding Universe of Digital Data Collections, Evaluating Curricular Effectiveness: Judging the Quality of K-12 Mathematics Evaluations, and Four Eye-Opening Science Education Research Studies: Connecting Science and Educational Research.*

The above symposia are only a few of the 200 or so AAAS program offerings in the physical, life, social, and biological sciences. For further details about the 2006 AAAS program, see the October 21st, 2005 issue of *Science* or visit the web site at http://www.aaasmeeting.org and look under "Program and Events."

AAAS annual meetings are the showcases of American science, and they encourage participation by mathematicians and mathematics educators. (Section A acknowledges the generous contributions of AMS for travel support and SIAM for support of media awareness.) In presenting mathematics-related themes to the AAAS Program Committee, I have found the committee to be genuinely interested in offering symposia on mathematical topics of current interest. Thus, Section A's Committee seeks organizers and speakers who can present substantial new material in an accessible manner to a large scientific audience. Toward this end, I invite you to attend our Section A business meeting 7:45 p.m.–10:00 p.m. Friday, February 17th, 2006 in the Benton room of the Renaissance Grand Hotel. I invite you also to send me, and encourage your colleagues to send me, symposia proposals for future AAAS annual meetings.

*Warren Page (*wxpny@aol.com*) is Secretary of Section A of the AAAS.*

From the Editor

Most of the articles published in FOCUS are written specifically for us, usually by members of MAA. Occasionally, however, we will reprint articles from other sources (with permission, of course) if we feel they will interest our readers. By coincidence, there are three such pieces in this issue.

Blair Madore's piece on choosing textbooks was originally written for internal use at his university as it discussed the issues surrounding textbooks. We thought it was interesting enough to share with the readers of FOCUS in slightly revised form. It is the latest installment in the "What I Learned" series, though it might almost have fit into the "What's the Best Textbook" series as well.

Frank Farris's account on what goes on behind the scenes at an MAA journal (specifically, *Mathematics Magazine*) was originally written in order to share the experience he has accumulated with future journal editors. We thought most members of MAA would be interested in knowing what their editors do, and so we present a version of Frank's paper here. It has been shortened a little, mostly by removing the parts dealing with the more boring aspects of the job.

Finally, "How We Measure Up" was originally published in *The New Atlantis*, a journal about technology and ethics. We thought it presented a provocative counter-argument to the oft-heard cries of despair about how badly our mathematics education system is performing.

We hope our readers will enjoy the mix of articles and that some, in fact, will wish to write articles of their own. Information on how to submit articles to FOCUS can be found at: http://www.maa.org/pubs/focussubmission.html.

Jenny Quinn Named Executive Director of AWM

Jennifer J. Quinn became Executive Director of the Association for Women in Mathematics (AWM) on October 1, 2005. Quinn, together with an association management company, will support the work of the volunteer officers of AWM. She will be actively involved with the AWM membership at the Joint Mathematics Meetings, the SIAM Annual Meeting, and other events in which AWM participates. Her duties will include generating new membership, grant reporting, facilitating committee rotation and volunteer efforts, and carrying out new initiatives.

Barbara Keyfitz (University of Houston), President of AWM and current Director of the Fields Institute in Toronto, says: "Following a year-long quest for a governance and staff structure in keeping with the increased reach and responsibilities of AWM, we are excited to have reached this point. AWM's capable staff understands and satisfies its infrastructure needs, allowing the volunteer leadership to focus on the mission of AWM: advocacy and support for women and girls in the mathematical sciences. Quinn will greatly enhance these efforts."

Quinn received her B.A. magna cum laude from Williams College with majors in mathematics and biology. Working as an actuary in Chicago after graduation convinced her to return to academic life. She earned her M.S. in pure mathematics from the University of Illinois at Chicago and her Ph.D. in combinatorics, working with Richard Brualdi at the University of Wisconsin, Madison. For the past twelve years, she has taught at Occidental College, rising to the rank of full professor and serving as chair of her department. Quinn's research interests include graph theory, combinatorial matrix theory, and exploring the connections between partitions and quantum physics. Her mathematical passion is for combinatorial proof. One lifelong goal is to prove Ernst Mach correct when he said: "There is no problem in all mathematics that cannot be solved by direct counting."

Quinn writes, "I chose to pursue this position because of its importance promoting mathematics and the role of women in mathematics. The major decisions regarding organizational operations are complete; now we can refocus

Jenny Quinn

on better serving and expanding our membership. I'm looking forward to my involvement in the enterprise. This is an exciting time for the AWM."

MAA members will know Quinn as the co-author, with Art Benjamin , of *Proofs that Really Count,* published by the MAA in 2003, and as co-editor, also with Benjamin, of *Math Horizons.* We are glad to report that she will continue her work on *Horizons* while she helps run AWM.

Summer Mathematics Program for Women

The mathematics departments of Carleton and St. Olaf Colleges intend, pending renewed funding from NSF, to offer again their month-long summer mathematics program for eighteen mathematically-talented first- and second-year undergraduate women. By introducing them to new and exciting areas of mathematics that they would not see in a standard undergraduate curriculum, and by honing their skills in writing and speaking mathematics, the program leaders endeavor to excite these women on to advanced degrees in the mathematical sciences, and, more importantly, to increase each woman's confidence in her own abilities and connect them all into a supportive network to carry them through their undergraduate and graduate education.

At the heart of the program are two demanding, intense courses under the supervision of female faculty who are active in research and renowned for their teaching. In past summers we have had the following instructors: Judy Kennedy (Topological Dynamical Systems), Erica Flapan (Knots and Chemistry), Laura Chihara (Algebraic Coding Theory), Karen Brucks (Low-Dimensional Dynamical Systems), Margie Hale (Fuzzy Logic), Rhonda Hatcher (Game Theory), Katherine Crowley (Morse Theory) and others.

Besides the coursework, participants take part in a variety of mathematical events: panel discussions on graduate schools and careers, colloquia on a variety of topics, recreational problem-solving, and visits from at least one REU organizer and the organizer of the Budapest Semester. The mathematical part of the program is balanced with optional weekend events including canoeing, hiking, picnics, and tubing. Past participants have reported (through program evaluations and the list server set up for their correspondence) increased facility with mathematics, bolstered self-confidence, and new or renewed excitement toward mathematics.

If you have first- or second-year women students whom you think would benefit from a demanding, invigorating month-long exposure to mathematics next summer (June 18-July 16), please refer them to the program web page at http://www.mathcs.carleton.edu/smp or have them contact Deanna Haunsperger at Department of Mathematics and Computer Science, Carleton College, Northfield, MN 55057 (dhaunspe@carleton.edu). The deadline for applications is February 24, 2006.

Archives of American Mathematics Spotlight: An MAA Photographic Mystery

By Kristy Sorensen

Do you know this mathematician?

Last year the Archives of American Mathematics received a valuable collection of historical documents from the Mathematical Association of America Headquarters (see the January 2005 issue of FOCUS for more details). Included in the materials are a group of photographs from what appears to be a production for the *Mathematics Today* film series in the 1960s. This series was developed by the Individual Lectures Project and the Committee on Educational Media in order to provide visual learning aids appropriate for those with a casual interest in mathematics, college mathematics students, and professional mathematicians. Twenty-four 16mm films were produced altogether, in both color and black and white, and they were available for purchase or rent from the Modern Learning Aids distribution company. One of these photos is on the cover of this issue of FOCUS, and another is on this page.

Our problem? We aren't able to identify the subjects in these fascinating shots. If you can help, get in contact with Kristy Sorensen, the archivist, at k.sorensen@mail.utexas.edu. Perhaps with the help of the readers of FOCUS we can find out more about the story of this project and what became of it. We will report on the answers we get in a future issue.

The Mathematical Association of America Records inventory can be found online at: http://www.lib.utexas.edu/taro/utcah/00328/cah-00328.html.

From the Mathematical Association of America Records, Archives of American Mathematics, Center for American History, The University of Texas at Austin.

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. Feel free to visit us on the web at: http://www.cah.utexas.edu/collectioncomponents/math.html

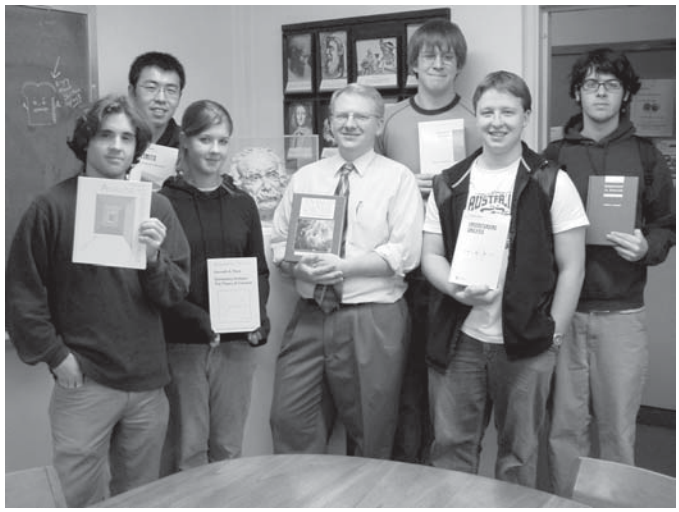
AAM at JMM!

Don't miss a special exhibit from the Archives of American Mathematics at the Joint Mathematics Meetings in San Antonio. The AMS-MAA Archives Committee has arranged for an exhibit of "selections from the Archives of American Mathematics." When you visit the exhibit hall, don't just look at books; come see a representative sample of the resources on the history of modern mathematics available at the Archives.

What I Learned About... The Frustrations of Choosing Textbooks

By Blair Madore

Most semesters I am besieged with textbook orders just when I am at my busiest. The furthest thing from my mind is next semester's courses and their textbook needs. And yet somehow I have to make time to make a wise choice of a textbook. A great textbook can make a course great. A mediocre textbook may not affect a course at all. But a poor textbook can destroy a course. And so I have started looking for books as early as possible.



Blair Madore and his students display analysis textbooks.

In Fall 2003, I was teaching advanced calculus, a course that is often considered the major obstacle to completing the math major for most students. At other schools this course might be called real analysis or introductory analysis. We study topics that include the axioms for the Real numbers, limits of sequences, the Heine-Borel theorem, the Bolzano-Weierstrass theorem, limits of functions, continuity and uniform continuity. This is material that I love but students sometimes hate. Having a good textbook can be crucial to the success of this course.

I started looking for the right book early the spring before and continued searching throughout the semester. I first considered two textbooks used in the past by other members of the department: *Introduction to Analysis,* by E.D. Gaughan, and *Analysis With an Introduction to Proof*, by S.R. Lay.

Two years earlier, I had taught Advanced Calculus II and out of consideration for the students' pocketbooks we used the same text, Lay, that they had used in Advanced Calculus I with another instructor. It had cost nearly $100 and I couldn't bear to make them shell out a similar figure for a different book. This seemed like a good idea at the time, but there were problems.

Lay had a number of typographical errors. In this advanced class, students read and present material from the text. Any small error, even a poorly worded sentence, can become a major obstacle to their comprehension. Of course, overcoming such errors is part of what they learn in the course, but I wished they could spend the majority of their time on mathematical obstacles, not typographical ones. Eventually, we found a crucial error in one proof. To resolve it we turned to Gaughan. In that book we found a theorem with a correct proof, but the theorem was weaker than the one in Lay. Was the stronger theorem false? No. It turned out that an earlier edition of Gaughan had the stronger theorem and a correct proof. How did it get edited out in more recent editions? Go figure.

For me, the only redeeming value of these texts was the excitement that finding errors generated in the students. It kept them engaged in the course, if not exactly in the way I had intended.

So for my Advanced Calculus course I gave up on those books and looked at a number of other texts offered to me by book representatives. Some looked ok. Others I feared were too much like the flawed books I mentioned above. Finally I settled on a great looking book: *An introduction to Analysis* by G.G. Bilodeau and P.R. Thie. It was in a textbook series that included a number of textbooks I respected, so I had hopes it would not be full of subtle errors that we would find later.

Unfortunately, we never got to find out. Just as I placed the textbook order, the publisher pulled the textbook from the market, citing a problem with copyright. I was furious and immensely frustrated. I was back to square one, and with little time to make my decision. One can send in late, even very late, textbook orders, and the bookstore will come through. But they can't help if the book is not available, as I had just learned.

I asked a colleague for new ideas and was shown a lovely little book by Ken Ross, *Elementary Analysis: The Theory of Calculus*, from Springer-Verlag. How had it escaped me? Springer publishes some great books but they do not beat down my door like reps from other companies do. Ross was almost perfect. It was very readable, written in the mathematical style I like, and comparatively inexpensive (only $40). Its one flaw was immense. It dealt with everything in terms of sequences and, from my point of view, didn't deal well with the standard topic of limits of functions. Since everything else was so good I was willing to try and compensate.

The students and I loved the book. Ross's sequence-based approach really simplified a lot of material and allowed the students to progress more easily.

Of course it wouldn't be a good Advanced Calculus course without a good dose of epsilon-delta, so I created some additional materials and exercises. Sometimes I would give epsilon-delta proofs and then show students Ross's sequence based proof. Comparing two proofs gave

the students more insight and a little more time to understand the theorem.

The real test for Ross was advanced calculus II in the spring of 2004. Almost the entire course consisted of students reading and presenting material. This is challenging for them and they didn't find Ross easy, but we found no real errors. Ross is excellent so far. Best of all, the book served students for two semesters for only $40.

Don't misunderstand me. Price is not everything. I once picked a book just because it was cheap ($30) and it ruined my course. I would gladly pick Ross at $80 or even $100 dollars. But $100 is the ceiling for me and the students. I am very price conscious. A publisher that took up the motto "The very best books for the very best price" and really meant it would earn this customer's loyalty.

What have I learned from all this?

1. Look for books early. It takes time. Ask colleagues, look for reviews, and discuss books at conferences.
2. Always begin by checking out offerings from respectable and non-pushy publishers such as Springer-Verlag, Dover, and the professional societies (AMS, MAA, SIAM).
3. Pick the best book regardless of price.
4. Price is not an indicator of quality in textbooks.
5. Picking textbooks will never be easy.

Blair Madore is Assistant Professor of Mathematics at SUNY Potsdam. He originally wrote this article for the campus bookstore to present at a board meeting specifically about the difficulties for faculty in making textbook orders.

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FOCUS Online
http://www.maa.org

MAA Announces Search for Director of Publications

The Mathematical Association of America (MAA) is seeking a highly qualified person for the position of Director of Publications. A candidate should have a significant record of work in publications in the mathematical sciences; a Ph.D. or other advanced degree in a mathematical science or related field is preferred. The position requires successful experiences in some of the following areas: book publishing; journal production; administration including financial management; editorial/reviewing experience; mathematical writing not limited to research publications; and electronic publications. Interest and experience with the use of the internet in publications, grants, personnel management, and marketing experience are desirable. Appointments may be made for two or three years, with the option of renewal for multiple years.

The Director will oversee a staff of six located in the headquarters office and numerous editors. S/he oversees publication of three journals, three magazines, nine book series, and a variety of columns and articles. Electronic publications include all of these types of materials as well as the MAA Mathematical Sciences Digital Library (MathDL). The Director's duties include personnel management, financial administration, acquisitions, production, grant proposal writing and project management, and marketing. The Director reports to the Executive Director. S/he is a key member of the MAA's staff leadership team, and will work closely with the Executive Director and other staff members, national officers, section officers, committee chairs, and others in strategic planning and program development.

The MAA, with nearly 30,000 members, is the largest association in the world devoted to college level mathematics. Membership includes college and university faculty and students, high school teachers, individuals from business, industry, and government, and others who enjoy mathematics. The Director of Publications is responsible for ensuring that publications encompass the interests of all major constituencies of the MAA, embrace all areas of mathematics, and are easily available to all our members and the larger community who are interested in mathematics, especially expository mathematics and materials for faculty and students.

The deadline for submission of applications is January 21, 2006. Interviews will be held during the months of January and February. It is expected that the new Director will begin work by July 2006, earlier if possible. The position is located at the national headquarters of the MAA in Washington, DC. Salary will be based upon the candidate's credentials or current salary for a reassignment position. The MAA offers a generous benefits package.

Candidates should send a resume and letter of interest to:

Ms. Julie Kraman
Mathematical Association of America
1529 18th Street, NW
Washington, DC 20036.

Applications may be submitted electronically to jkraman@maa.org. References will be requested after review of applications. Applications from individuals from underrepresented groups are encouraged. Additional information about the MAA and its publication programs may be found on MAA's website: http://www.maa.org . AA/EOE.

Looking Beyond the Curriculum in Jamaica

By Jon Jacobsen and Michael Orrison

In August 2004, we had the opportunity to travel to Jamaica to lead a pilot workshop for Jamaican high school math teachers. The workshop focused on the importance of mathematical context in the teaching of mathematics. It was sponsored by the Gibraltar Institute, a Jamaica-based nongovernmental organization led by Trevor Campbell (Pomona College) and Reginald Nugent (Cal State Pomona), Jamaica's College of Agriculture, Science and Education, and Harvey Mudd College.

The workshop participants shared numerous challenges, some of which are universal, such as students' attitude towards work, high pupil/teacher ratio, math phobia, and limited parental support. Other challenges are more specific to Jamaica (and other developing nations), such as lack of equipment and material, illiteracy, and a curriculum focused on a national exam. Indeed, an expression many teachers lamented hearing from their government and administrators in response to low test scores was, "If they've not learned it, you've not taught it." Moreover, student motivation is often lacking. "Why should I do maths, when I can sell to tourists and make more money?" is a question that one teacher often hears. These frustrating conditions propelled Jamaican nationals Campbell and Nugent to collaborate with us and host the workshop "Unlocking Barriers in Mathematics Education: A Mathematics Innovation Programme."

The focus of the workshop was on the impact that a solid understanding of mathematical context can have on learning for students of mathematics. Although the challenges the teachers face with regard to class size and lack of resources are substantial, we felt that deepening the instructors' knowledge of mathematics would have a positive impact on their student's learning. By gaining some "big picture" ideas, the teachers could have a sense for how the mathematics they teach is related to the mathematics their students might learn in the future. Additionally, we sought to connect the teachers to several interesting and lively current areas of mathematical research that use, in an essential way, many of the tools taught in their curriculum. For example, Orrison discussed voting theory from an algebraic perspective. They saw how mathematics can be used to predict, detect, and analyze paradoxical results that arise in voting. We also explored the connections between the natural numbers, integers, rational numbers, real numbers, and complex numbers.

"Feeling comfortable with real numbers helps you point out the special role that fractions play in mathematics, while a familiarity with complex numbers helps to highlight some of the subtleties associated with real numbers," said Orrison. "It may sound obvious, but knowing the next step in a mathematics curriculum helps an instructor to prepare students to take that next step."

Jacobsen discussed iterating maps and connections to chaotic dynamics and fractals. While none of the teachers had seen fractals before, they all appreciated the mathematics behind the images and the power it could have in the classroom setting. Students can see how simple rules yield complex behavior, and how basic algebra can be used to shed light on the situation. There is also a sense of exploration, where students can change parameters or rules and explore the dynamic and fractal landscape.

"Dynamical systems provide a fascinating framework to excite and motivate students to think about mathematics and how it may be used to model complex phenomena. I also tried to highlight the experimental side of mathematics, that math is alive," said Jacobsen.

A final goal of the workshop was to begin the creation of a core group of Jamaican high school math teachers who can benefit from a global network of researchers actively engaged in exploring ways to break down the barriers that students face in learning math. The response to the workshop was very positive. Here are some sample comments:

The hardest question to answer in any mathematics class is, "Why is this important?" I've never been able to give what I feel is a satisfactory response. Having participated in this workshop I now feel more confident that I can provide the perfect answer.

This workshop opens the door for mathematics teachers to begin to look at mathematics as not just a subject that it taught formally but mathematics itself is what the universe is living, today, yesterday, and tomorrow.

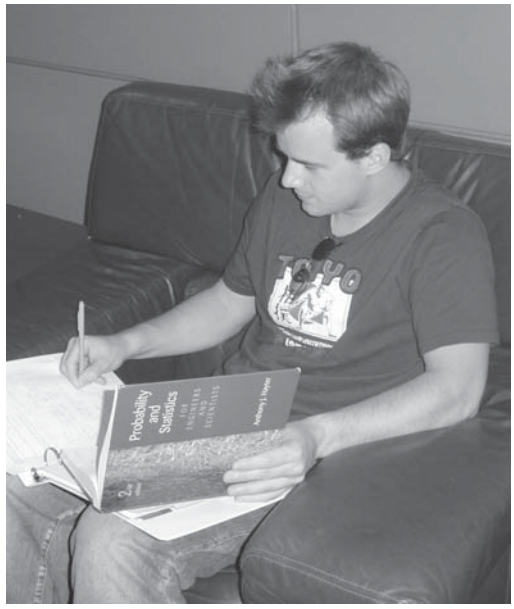
I realize more clearly that mathematics is fun, power and life. I am empowered to be more of an ambassador for the subject and transfer this zeal to my students.

Given the success of the workshop, we are making plans to lead similar workshops for mathematics teachers in Southern California.

Jon Jacobsen jacobsen@math.hmc.edu
Michael Orrison orrison@math.hmc.edu
are Assistant Professors of Mathematics at Harvey Mudd College.

Coffee and Mathematics, Once Again

In May 1996, the UNC Charlotte Math department moved to its new home, the E K and Dorrie Fretwell building, with eager anticipation. We would occupy most of the third floor and use dedicated rooms for reading journals, keeping our book library, holding seminars, housing web servers, and we would be able to enjoy modern "computerized" classrooms. Two years later our lives got even better. The large student lounge on the ground floor had not been successful. Manned with vending machines and not-very-comfortable chairs, it attracted very little business. Then someone got the idea of converting it into a Starbucks-style coffee shop. *Jazzman* opened in 2002 and never looked back. *Jazzman* is branded by Sodexho (the food service company on campus at the time). When Sodexho lost the catering contract to Chartwells in May of 2003, *Jazzman* became *Ritazza*, but little else changed. Serving breakfast sandwiches, bagels, freshly made salads, soups and sandwiches for lunch and dinner along with desserts, it became the hottest spot on campus. A large coffee menu, comfortable chairs and sofas, and an outdoor dining patio all contributed to its success as well



Five Years at the *Magazine*

By Frank A. Farris

What do the editors of MAA journals do? What is so different about editing expository mathematics? After my five years as editor of *Mathematics Magazine*, I have strong opinions about these matters. The goal of most mathematics journals is to print the very latest results from the forefront of research. The goal of *Mathematics Magazine* is to remind us all why we loved mathematics in the first place, with stimulating articles and notes accessible to advanced undergraduates.

Receiving and handling manuscripts

Everyone who takes time to prepare and submit a manuscript to an MAA journal deserves to be treated with respect. After all, without the creative output of our authors, there would be no journal to edit. On the other hand, not every author deserves a great deal of the editor's time. Woody Dudley's excellent book *Mathematical Cranks* prepared me for the range of imaginative thinkers I encountered.

When a manuscript is submitted to the *Magazine*, my able assistant, Martha Giannini, acknowledges it promptly, including a general word to explain that it takes at least several months to evaluate a manuscript. We ask authors to wait for our office to contact them. A certain amount of the material submitted looks reasonable at first glance, but on further examination can be seen to be unsuitable for the journal. Perhaps the piece is too technical, written for the wrong audience, or substantially duplicates something that has already appeared. (Many well-meaning authors have rediscovered gems that were printed decades ago.) There is little point in sending these manuscripts to referees. However, since the author has taken the care to submit the piece, he or she deserves a respectful letter, explaining, in as much detail as time permits, why the manuscript will not be given further consideration.

My reactions to these authors are as various as the manuscripts that fall into this category. If there is any way that I can help steer an author in the right direction, I try to do so. Sometimes, I have occasion to use the template I call "Reject Terse," which omits the phrase, "I hope that this news will not discourage you from future submissions." In any case, I hope that the author will feel that someone spent some time with the manuscript. Every editor can tell amusing or distressing tales of cranks, but even when I hope that a particular author will never again submit any manuscripts to any journals ever, I try not to sound dismissive.

As I gained experience with the *Magazine*, I was able to see more quickly which submissions should be rejected without review. My experience is that only about half of what I receive is evaluated by (usually two) referees.

Referees

I use a large pool of referees, which has its benefits and pitfalls. For instance, early in my editorship, I added about thirty young referees from Project NExT to my database, even though this meant that I had to interpret their analysis in context: These kind young people seldom recommended against publication, seeming to feel that every manuscript could be saved. Perhaps every manuscript *can* be saved, with enough work. In my instructions to referees, I say, "It happens very often that an author has a good idea for a paper suitable for the *Magazine*, but presents it in a way that does not meet our expository criteria. When thinking of your overall recommendation, please make an assessment of the attractions of the manuscript as it might appear after all expository problems are solved."

I ask referees to fill out two forms, *Comments for Editor* and *Comments for Author*. On the form intended for my eyes only, I ask them to mark an overall recommendation as to whether I should print or not print a *suitably revised* version of the paper. I ask them to base this recommendation on the accuracy and attraction of the mathematical content, as well as the expository style. I make it clear that novelty is not a prerequisite for publication in the *Magazine*, but if one is going to write about something that many people know, one had better write it in an extremely interesting new way.

It is a lamentable truth that no one really knows everything that has appeared in MAA publications, but some referees come close. It is distressing, but ultimately a great relief, when I send off a piece, thinking that it is extremely promising, and hear back that "essentially the same thing appeared in 19xx." There are excellent electronic tools we can all use to research the past history of any given mathematical idea that has appeared in print — JSTOR, Google Scholar, and ArXiv come to mind. Even so, an experienced person can easily trump someone armed only with the internet. For instance, it remains extremely difficult to learn whether a particular idea might have appeared in a past Problems column in one of the MAA journals.

On the *Comments for Authors* form, I ask referees to give *constructive* criticism. I frequently find myself telling an author that, while the paper is not suitable for the *Magazine*, it probably ought to be published somewhere, especially after it is improved according to the referees' reports. A letter of rejection is not so bad when it helps an author improve the manuscript.

The confidentiality of referees is protected, except in an exceptional case that I call the "arranged marriage." When an author has learned so much from a referee's report that he or she feels indebted as if to a coauthor, I can inquire whether the referee feels comfortable being unveiled. I believe I have arranged four such marriages over my editorship; three were quite happy occasions and the fourth ended well after some mediation.

In the world of narrow disciplinary research mathematics, the tastes of the referees and editor should not matter all that much. In pure mathematics — as opposed to, for instance, the humanities — there is an excellent chance that our entire community will agree on the value of a new discovery. In our MAA journals, where the highest value is *commu-*

nicating mathematics, decisions require a human touch. Since the most important question I ask is whether the piece is likely to interest readers, nothing can be done to isolate decisions from my taste. That said, I am aware in every decision that I have been trusted to use my best judgment to offer the best, most useful material possible.

Acceptance, Revision, Rejection

When evaluating a manuscript at this stage, I will have a folder on my desk containing the original manuscript and at least two referee reports. I think of the phrase from our editorial guidelines: **The Magazine has a higher duty to its readers than its authors**. And I try to figure out what to do.

The occasional no-brainer is welcome: Both referees love the piece and it reads like a dream; into the *Magazine* it goes. More often, both referees see potential in the piece, but each has a long list of recommendations for necessary revisions. Combining their insights with what I found by working through the piece, I decide whether it could eventually fly. A common outcome is a letter suggesting that a suitably revised version might be accepted. It is quite impossible to predict what authors are able to do, even with what I think is excellent and specific advice, so I warn authors that I cannot guarantee that their revised papers will appear in the *Magazine*. Since I receive four to five times as many manuscripts as I can print, I have learned to be cautious in soliciting revisions.

There is wide variety in the quality of authors' revisions. Sometimes I am disappointed to see that an author has remained married to an existing word-processor file, making only a few cosmetic changes instead of the requested thorough revision. Sometimes the new version is evidently perfect for the *Magazine*; writing an acceptance letter is simple. In many cases, I ask one of the original referees and one new one to review the piece before I make a final decision. I have faced a number of awkward situations where I encouraged a revision and had to turn down the final version, despite evidence that the author had tried very hard to comply with my suggestions. This is why editorial work is not for the faint-hearted.

Steps to Publication

Almost every acceptance letter contains a list of additional changes that must be made before publication, even if the manuscript has already been revised more than once. It would probably surprise many people to learn just how many versions of a manuscript go back and forth before its final appearance in print. When putting an issue of the *Magazine* together, I start with authors' final versions of manuscripts and work them over in depth to prepare final editions. I ask myself: Does it begin well? Is the organization optimal? Could it be shortened? I am not shy about proposing changes at this stage.

Occasionally, authors have found my editorial hand to be a bit heavy. ("You changed my words!") More often, authors express gratitude for improvements to their piece. This can be a tricky interchange; editing an author's work is a distinctly intimate act. On the whole, I have very much enjoyed this contact with authors, whom I find to be a remarkably creative bunch, striking in the variety of their ideas and ways of expressing them.

Some mathematics journals require that manuscripts be published in the order in which they were received. Such a policy would not be appropriate for MAA journals, which offer a balance of subjects in an effort to represent the many branches of our field. Once I have selected pieces that seem to hang together to make an issue, I submit the issue by mailing a large envelope to Managing Editor Harry Waldman at MAA headquarters. This hard copy catches up with the electronic files at the compositor's office — Integre Technical Publishing in New Mexico — and the composition begins.

A few weeks later, the authors and I receive electronic page proofs. We scrutinize these, hoping to maintain the *Magazine*'s reputation for printing remarkably few errors. I have almost a month to work on this first set of pages before returning them to Washington. A set of revised proofs arrives a few weeks later and we go through one more round of checking. (Martha Giannini holds the record for the most impressive proofreading feat: During our first year, she noticed that the page numbers on odd- and even-numbered pages were set in slightly different fonts!)

Along with the revised pages, I typically send in what used to be called "camera-ready copy" for last-minute items such as Allendoerfer citations and problems and solutions for the Putnam, USAMO, and IMO competitions. Paul Campbell's Reviews column also goes in at this time and, if possible, the image for the cover. Just before the compositor sends the files to the printer (from New Mexico to Vermont), there is one last chance to make additions. About ten days later, the "bluelines" arrive. These are actually final digital page proofs, representing the last chance to find and correct errors. Occasionally, I have cried, "Stop the presses!" and asked Integre to prepare a corrected page or two. After that, it takes about three weeks to see the issue in its final form, which, of course, is immensely satisfying to the weary editor.

Would I do it all again?

Yes. Editing an MAA journal is a great job. It does take over one's life, but the benefits are vast. One learns lots of new mathematics, meets hundreds of people, almost all of whom are delightful to know, and feels deep satisfaction in serving a remarkable Association.

On my computer desktop, I keep a file of kind comments about my editorship; I paste these in randomly without recording who said them. When the workload becomes overwhelming, I'll glance through and appreciate how these people found time to say something nice. Here are three samples: "My eye is not of the eagle variety — that's why you are the editor and I am a mere ink-stained wretch." "I appreciate your prompt response. Also, I can tell my wife that I'm not the only mathematician who works on weekends." "If you go through all of this with every paper in the *Magazine*, you deserve sainthood. If it's only my paper, I apologize."

Frank Farris will finish his term as editor of Mathematics Magazine *this month.*

Mathematically Speaking: Expanding the Role of Oral Communication in Mathematics Programs

By Stephen J. Curran, Michael N. Ferencak, John W. Thompson, and Susan M. Wieczorek

Recently, a group of mathematics faculty at the University of Pittsburgh at Johnstown (UPJ) collaborated with a member from the communication department to develop a course that addressed the speaking demands facing our majors upon graduation. Initially the idea stemmed from a new general education requirement to incorporate speech into the curriculum of all majors.

However, upon development of the course, we realized that not only was this a valid university requirement but a necessary *major* requirement for the successful job and academic goals of our future graduates. Thus, we designed a course modeled after a standard public speaking class but utilized mathematically related topics.

Despite the similarity of the two courses, we felt the technical nature of mathematics posed a specialized demand on the content and design of the course. As a result, the lecture materials and speech designs incorporated examples and language appropriate to mathematics. In turn the speeches themselves likewise contained varying degrees of technically sophisticated language which was to be adapted for the audience's assumed degree of mathematical understanding.

During the creation of this course, we pondered several fundamental questions: What occupations do our students pursue upon graduation? How well have we prepared them for these societal roles? How might we improve their future job marketability? What changes in our curriculum are necessary to address these needs?

Despite having addressed the students' needs in our individual courses, we hoped to broaden our focus to include the mathematics curriculum as a whole. We turned to the CUPM Curriculum Guide 2004 and disappointedly found more information relating to service courses than to courses intended for mathematics majors. Included in the guide was one statistic that really jumped out at us from a 1997 survey of the 1994–1996 graduates in the mathematical sciences. Of students earning bachelor degrees in mathematical sciences, 92% enter the workforce directly after graduation.

From left to right: John Thompson, Susan Wieczorek, Stephen Curran, and Michael Ferencak.

As we thought about our recent graduates and where they have ended up, we realized that UPJ Mathematics majors align very closely with this statistic. It is interesting to note that among the faculty in the mathematics department at UPJ, there is very little experience in the very workforce in which our students eventually find themselves. Despite this, our students seem to adapt well to their new environments. Nevertheless, the question remains: How can we provide the best possible education for our students to prepare them for what awaits them in the outside world?

With the dearth of practical business experience in our mathematics department, it is fortunate that our colleague from the communication department has such experience. Due to this 'outside' influence, we concluded that creating a team taught interdisciplinary course was one of the better things we could have done. As CUPM 2004 points out, employers list good communication skills as one of the most important skills for mathematics majors. Despite this, discipline specific oral communication training is almost completely absent from most undergraduate mathematics curricula.

The preliminary results of a recent survey of UPJ mathematics department alumni seem to confirm both the demand for excellent communication skills in the workplace and the lack of such learning opportunities in our undergraduate mathematics program. Nearly 95% of the responders indicate that oral communication skills are important, if not crucial, to their effectiveness in the workplace. Several commented specifically that communication skills are weighed heavily when hiring, when making or receiving evaluations, and when considering, or being considered for, promotion. Further comments indicated that it is important to be able to communicate a complicated idea not just in detail, but also in a simplified fashion. Recognizing the technical familiarity of the audience is paramount to determining both the level of detail and the level of rigor that the speaker should use in the explanation.

Problems We Faced

Most realize that over the past 10 to 20 years an emphasis has been placed upon writing within the mathematics curriculum. Clearly, writing within the curriculum is extremely important and can be an effective pedagogical tool in learning and understanding mathematics. But

speaking within the curriculum actually has its roots further back as attested by veterans of the "Texas method" developed by R.L. Moore.

Still, the type of oral communication required in a Moore method approach really does not address the core aspects of communicating technical material to an audience of varying technical expertise. The emphasis of most oral communication in mathematics classes is on enhancing and developing technical understanding. Although this is a necessary consideration, mathematics classes should focus on the technical understanding of the material while still addressing the employment expectations for our students to communicate mathematics information to audiences of varying levels of expertise. This has compelled us to make changes in how we teach presentation techniques to our students today.

Although this course remains in its early stages of modification, we have come to recognize its tremendous importance. First and foremost, it acknowledges the need for students to present comfortably to audiences of diverse technical training in a variety of presentation environments and situations. Second, it in no way eliminates any of the major requirements of the discipline since it is taken in addition to the regular mathematics major course load and is intended as a discipline specific substitute for Introductory Public Speaking, a course that might normally be taken as a humanities elective.

The Course Itself

This newly created course satisfies both general education and future graduation needs of our mathematics students. It is important to keep in mind that it is fundamentally a class on public speaking. It includes five speeches ranging from a commemorative speech of a mathematician that one might give to a general, non-mathematical audience to a more technical speech appropriate for an MAA Section meeting.

An example of this is our Applied Problem Solving Speech. In this speech of persuasion, we gave student groups an applied max/min problem and asked them to identify an appropriate scenario wherein they presented their solution to the problem as if they were project team members in, or outside consultant to, some industry. Both the speaker and the audience were to assume appropriate roles with the target audience being primarily managers and supervisors. Such an audience would have some basic familiarity with the mathematical concepts but would be more interested in the bottom line, as it were.

This speech is exactly the type of workplace situation that the majority of our undergraduate mathematics majors face repeatedly throughout their careers. Yet explaining technical information to a non-technical or semi-technical audience, and doing so in the form of a persuasive speech, is a skill whose acquisition is rarely, if ever, addressed in either mathematics or communication curricula.

Mathematically, the most challenging speech for the students was the Group Concept Introduction Speech. The goal was for a small group of students to present an introduction to a mathematical idea or concept about which neither they nor the audience was to have prior knowledge but one where the audience was assumed to be mathematically adept.

As noted above, this resembles a group presentation at a mathematical conference for post-undergraduates. This speech forced the students to research a topic unfamiliar to them and to present their findings by applying group presentation skills.

Naturally, the mathematicians determined that the proper order for the speeches should be from least technical to most technical in terms of both the subject and the level of rigor appropriate to the presentation (prescribed by the audience). This, of course, was utterly wrong. In direct contrast, the most challenging presentation from a public speaking perspective was the persuasive Applied Problem Solving Speech.

Our students were in fact overwhelmed by the presentational demands of the latter speech too early in their learning process. This supports the notion that this course must be developmentally organized from least to most difficult in presentational skills instead of least to most difficult in mathematical technicality.

Again, fundamentally, this is a speaking course with progressively more and more difficult presentational expectations. Students simply felt much more comfortable presenting more difficult technical concepts than they did adapting to a higher level of rhetorical argument. Consequently, we plan to rearrange the order of the speeches to end with the persuasive one and begin with the instructional demonstration of a concept or theorem from calculus (this particular speech experience being most useful to students who become graduate teaching assistants or high school educators).

Concluding Remarks

As many of us wrestle with increasing the number of mathematics majors, we must realize that our programs need to be relevant to what our students want to do upon graduation. Despite many of our desires to send students on to graduate schools, the vast majority will not utilize their education in this manner.

In light of this, is it appropriate that all of our communication time is invested in making technical presentations to technical audiences? An oral communication course that includes oral presentations to audiences with lower levels of mathematical understanding seems more appropriate for our students and their future professional endeavors. This course addresses the practical needs stressed not only by academia but also by the professional job markets open to mathematics majors today.

Susan M. Wieczorek is in the Department of Communication, and Stephen J. Curran, Michael N. Ferencak, and John W. Thompson are in the Department of Mathematics of the University of Pittsburgh at Johnstown, in Johnstown, Pennsylvania.

Lost in Shakespace

By Stephen Abbott

As the train pulls into Cardiff station I begin to wonder just how it happened that a well-meaning mathematician like myself has ended up in Wales attending a theater conference. My mind flashes back to a phone call several years back — it's a colleague in our theater department innocently asking if I would come talk to her cast about the mathematics in an interesting new play by Tom Stoppard called *Arcadia*. Sure, why not? What harm could come of that? But it's not just an interesting play, it's an intoxicating one. And soon I am having lunch with cast members, then closing my office door to read Stoppard plays, and before I realize it the director and I are coteaching "Stoppard and Science" during Middlebury's one-month winter term. But I'm still OK. It's winter term after all, a four-week semester custom-made for this sort of whimsical pursuit into new inter-disciplinary lands. Nothing more.

Then came a conspiracy of events far beyond my control. Michael Frayn's *Copenhagen* takes the 2000 Tony Award for Best Play, David Auburn's play *Proof* wins the 2001 Pulitzer Prize and *A Beautiful Mind* dominates the Oscars in 2002. The vortex that is formed at the intersection of mathematics and art overwhelms my pathetic defenses and I am pulled in, dashed about, and deposited here at the Cardiff train station car park, waiting for a shuttle to take me to the "Theaters," excuse me, "Theatres of Science" conference at the University of Glamorgan in nearby Pontypridd.

"I'm Steve Abbott" I say to a slightly more senior gentlemen waiting next to me who just looks the part, so to speak.

"Hi. Christopher Innis," he replies with the appropriate British accent, though it turns out he teaches in Toronto. "Where have you come from?"

"Arcadia," I say. Oh dear. In addition to answering the wrong question, I've put my best credentials on the line and it is everything I can do to stifle the panic welling up inside me.

"One of the best plays of the 20th century," he says. Extraordinary. Stoppard's wild ride through Euclid, Fermat, Newton, and Fourier is on someone's very short list, and now I can't stop wondering who this person is and whether he knows what he is talking about.

Day 1

The conference has started when we arrive and I settle in for a presentation on how medical dissection in the Renaissance became a form of public theater. Afterwards I head off to attend a workshop where a young Canadian playwright named Vern Thiessen presents a scene from his play, *Einstein's Gift*, about chemist Fritz Haber whose groundbreaking work produced both the fertilizer that fed Europe and the gas that poisoned thousands of soldiers in WWI. These workshops turn out to be a highlight of my week. Actors offer rehearsed readings, sometimes a scientist of the appropriate sort is available to explicate technical details, and what follows is a process of open and honest feedback between playwright and audience about how to make the script do what it is supposed to do.

At lunch I make it a point to seek out Kirsten Shepherd-Barr whose early morning talk on *Copenhagen* I had missed. A respected theater scholar, it turns out that for several years she has been teaching a course on science plays much like the one I am scheduled to coteach in the upcoming term. I also meet Paul, a young Brit with degrees in both physics and the dramatic arts, as well as a gaggle of jet-lagged graduate students who have recently completed a science and theater course at NYU. Everyone is exceedingly pleasant to the rogue mathematician among them, and from their anecdotes it is safe to conclude that the number of scholars, scientists, and artists gravitating toward the intersection of theater and science has hit critical mass.

After lunch, I head off to another workshop for a new play called *Comet Hunter*, by Chiori Miyagawa. This play tells the story of early nineteenth-century astronomers William and Caroline Herschel, and what is especially notable and satisfying is that, as objects of scientific study, the stars and planets manage to keep hold of their romantic identity in this script. Still, even in the artistically friendly confines of celestial mechanics, it becomes eminently clear that bridging the gap between C.P. Snow's two cultures — the sciences and the humanities — is going to be harder than it looks. One by one, the scientists-turned-playwrights in the audience begin asking if, in a full production, might we be able to use some projection to actually see the images in the telescopes on stage and thus better understand what the scientists are doing. "No," the artists say, "this is not a lecture! Even if it sounds like a foreign language, the vocabulary of astronomy can still work as an artistic device." And so it goes. It is a worthy debate. Although, my sense and sympathies are firmly with the artists on this point, I find myself puzzling over why plays that expose audiences to theories of, say, politics are not automatically dismissed as "lectures" or "pedagogical demonstrations."

Day 2

The conversation picks up again the next morning at the keynote address by Carl Djerassi. Djerassi is a distinguished chemist and prolific novelist who, among numerous other achievements, was awarded the National Medal of Science in 1973 for the first synthesis of a steroid oral contraceptive; i.e., he pioneered the invention of "the pill." Women's reproductive issues pepper Djerassi's early non-fiction, and then in 1997 he wrote *The Immaculate Misconception*, a play that explores the politics of in vitro fertilization. Djerassi has since written two

other full length plays. One is called *Calculus*, which is about Newton, Leibniz and their famous debate over the priority of the discovery of calculus. The other is called *Oxygen*, which is about Priestly, Lavoisier, Scheele and the debate over (you guessed it) the priority of the discovery of oxygen. This latter play is co-authored with chemist and Nobel Laureate Roald Hoffman.

As he seems to be on most points, Djerassi is strongly opinionated about what constitutes a good "science play" and maintains that, first and foremost, real scientific content must be included. He explicitly makes the point that, for instance, *Proof* does not qualify under his definition. The fireworks between artists and scientists start again but it quickly becomes clear that we have gravitated to the wrong question. To put it bluntly, a warning label such as "Caution: contains 10% real mathematical science" isn't going to reveal much about the script itself, and most of us recognize this.

What does emerge, for me at least, and I will confess that this is mostly the product of my own need to organize a tremendous amount of new material, is a short list of categories into which most science plays can be loosely classified. In addition to the squabbles over credit, there is an interesting group of plays that take up the changing moral issues generated by scientific discovery. Durenmatt's *The Physicists* (nuclear devastation, 1962) and Stevenson's *Experiment with an Airpump* (embryonic research, 2000) are fine examples. A third type consists of plays that look at real historical scientists as dramatic characters. Alan Turing is the subject of Whitmore's *Breaking the Code* as well as Wilson's *Lovesong of the Electric Bear*, and Richard Feynmann is the subject of several recent plays. Brecht's *Galileo* is another example, although this script also points to a distinct class of plays that focus on the conflict of science with established institutions, especially the church. Another popular example of a play in this genre would be *Inherit the Wind*, which, incidentally, Djerassi would have to exclude from his bibliography of science plays.

In the afternoon I make a special point to see Chistopher Innis' talk. I have done a bit of research on my new friend from the train station and it turns out he has authored some of the leading survey texts in modern drama. "A bit of a rock star," was how one graduate student put it. Innis begins by offering us a list of categories of science plays roughly like my own (I am delighted by this, by the way), and then proposes a new, modern category consisting of scripts in which the structure of the play reveals or reflects the science it discusses. *Arcadia* is his archetype for this phenomenon, and the argument is compelling. Principles of thermodynamics are superimposed onto the romantic shenanigans of the characters ("the actions of bodies in heat"), the so-called "butterfly effect" from non-linear dynamics is illustrated in Bernard's doomed attempt to reconstruct details of Lord Byron's visit to the Croom estate, and the self-similar quality of Thomasina's fractals is reflected in the deep parallels that exist between the two time periods that make up this remarkable play.

If *Arcadia* occupies sacred ground in the canon of science plays, then it shares it with Frayn's *Copenhagen*, a play that also exploits the power inherent in the merging of form and content. In this latter play, it is the principles of quantum mechanics being applied to the debate over Heisenberg's behavior during WWII. The question under investigation in this case is Heisenberg's 1941 visit to Bohr in Copenhagen and what precisely motivated Heisenberg to seek out his old friend and mentor who was then living under German occupation. Over and over again the experiment of Heisenberg's visit is carried out, and each time the wave-function collapses around a different measurement that ultimately sheds light on something like an uncertainty principle for human introspection.

Thoughtfully comparing Frayn and Stoppard's work to the new plays I am reading this week has the effect of instilling a heightened sense of reverence for the art of play writing itself. *Arcadia* and *Copenhagen* each include a significant amount of technical detail and each probes deeply into the theories they present for rich and rewarding metaphors. But amid the science and the stagecraft there is also, in both of these plays, an undeniable instinct for good storytelling. Frayn's play has the feel of a suspenseful mystery and in Stoppard's case we find wit, romance and ultimately heartbreak. There are glimpses of this kind of synthesis in the plays being workshopped at the conference but it is another matter to sustain the trick for two full acts. This evening's reading is a work in progress called *Remembering Miss Meitner* that falls into the debate-over-proper-credit category. Female physicist Lise Meitner meets Otto Hahn and Manne Siegbahn in the afterlife to hash over who was really responsible for the discovery of nuclear fission. The problem is that this play looks like *Copenhagen*—three scientists in the afterworld arguing about what happened in the real world — but it simply can't sound like *Copenhagen,* and that is its undoing.

Every night after the final readings the conference organizers turn the cafeteria into a rather well lit pub. I am desperate to get rid of the jet lag that has me confusing midnight in Wales with 7pm back home, but even after several beers of the consistency of motor oil I still end up in my tiny dorm room cot staring at the ceiling tiles. To add to the trouble, there is a regular nightly chorus of what I assume to be a horde of Welsh revelers. The first night I made the best of things by getting some work done on the computer, but now my batteries are dead and there is no way to recharge without a converter that, of course, I do not have.

Day 3

Whatever confidence as a budding theater scholar I have been acquiring during the week is momentarily shattered when I walk into my first talk this morning on "Extended Minds and Conscious Artifacts." It is as though I have gone to sleep and woken up at a different conference. "Are the mind and world separate or continuous?" the speaker asks in his opening statement. Well, let's see. I take the question to mean "separate or

connected" but either way, I am going to say that the mind is supported in the brain. Final answer. But apparently not—or at least not according to the theory of "extensionism" that puts forth the proposition that not only is the mind globally supported across all physical boundaries but that it can also propagate forward and backward in time. Following this argument we end up at the remarkable and somewhat charming conclusion that when standing in front of a self-portrait of Rembrandt, we are in fact in an intellectual presence — his, even! Flummoxed by this, I look around the room to see if anyone else sees a naked emperor but it is all poker faces at the moment. "Very interesting," says an audience member. "This is very much like my theory of 'Shakespace'" which he goes on to explain as a kind of alternate Shakespearean reality, closed under the operation of dramatic readings, I am assuming.

Still looking for a hint as to whether I have missed some key metaphorical leap, I work my way over to Mr. Shakespace, and as we break for the next talk I ask him for his opinion on what we have been hearing. "Well it is a little old-fashioned don't you think? I mean the idea that the mind lives inside a skull is a bit of straw man at this point." Feeling as brainless as the Scarecrow himself, I have no choice at this point but to follow him into the next room to hear his talk on "transversal power," and I don't fare much better here. These are very smart people, to be sure, but the jargon has grown too thick and in my frustration I begin to conjure up images of math talks I have heard where one is subjected to several pages of definitions en route to a half-page theorem.

After lunch things return to earth a bit with some interesting talks on quantum mechanical theories of art. Tom Stoppard's sometimes off-putting spy-thriller *Hapgood* from 1985 comes across as a play ahead of its time in these conversations, whereas *Copenhagen* was transformative. The scholars and practitioners at this conference are well-versed and enamored with the concept of the observer being a part of the system being observed, and I learn how this principle is being thoughtfully explored in drama and dance performances where the audience interacts with the cast in a way that alters each performance. The more I listen, the more it occurs to me that the scientific avenues at work really go in both directions. With each addition to the growing canon of science plays, the insights of Newton, Darwin, Bohr or Turing find a new voice and a new audience. But what is absolutely clear is that this is not just a case of theater performing a dutiful public service by mining the mathematical sciences for worthy stories to tell. Since my fateful encounter with *Arcadia* years ago, I have been following mathematical and scientific threads on my way to the moral and humanistic truths that lie at the center of the best plays of this genre. This is the real heart of the matter, it seems to me. What makes a science play successful is when the mechanisms by which art and science seek out their respective truths are working in tandem, each one enriching a part of the picture for the other.

For our last night in Wales, we are treated to an incongruous "banquet" in the same cafeteria where we have been eating for the week. The staff, which has been impeccably congenial all week, is dressed in traditional Welsh attire but the band in the corner didn't get the memo and is playing Sinatra tunes. After dinner, we leave campus for literally the first time to go see a new, very post-modern play about Nikola Tesla that concludes with a mind-numbing arc of electrons across a 10 foot Van de Graaf generator at the back of the stage. Heading back to my room after the show I discover that the carousing Welsh teenagers I have been hearing every night are in fact the American conference delegates who, like me, have been unable to sleep. With complete disregard for the talk I am giving in the morning, I settle in for some significantly less formal conversations about extended minds and transversal power. Let's just say the whole thing goes down much smoother with a wine chaser.

Day 4

Having nearly completed my first theater conference, I am now in a position to say that the differences between a math conference and this one are in many respects superficial. The theater crowd possesses more social dexterity — they dress better (who doesn't?) and they don't write on the napkins. Another interesting phenomenon is that, for the most part, presenters *read* their papers rather than describe what is in them. I had been tipped off to this by my art historian wife and was prepared to follow suit, but now that the day has come I decide to be true to my extemporaneous roots and try to teach a little mathematics. It occurs to me that although the hard sciences have played a major role during the week, mathematics has been left largely on the sidelines. *Arcadia* is the one exception but even here the thermodynamics often overshadows the fractals. Auburn's *Proof* has received no positive reviews, the consensus being that one could just as easily write the mentally ill father as a genius composer rather than mathematician and nothing much would change.

The audience is rather thin when my turn comes to present my talk on "Gödel, Escher, Stoppard." Not only am I competing with "Soft Dark Matter" in the next room and "Meme Theory" two doors down, but my guess is that very few of my compatriots from the previous night have made it out of bed. This is all fine with me, actually, because it is suddenly clear that my talk is far too ambitious for a twenty-minute time slot on the morning of the last day.

Essentially, I attempt to explain Godel's Incompleteness Theorem by taking each part of Godel's argument and finding a dramatic parallel in the self-referential constructions of Tom Stoppard's plays. In my own defense I will say that this really is a fascinating exercise but it is not for the squeamish and definitely does not go well with a hangover. The silver lining — and I find this to be true whenever I do something mathematical outside of a math class — is that my few stalwart audience members are genuinely delighted to be learning, or at least be in the presence of, some serious mathematics. Routinely, well-educated people will say quite publicly how poor they are at mathematics without realizing that professing one's ignorance about any other subject is considered bad social form. On this particular morning however—and

in fact throughout the entire week—we are all keenly aware of just how much we stand to learn from each other and this puts us all at our passionate and respectful best.

The final curtain of the final talk falls in the late morning. As hugs and e-mail addresses are being passed about, I opt out of the tour of Tintern Abbey and catch the early shuttle to the train station thinking I might make it back to London in time to see another play that evening. To my great delight, standing on the platform are Chris Innis and Kirsten Shephard-Barr, and the long rocking train ride to London gives us one more chance to take on Snow's cultural divide. Chris and Kirsten talk about their latest projects, and I tell everyone why I think they might be wrong about *Proof*. Kirsten was one of the brave souls who had made it to my talk that morning, and she earnestly asks if I can give her the punchline one more time.

"Well, the idea is that you develop this very deterministic, rule-driven notion of what is meant by mathematical proof," I say again. "You essentially create a theorem proving machine, and then you ask whether it can supply proofs for every true mathematical statement that it is capable of expressing. But it turns out that it can't. There are always truths that your machine just can't derive." There is no shock on anyone's face, of course. This is a conclusion my artful friends have long ago made their peace with, but they are nonetheless delighted to hear it coming from me. "What's really interesting," I add, "is not just the result itself but the *reason* why it is true." And here I get as conceptual as I can. "What happens is that you keep making this theorem-proving machine stronger and stronger by giving it more rules to employ, enabling it to reach farther and farther into the spectrum of true mathematical statements. But then this extraordinary thing happens. As soon as the machine hits a certain critical strength, it acquires the ability to be introspective. Suddenly the machine no longer just talks about mathematics — it can also talk about itself — and this opens up a whole new crazy world."

As the train clicks along its parallel tracks on the way to Shakespace, I role this image around in my head and decide that I like it a great deal because what it says is that there aren't two cultures after all. You can't have one side of the brain without the other. You can't have science without art. You can try to build a machine that only knows mathematics but eventually, when it gets smart enough, it acquires a little self-awareness and all of the poetry that comes with it.

Stephen Abbott teaches at Middlebury College.

SUMMA National Research Experience for Undergraduates Program

The MAA, through its Strengthening Underrepresented Minority Mathematics Achievement (SUMMA) program, supports the participation of mathematics undergraduates from underrepresented groups in focused and challenging research experiences to increase their interest in advanced degrees and careers in mathematics.

We invite mathematical sciences faculty to apply for grants to host an MAA Student Research Program on their own campuses for six weeks in summer 2005. These grants will support stipends for one faculty researcher and a minimum of four local minority undergraduates, as well as costs for student room and board. Deadline for proposals is February 21, 2006.

Additional details are available at http://www.maa.org/nreup.

The MAA booth at a recent meeting of the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS), held in Denver September 29 – October 1. SACNAS focuses on mentoring students. There were 279 booths in all, making this the largest exhibit turn-out in SACNAS history. The conference had 2212 general attendees; 1103 of which were students. 485 of those students presented posters at the meeting.

Short Takes

Compiled by Fernando Q. Gouvêa and Harry Waldman

NCTM Defines "Highly Qualified"

It is a requirement of the "No Child Left Behind" act that schools hire "highly qualified" teachers. But the definition given in the law is fairly minimal: teachers who have a bachelor's degree and full state certification or licensure. NCTM has just issued a position paper arguing that "teaching mathematics demands much more," and offering their own definition of what it means to be "highly qualified." Their summary statement is:

Every student has the right to be taught mathematics by a highly qualified teacher — a teacher who knows mathematics well and who can guide students' understanding and learning. A highly qualified teacher understands how students learn mathematics, expects all students to learn mathematics, employs a wide range of teaching strategies, and is committed to lifelong professional learning.

The statement also specifies that

NCTM expects that high school teachers will have completed mathematics coursework equivalent to that required for a major in mathematics. Middle school teachers should have acquired the depth and proficiency in mathematics equivalent to at least an undergraduate minor in mathematics. Elementary teachers, resource teachers, and all others charged with providing instruction in mathematics should have completed the equivalent of at least three college-level mathematics courses that emphasize the mathematical structures essential to the elementary grades

The position paper, which includes a more detailed discussion of the qualifications for teaching mathematics, can be found online at http://www.nctm.org/about/pdfs/position/qualified.pdf.

Tom Banchoff Honored for his Teaching at Brown University

Thomas Banchoff, a longtime member of the MAA and veteran of the Brown University faculty, has received one of his university's highest honors for innovation and excellence in undergraduate teaching. He will serve a three-year term as a Royce Family Professor of Teaching Excellence, through June 30, 2008.

Banchoff has given Brown University students "extraordinary instruction, encouragement and mentoring," said Rajiv Vohra, dean of the faculty. He was honored for the "thoughtfulness and adaptability" that he brings to teaching, "incorporating new instructional technologies, broadening perspectives by reaching across departmental boundaries, and enriching the academic experience" of his students.

The Royce Family Professorships were established in March 2004 by a $5.5-million gift from Brown alumnus and trustee Charles M. Royce. The professorships are intended to recognize, reward and encourage innovation and excellence in teaching among the Brown University faculty. Each carries a $20,000 annual stipend in addition to the recipient's regular salary and provides a $20,000 annual teaching excellence fund to develop teaching aids and support scholarly activities, including employment of undergraduate assistants.

NAS Warns U.S. Could Lose Lead in Science and Technology

A National Academies panel composed of scientists, educators, and business leaders has warned that the nation could lose its lead in the sciences and technology to China and India. Compared to the U.S., the panel reports that China and India are graduating, for example, five to nearly ten times more engineers annually. The U.S. graduated 70,000 engineers in 2004.

The U.S. response, the panel recommends, should be to double the Federal investment in research over the next seven years; to fund more scholarships and fellowship in the sciences; and to annually train thousands more science and math teachers. The report can be accessed at http://books.nap.edu/catalog/11463.html.

Undergraduate Paper Competition Offers Cash Prizes and Publication

Cryptologia — a scholarly journal dealing with the history and technology of communications intelligence specializing in the mathematics of cryptology — is sponsoring two undergraduate paper competitions. The winners will receive $300 and have have their papers published in *Cryptologia*.

The journal has a record of investigating technical and mathematical cryptology as well as intelligence history, fostering the study of the many aspects of cryptology — technical as well as historical and cultural. Editor-in-Chief Brian Winkel, Dept of MathSci, United States Military Academy, West Point, and an editorial board of scholars in cryptology will disseminate worthwhile papers to mathematicians, security specialists, computer scientists, historians, political scientists, and teachers. For more information, see the journal's website at http://tandf.co.uk/journal/titles/01611194.asp.

GE and IBM Foundations Unveil Projects to Improve Math and Science Learning

Two major U.S. corporations say they will be investing millions of dollars in American school programs that they hope will improve math and science learning. The General Electric Foundation will distribute $100 million in grants over the next five years to raise mathematics and science scores in up to five school districts.

One county can already call itself lucky. The school district of Jefferson County, Kentucky, is the first to receive a $25 million grant. The district plans to use the money for a new district-wide curriculum and professional development for teachers.

The IBM International Foundation will pay college tuition costs for up to 100 of its employees who want to train as math and science teachers. In order to participate in the "Transition to Teaching" program, its employees have to have a bachelor's degree in math or science (or a higher degree in a related field), teaching experience, and at least 10 years of employment at IBM.

American Institute of Mathematics Offers Five-Year Fellowship

The American Institute of Mathematics, Palo Alto, CA, is offering five-year fellowships to mathematically worthy candidates. This fellowship funds a researcher — at $4,000 a month — and may be used anywhere that is consistent with the research goals of the recipient.

AIM's aim is to provide the fellowship to an individual with the potential to make a lasting impact on mathematics. The deadline for applying is December 31. See http://www.aimath.org/fellows for details.

Design Science Receives Grant to Make Math Accessible in MS Word and Adobe PDF

Design Science has received a National Science Foundation grant to continue research in making mathematical content accessible to people who are visually impaired. The aim is to increase mathematics accessibility to Microsoft Word and Adobe PDF documents. The company is also striving to improve its speech-generation algorithms.

The need for easily accessible mathematics was highlighted in this year's U.S. Department of Education announcement, "Raising Achievement: A New Path for No Child Left Behind." It asked institutions to provide sensible and informed approaches to testing students with academic disabilities.

"The prevalence of Word and PDF documents in science and education makes bringing math accessibility to these formats the next logical step," said a Design Science spokesman. The organization's goal is to develop a "robust, market-ready system."

Next Spring: Zeta Functions All the Way

On May 15-26, 2006, on the campus of the Institute for Advanced Study in Princeton, NJ, the Program for Women in Mathematics will sponsor mathematics sessions under the rubric "Zeta Functions All the Way." There will be two courses for undergraduate and graduate students; seminars; and a variety of mentoring activities. Junior and senior women mathematicians will be involved as lecturers, TA's, and mentors.

The advanced course will be given by Kate Okikiolu (University of California, SD) on "Spectral zeta functions in geometry." Audrey Terras (UCSD) will teach "Zeta and L-functions of graphs." The introductory course on zeta functions will be given by Giuliana Davidoff and Margaret Robinson (Mount Holyoke College).

Enthusiastic women students and postdocs are encouraged to visit http://www.math.ias.edu/womensprogram/ for more information.

National School and Business Partnership Awards

The National School and Business Partnerships Award program will be sending money to what they call "six exemplary school-business partnerships" next year. Each of these school-business partnerships will receive $10,000.

The National School and Business Partnerships Award "supports and recognizes the efforts of schools and businesses that improve the academic, social or physical well-being of students," says the press release from the Council for Corporate & School Partnerships. The Council, chaired by former Secretary of Education Richard Riley, "serves as a forum for the exchange of information, expertise and ideas to ensure that partnerships between schools and businesses achieve their full potential for meeting key education objectives." It was founded by The Coca-Cola Company in 2001. For more information, including application forms, see http:// www.corpschoolpartners.org.

Sources

NCTM: *Education Week*, NCTM web site. Banchoff: Brown University. NAS Report: NASSMC Briefing Service, http://books.nap.edu/catalog/11463.html. Cryptologia: Taylor & Francis, Cryptologia editors. GE and IBM: *Education Week*; see http://www.edweek.org/ew/articles/2005/09/28/05ibm.h25.html. AIM Fellowship: email communication, AIM web site. Design Science: email communication, http://www.dessci.com/en/company/press/releases/ IAS Program for Women: email communication. National School and Business Partnership Awards: email press release.

MAA Regional Undergraduate Mathematics Conference Program

The MAA has received funding to provide support for institutions or groups of institutions that wish to initiate or expand undergraduate mathematics conferences. Conferences may assume any format that accomplishes the primary object of the grant, which is to provide undergraduate students the opportunity to present mathematical results and to better expand their knowledge of the wide range of theory, history, and applications of the mathematics sciences.

The requests for funding will be reviewed throughout the year. It is anticipated that most awards will be between $1,000 and $4,000, but smaller and larger requests will be considered.

More detailed program information, including guidelines for conference organizers and sample proposals, are available through the project website, http://www.maa.org/rumc.

Our Experiences as IMMERSE Faculty

By Keith Agre, Tracy Hamilton, Jacqueline Jensen, and Keri Kornelson

The IMMERSE (*I*ntensive *M*athematics: a *M*entoring, *E*ducation and *R*esearch *S*ummer *E*xperience) program at the University of Nebraska - Lincoln (UNL) is a summer program, funded by an NSF MCTP (Mentoring Through Critical Transition Points) grant, which is designed to bring together early-career faculty, graduate students, and pre-graduate students for an intensive six week program. The activities included courses for the pre-grads in algebra and analysis, problem sessions led by the graduate students, invited speakers, and panel sessions with the goal of preparing the pre-grads for graduate school. This article is a description of the IMMERSE program through the eyes of the early-career faculty participants.

IMMERSE participants, summer of 2005. Photograph by Marilyn Johnson of the University of Nebraska-Lincoln.

What is IMMERSE?

IMMERSE was designed with a ladder-like structure of participation, with participants in each group serving as mentors for those earlier in their careers and receiving mentoring from the more experienced participants. The pre-graduate students accepted into the IMMERSE program were selected primarily from schools without Ph.D. programs, but they all planned to begin a Ph.D. program in the fall. For the pre-graduates, the goal of the program is to increase their level of preparation for their graduate program and to give them a view of the atmosphere of graduate school. The UNL graduate students mentor the pre-graduates by overseeing problem sessions and answering questions about life in graduate school. This gives the current graduate students mentoring experience. The four early-career faculty (the authors of this article) were also selected from institutions that do not have Ph.D. programs. We functioned as instructors and mentors to the pre-grads and graduate students, while pairing up with a research mentor from the UNL faculty to work on research and receive career guidance.

Two early-career faculty members were assigned to teach the algebra course, while the other pair taught the analysis course. Rather than concentrating solely on material from standard textbooks, each course was focused around reading a relatively recent research paper. In this way, the paper served as a guide for discussing mathematical ideas that will be seen in graduate level courses in algebra and analysis. The early-career faculty also gave advice on graduate school, based on their own experiences, to the pre-graduates. We were thereby able to gain experience in mentoring students, encouraging students to pursue graduate mathematics, and teaching graduate level mathematics. These will be valuable assets to incorporate into working with our own students when we return to our home institutions.

Our Experience

We arrived in Lincoln two weeks prior to the arrival of the pre-graduate students. During those first two weeks, we finalized the preparations for the courses, decided on speakers to invite throughout the program, planned panel discussions, and developed a daily schedule for classes and problem sessions. The schedule turned out to be an intense one for the students, with both algebra and analysis holding 90 minute lectures and 90 minute problem sessions four days per week. This provided the students with extensive access to both the graduate mentors and the early-career faculty. The preparations during these two weeks also included discussing which mathematical concepts were relevant to the research paper we were using as the center for our courses, writing homework assignments, and exploring different methods which could be used to co-teach a graduate level course.

We were all new to the practice of team-teaching, and we chose different pedagogical approaches. One pair of us decided to alternate lectures, with each person being responsible for certain topics. The other pair decided to more completely "team-teach" by jointly preparing for most lectures. One person would take the lead in the presentation, while the other interjected important supplements to the material being presented. All of us wanted to intersperse lectures on new material with discussions about the research papers as the course progressed, but we did this in different ways. One pair decided to have groups of students present the important parts of the research paper at different points in the course. The other pair decided to conduct class discussions of the theorems and proofs. We felt the different approaches were good for the students, so that they would be exposed to different styles of presentation, and required to adjust their learning styles accordingly.

As part of the IMMERSE program each of us was paired with an experienced re-

searcher at UNL. The initial two weeks that we were in Lincoln were also intended to provide time to begin these research connections, which ranged from an exchange of ideas to active pursuit of a research project. Our research mentors were all talented mathematicians and willing mentors, but some of these pairings were less productive due to their other obligations. Some had planned extensive out-of-town trips during the program, which slowed the research progress. Because of these absences, this part of the program didn't work exactly as the organizers planned. However, at least two of us made significant progress on a new project, while another continued work on an existing problem.

The IMMERSE program provided a great opportunity to interact with very bright students who will be going on to graduate programs. We were delighted to find that of the 17 pre-graduate participants, 11 were women. We were able to give some (hopefully sound) advice to students about what graduate school is like, coping strategies that we employed, and some warnings about the difficulties that they may face in their academic and personal lives while in graduate school. In one such discussion, we were reminding the students that there are many successful routes through graduate school. One of the IMMERSE pre-graduate students said, "My graduate school experience is going to be unique. Based on decisions that I make, my experience will be different from anyone else's." One student commented that he was amazed by how much he had learned in such a short period of time. He was especially impressed by the amount of assistance he received from other pre-graduate students.

All in all, the IMMERSE program is appropriately named — it is an *I*ntensive experience for both the pre-graduate students and the early-career faculty. We spent many hours preparing lectures and homework assignments, and many more visiting with the students during breaks. The students also spent many hours, both in class and out, doing mathematics. As with any intensive experience, however, they formed friendships and support networks (read: Dutch Blitz teams) that enabled them to cope with the stress and work even harder than they thought they could.

While participating in the program meant a long stay in Lincoln, away from our home institutions and family, the interactions with these amazing and talented pre-graduate and graduate students made the experience lively and invigorating. The opportunity to embark upon new research projects gave our research programs a boost of new energy as well. We have learned a great deal from the students about mentoring, and about concerns students have when they are preparing to start their graduate careers. The students also expressed that the experience was worthwhile, with most feeling more prepared for their graduate programs than they were upon their arrival in Lincoln. As one student put it, "IMMERSE provided an opportunity to review a great deal of material and learn many new things. I gained confidence, too! I feel ready for the fall semester." Comments like this are what made IMMERSE a rewarding experience for all of us.

Keith Agre is an assistant professor at St. Cloud State University. Tracy Hamilton is an assistant professor at California State University Sacramento. Jacqueline A. Jensen is an assistant professor at Sam Houston State University. Keri Kornelson is an assistant professor at Grinnell College.

Musings on the Two-Body Problem

By Brian Birgen and Jean Bee Chan

A curious thing happened on our way to lunch at the 2005 Joint Mathematics Meetings at Atlanta. As components of mathematical couples, we discussed the challenge of finding geographically close positions for ourselves and our partners. This challenge is informally called the Two-Body Problem. In a moment of enthusiasm, we decided to share our musings and urge institutions to help solve the Two-Body Problem for mathematical couples. Such a solution would benefit both hiring institutions and the mathematics profession.

Between bites of our sandwiches, we identified several known solutions. They are: (1) The partners find two positions in the same institution; (2) they find two positions at different but nearby institutions; (3) one partner finds a position in an academic institution, while the other a position in nearby business, industry, or government (BIG); or (4) they share a single position at one academic institution.

For the hiring institution, one clear benefit of any solution is stability. Once a viable solution has been found, the daunting prospect of returning to the job market tends to keep the couple in place. In fact, smaller and isolated colleges can become attractive "fixed points."

A similar benefit is that "happy workers are productive workers." When concern about employment is minimized, the partners can focus more effectively on their work. They become more involved in their institutions and protective of the solution they have found. They tend to be active on hiring committees and willing to mentor new members. Even if the dynamics of a department become chaotic, the partners are motivated to take leadership roles to improve the department. Often these members have an increased loyalty to their own institution and are more likely to stay put even if one partner becomes distinguished in a field of study.

The advantages of solution (1) are that commuting difficulties are minimized, partners can work on related projects, and they share all aspects of professional life. The institution can sometimes attract higher quality members by hiring a couple because these mathematicians are not simply looking for the highest paying or most prestigious positions.

When partners hold positions at different but nearby institutions as in solution (2), communication between the two institutions naturally increases. In practice, the couple connects two disjoint institutions so that members at both institutions can share opportunities and collaborate on projects, making a positive impact in the profession.

Finding one position at an academic institution and one at a BIG institution leads to better placement of students into internships, more real-world applications in the classroom, and mutual appreciation between academia and BIG. While the more rigid work schedule of the BIG institution may create pressure on the academic partner, a higher BIG salary can help ameliorate that problem.

Solution (4), partners sharing one single academic position, will allow both partners to devote more time to research and other creative activities. A benefit is the increase in specialties represented among the faculty. The "same" faculty member might teach abstract algebra, differential equations and statistics. By hiring a couple with partners from different research areas to fill a shared position, a small college can feature more specialties and have better qualified faculty members for advanced courses.

Are there drawbacks to hiring a couple? If the partners are in the same department and their relationship sours, the entire department will be affected. With a shared position, the handling of a dissolution is even more difficult. Problems may also arise when one member of the couple is a good fit for the department, but the other is not.

Problems aside, an increasing number of institutions realize the benefits of hiring a mathematical couple. There was a time when anti-nepotism rules meant that mathematical couples in the same department were rare, but currently an institution's best interests lie in developing policies about mathematical couples. For example, the University of Kansas Domestic Partner Accommodation Guideline includes the following:

"With two-career couples becoming the norm rather than the exception in academia, we are willing, indeed eager, to investigate possibilities for domestic partner accommodations when such accommodations will increase our number of quality faculty and staff."

As members of two-career couples ourselves, we encourage others to be persistent and creative when searching for positions. Make the institution an offer it cannot refuse. Once a couple accepts an offer of two positions, performance above and beyond normal expectations will encourage other institutions to explore the value of mathematical couples in the future.

Institutions can help solve the Two-Body Problem. A solution will empower both partners to reach full career potential. If institutions seek opportunities to offer positions to couples, they will be richly rewarded with loyalty, dedication, and stability.

Brian Birgen is Assistant Professor of Mathematics at Wartburg College in Waverly, IA. Jean Bee Chan is Professor of Mathematics at Sonoma State University in Rohnert Park, CA.

What Does ACMS Stand For?

By Robert L. Brabenec

In the early seventeenth century, Johannes Kepler believed that in doing mathematics, he was thinking the thoughts of God. Was he right? Does such a question even make sense in 2005?

Like all other academic disciplines, mathematics has a core of concepts and methods that are independent of the world views of individual mathematicians. In fact, some mathematicians have regarded that core as the entire discipline. For example, writing in 1927, David Hilbert articulated his vision that mathematics could become a "presuppositionless science." Hilbert's vision, though, seems to require a very narrow assignment of the boundaries of mathematics, one that includes formal axiom systems, definitions, and deductive reasoning, but not much else. Other mathematicians have preferred a broader definition of the discipline, one that incorporates the philosophy and history of mathematics, mathematics education, its role in contemporary culture, its connections with other disciplines, and much more.

Scholarly work in these broader areas, though, is often influenced by world views. One group of mathematicians that has embraced these broader aspects of mathematics and sought to explore how world views might impact scholarship in these areas is the Association of Christians in the Mathematical Sciences (ACMS). Some of the questions ACMS members have explored include the following.

- What is the nature of mathematical objects? Are they social constructions? Do they exist in the mind of God? Are these perspectives reconcilable?
- Mathematicians often describe their subject as "beautiful." What is the concept of beauty used here? How does it relate to other concepts of beauty including the theological notion of the "beauty of God"?
- How did Enlightenment thinkers see the role of mathematics in human culture? Are we as mathematicians comfortable with such an understanding of mathematics? Now that the Enlightenment perspective has fallen out of favor, how may our culture's perspective on the role of mathematics change? What responsibility do we as a mathematics community have in shaping this perspective?
- Does a theological perspective provide any helpful insight into the issue of the "unreasonable effectiveness" of mathematics?

ACMS was organized in 1977 and now has more than 300 members. Many ACMS members are mathematics faculty at Christian liberal arts colleges, where integrative questions such as those listed above are encouraged. There are also members from secular colleges and universities, high schools, and industry, as well as graduate students and a growing number of teachers of computer science. ACMS members do not believe that there exists a distinct Christian mathematics, but rather that dual knowledge of faith issues and mathematics enriches and informs both areas. A familiar analogue is the way that the separate disciplines of geometry and algebra supplement each other in analytic geometry.

The main activity of ACMS is a four day conference, held every two years from Wednesday evening until Saturday noon of the week following Memorial Day. The 15th conference was held in May 2005 at Huntington University in Indiana, and the 16th conference will be at Messiah College in Pennsylvania from May 30 until June 2, 2007. These conferences offer a chance for about 100 delegates to share several days together. Activities include invited talks by featured speakers, shorter papers by ACMS members on a wide variety of topics, many opportunities for informal discussion, and a time of common worship.

The following list of past featured speakers and their topics illustrate the diversity of interests within ACMS. Donald Knuth (at Calvin College in 1987) spoke on the writing of his book *Surreal Numbers* and his efforts to develop a book on Bible study, while Tom Banchoff (at Messiah College in 1989) spoke on his involvement with students in computer representations of four dimensional space and on the background of Edwin Abbott Abbott, the author of *Flatland.* Joseph Dauben (at Westmont College in 1993) presented material from his books on Georg Cantor and Abraham Robinson, and Owen Gingerich (at Wheaton College in 1997) spoke about his special interests in the history of astronomy, arising from his joint appointment at the Smithsonian Astrophysical Observatory and Harvard University. Bill Dunham (at Gordon College in 1999) spoke about some of Euler's results, including geometry in addition to the more usual topics from analysis and algebra, while Paul Zorn (at Point Loma Nazarene University in 2003) presented examples of material he encountered during his time as editor of *Mathematics Magazine*.

The *Proceedings* from every conference have been published and are available for purchase. The tables of contents may be perused at the website (http://www.acmsonline.org), where one may also find directions for ordering a copy of the *Proceedings* or for becoming an ACMS member. The organization recently began an online journal for articles dealing with the integrative issues mentioned earlier. The texts of twenty six papers from previous conferences are also included on the website. In addition, several ACMS members authored the book *Mathematics in a Postmodern Age*, published by Eerdmans in 2001. (It was reviewed in the MAA's *Read This* online book review column; see http://www.maa.org/reviews.) Another publication is the *Bibliography of Christianity and Mathematics (1910–1983),* which was compiled in 1983 and is presently

being revised and enlarged by Gene Chase at Messiah College.

Every January, in conjunction with the Joint Mathematics Meetings, ACMS sponsors a dinner followed by a talk of a general nature. In Atlanta in 2005, Tom Banchoff spoke about his involvement over a period of ten years with Salvador Dali on the use of computer graphic systems to enhance artistic representation of multidimensional images. When the Joint Meetings include a Sunday, as they will in San Antonio in 2006, ACMS also prepares an early morning non-denominational worship service for interested participants.

ACMS members are also involved in the general program of the MAA. David Lay (University of Maryland) played a leading role in the reform of the linear algebra curriculum and the writing of an influential textbook on this topic. Wayne Roberts (Macalester College) has long been involved in calculus reform, serving as editor of the 5 volume *Resources for Calculus* publications. Charles Hampton (College of Wooster) is active as an officer in the SIGMAA for the Philosophy of Mathematics. Robert Brabenec (Wheaton College) and Al Hibbard (Central College) are MAA authors. Francis Jones (Huntington University) was chosen for a MAA section teaching award. Judith Palagallo (University of Akron) serves on the editorial board of the MAA series Classroom Resource Materials and began the Mentoring Women in Mathematics program. Fernando Gouvêa (Colby College) is, among other things, editor of FOCUS. Andrew Simoson (King College) has published a dozen articles in MAA journals and Francis Su (Harvey Mudd College) has served on the editorial board for the *Spectrum* book series.

The website mentioned above contains additional information about the ACMS organization. Anyone interested in its programs is welcome to participate in its activities.

Robert L. Brabenec is Professor of Mathematics at Wheaton College in Illinois. He was one of the founders of ACMS.

Additions to the Joint Mathematics Meetings Program

NUMB3RS and Math, The "We All Use Math Every Day" Program, Organized by Linda Beheler, Texas Instruments. Thursday, 5:00 p.m. - 6:30 p.m. "We all use math every day..." These words open the weekly introduction to the hit CBS show, NUMB3RS in which an FBI agent and his math professor brother solve crimes using math to figure out clues and drive the investigation. These words are also the title of a TI program in partnership with CBS to promote student interest in math. The program includes weekly online activities that correspond to the math in each episode of NUMB3RS and a special teacher kit. See how to use NUMB3RS to help excite students about the real world relevancy of math, receive a teacher kit, and meet a cast member from NUMB3RS. Autographs and photo session follows the event. Cast member to be announced prior to show. The session is sponsored by Texas Instruments, The Mathematical Association of America, and the American Mathematical Society.

Jacob Fox of MIT, winner of the 2005 Morgan Prize, will speak on "Ramsey Theory on the Integers, Rationals, and Reals," at the **Research in Mathematics by Undergraduates** session Friday 6:00 pm to 6:20 pm. Darren Narayan is the session organizer.

Save the *Monthlies*

Do you have lots of issues of the *Monthly* taking up space on your bookshelves? Before you put them in the recycling you might consider the following. Two issues of the *Monthly* appear in a new booklist from the Los Angeles rare book dealer, Michael Thompson. Each of the issues — volume 59, number 8 (1952) and volume 62, number 9 — contains an article by W. V. Quine on the simplification of truth functions. The articles are of interest because they were precursors of Quine's later work on the Quine-McCluskey method of logical circuit minimization. The asking price is $1250 for the pair. (Thanks to Jerry Alexanderson.)

Shapes of Sacred Space

At the Joint Mathematics Meetings, the History of Mathematics SIGMAA will be sponsoring a special presentation by Edwin L. Barnhardt, Director of the Maya Exploration Center, and Christopher Powell, a senior research associate of the Center. They will discuss a new line of research on what is known as "Maya Sacred Geometry," examining how the Maya used proportions derived from nature in their art and architecture. The talk will be on Thursday, January 12, from 9:30 am to 10:50 am. (This talk was not listed in the October issue of FOCUS.)

Thirty Years and Counting: My Involvement With the MAA

By George Bradley

I first got involved with the MAA in April of 1974. This was the end of my sophomore year at Allegheny College, a liberal arts college in Meadville, Pennsylvania. Because of our three term calendar, I had already completed calculus I, II and III, an introductory analysis class based on the Moore Method, and linear algebra. I was enrolled in abstract algebra, and had decided to major in math. It was exciting to meet students and faculty from colleges all over the region and hear interesting and understandable mathematical talks!

In January of 1975, the faculty decided to take two seniors and two juniors (including me) to the Joint Meetings in Washington, DC. It was a wonderful experience. We drove to the meetings in Rich Lundgren's orange VW bus (called "The Pumpkin"), playing bridge all the way. It was exciting to be in Washington, which I had visited only once before. I roomed with Ben Haytock, one of my professors at Allegheny. I also met Kathy Taylor, who was already teaching at Duquesne. Kathy is a past winner of the MAA service award from her section. We did some sightseeing, including the National Gallery, the zoo, and many of the monuments. After this meeting, I knew I wanted to become a professor of mathematics and become involved with the MAA.

The 1976 spring meeting of the Allegheny Mountain Section was held at West Virginia University. I gave a talk based on my senior project under the direction of Dick McDermot. I was nervous, but it was definitely a valuable experience.

During my graduate years at Notre Dame, I maintained my membership in the MAA, even though neither my fellow students nor the faculty were much interested in the organization. I looked forward to getting a teaching position at a school that valued excellence in teaching and supported involvement in the MAA (if only Project NEXT had been around then!). I was therefore very pleased to accept Duquesne's offer for a tenure- track position to begin in the fall of 1981, and to be able to return to my home town and the Allegheny Mountain Section.

The faculty at Allegheny were (and still are) very much involved with the Section, as were (and still are) the faculty at Duquesne. Attending the annual section meeting was a very high priority for me. In a few years, I was asked to become Student Program Coordinator for the Section. I have been told that our Section was one of the first to start including programs for students and having students give talks.

This appointment was the start of my fifteen years as an officer of our Section. I also served as newsletter editor, co-director of short and minicourses, and Governor of the Section. My first fall section officers meeting was at Clarion University. Ben Freed's wife provided a very nice meal for us at the conclusion of the meeting. This allowed the officers time to get acquainted on a personal level and to be fortified for our trip home.

The next year, I asked if people would like to come to my home for the meeting, since it was centrally located in the section, and I would provide the meal. Everyone enjoyed the relaxed atmosphere of meeting in someone's home. The meeting was very productive, and people ate my cooking with no complaints. My mother graciously provided homemade pies, which were the hit of the meal. For my remaining years as an officer, and for one year after my term ended I continued to host the fall meeting of the officers.

I was privileged to be one of the organizers of the last section meeting we had at Duquesne. Since coming to Duquesne, I have missed only one section meeting. Ironically, it was the meeting at which I was honored with an award for outstanding service by our section.

Because of my involvement with the section, Dick McDermot, founder of the Section Summer Short Course, and MAA award winner for distinguished service to the section, nominated me to the national Minicourse Committee. I served on that Committee for 8 years, chairing it for 3. I am now serving on the Committee on Sections, the Committee on Professional Development, and the Coordinating Council on Meetings. I also have been organizing on-site receptions for GLBT members of the MAA at our national meetings.

My many years of involvement with the MAA have been rewarding. I have met so many wonderful, dedicated, and friendly people. I (and in some cases my partner, my parents , sister, and brother-in-law) have seen much of the country by attending the Joint Meetings and MathFest.

The MAA is a vital and vibrant organization. Of course, the national staff is very dedicated, but it is because so many people volunteer their time and energy that makes the organization work. If you haven't been active in your section, I urge you to become so. If you have, consider an appointment to a national committee. The organization will be grateful, and you will find it to be one of the most exciting parts of your career.

Last spring the position of Section Historian became vacant, and I was asked to take that position. I am very glad to once again be involved in the affairs of the section. Oh, and Mom, could you please make a couple of pies for our meeting?

George Bradley is Associate Professor of Mathematics at Duquesne University in Pittsburgh, PA.

How We Measure Up
Is American Math and Science Education in Decline?

By The Editors of The New Atlantis

As if coordinated to provoke headlines, top executives at three of the nation's leading technology firms recently issued bleak appraisals of the American education system, criticizing especially how American students are taught science and mathematics. Microsoft Chairman Bill Gates minced no words at a summit of the nation's governors: until high schools are redesigned, he declared, "we will keep limiting, even ruining, the lives of millions of Americans every year." The chief executives of Intel and Cisco Systems shortly followed suit, suggesting that America's lackluster schools will increasingly force companies to look overseas for talent.

Of course, these concerns are hardly new. But the somber prognoses from the heights of high-tech have added high-profile urgency to recent press reports about the declining performance of U.S. students in science and math compared to other nations, and the potential rise of China as a technological and economic superpower. Leading U.S. media outlets have featured major stories on the consequences of China's rise for America's future, like the recent *Newsweek* cover story by Fareed Zakaria appealing for a "massive new focus" on science and technology in the U.S., lest America "find itself unable to produce the core of scientists, engineers and technicians who make up the base of an advanced industrial economy." In such a media atmosphere, one could be forgiven for having concluded that the United States is drifting unawares into an educational backwater while the rest of the world paddles furiously past it.

The truth is more complex. Cross-national studies of scientific and mathematical ability, interpreted rightly, tell a complicated story, giving reason to question how well the tests measure America's real educational standing in the world. The two tests cited most frequently in press reports are the Program for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS). PISA, undertaken by the Organization for Economic Cooperation and Development (OECD), most recently spanned 41 countries and tested 15-year-olds on mathematical word-problems. The latest TIMSS, in 2003, comprised more traditional, textbook-style math and science problems and was administered to fourth- and eighth-graders in 25 countries by an international team of researchers based in Boston and Amsterdam. The Department of Education funded both studies in the U.S., with help from the National Science Foundation.

Both tests have repeatedly been invoked by sensationalists seeking to cast the United States as unprepared for the high-tech, global economy. When the latest PISA results were released toward the end of last year, for instance, the *Christian Science Monitor* ran with the headline "Math + Test = Trouble for U.S. Economy," and concluded that the study's emphasis on "real-life" math skills makes it an accurate and "sobering" predictor of students' performance in "the kind of life-skills that employers care about." Federal officials expressed concern about the test results, too. "If we want to be competitive, we have some mountains to climb," said Deputy Education Secretary Eugene Hickok.

To be sure, the results of neither TIMSS nor PISA should send American educators and policymakers rushing to the champagne. In most math areas tested by PISA, the gap between the average U.S. student and the average student in the highest-scoring countries—often Finland, the Netherlands, Singapore, Japan and Hong Kong—was roughly equivalent to the gap between the United States and low-scoring countries like Uruguay or Mexico. Where 44 percent of Singapore's students reached the TIMSS "advanced international benchmark," only 7 percent of U.S. students did. And, in general, the longer students had remained in the U.S. school system, the worse they performed relative to their peers abroad.

The first question that must be asked of such broad results, however, is whether the tests themselves accurately represent the countries' student populations. International surveys such as these are not given to every student in each participating country; the tests' organizers pick out statistical samples that are supposed to represent each country's entire student population. Even so, schools—especially in the United States—sometimes decline to participate in the tests, potentially skewing the sample. As far as accurate sampling is concerned, early incarnations of the tests were not encouraging. In the first TIMSS general achievement test, conducted in 1995, only 5 of 21 participating countries met the study's guidelines for conducting representative samples. While most countries participating in the latest studies have dramatically improved their overall sampling, the United States remains a notable exception. Only 73 percent of U.S. students chosen to be sampled were actually tested, a figure below the "minimum acceptable" rate of 75 percent. In most other countries, that number was well over 90 percent. If the omitted 27 percent of U.S. students were even slightly above or below average, their exclusion casts serious doubts on the accuracy of the U.S. sample.

The studies also inevitably confront large differences between countries' school systems. "In Cyprus, students taking the advanced mathematics test were in their final year of the mathematics and science program; in France, the final year of the scientific track; in Lithuania, the final year of the mathematics and science gymnasia; in Sweden, the final year of the natural science or technology lines; and in Switzerland, the final year of the scientific track of gymnasium," Professor Iris Rotberg of George Washington University wrote in *Science* concerning the 1995 TIMSS assessment, which tested high-schoolers. "In contrast, students in

several countries, including the United States, attended comprehensive secondary schools. The major differences in student selectivity and school specialization across countries make it virtually impossible to interpret the rankings." In TIMSS, especially, tests are conducted by grade-level rather than by age. In elementary and middle school, where topics are often covered and learned over the course of a few weeks, the risk of comparing students at incommensurate stages of their education is great.

Broad curricular differences have probably had a role in deflating U.S. scores. TIMSS and PISA use the same test in every participating country, and the material that makes it onto the test is selected through a winnowing process that leaves the tests considerably narrower than any single country's general curriculum. Countries that include large amounts of material in their typical curricula are therefore at a disadvantage compared to those countries that focus their curricula more intensely on fewer subject areas. Regardless of its other merits or failings, the American strategy of repeated exposure to a broad range of subjects—American textbooks are the bulkiest in the world—is likely to lend itself to unduly poor performance on standardized tests, as full understanding of any single concept takes longer to develop.

Demographics and culture are also thought to confound the results of cross-national comparisons. In the United States, the tested students come from every socioeconomic rung, while other countries sometimes lack some rungs because of cross-border employment. For example, much of the labor force in Hong Kong (which is treated on the tests as an independent entity) is made up of tens of thousands of low-paid Filipino household workers whose children live and are educated in the Philippines; in light of the extensive literature tying socioeconomic indicators to educational achievement, this cross-border employment surely affects both countries' scores. A similar situation obtains in other places with significant immigration and cross-border commerce, as Gerald Bracey points out in a 1997 article in the journal *Educational Researcher.* "Each morning thousands of Malaysians enter Singapore to sweep streets, pick up garbage, and do other low-level jobs. They return to their homes at night, relieving Singapore of having to educate the children of poor laborers," Bracey writes. "If one reads the [domestic] educational research literature, one is struck by the lengths—the extreme lengths—that researchers go to to ensure that samples in their studies are comparable....The research community would never accept test results in this country that simply compared scores in an inner-city slum and an affluent suburb as if they were comparable," he writes. The opposite circumstance holds in the United States: Students from all socioeconomic rungs are educated and scored on these tests.

Amid this deluge of confounding factors, the inference that the U.S. education system is going down the tubes is an unjustified logical leap. The United States is still pumping out tremendous numbers of new Ph.D.s in the sciences—more, in fact, than our economy can presently absorb, as there is a well-reported dearth of jobs for newly-minted science Ph.D.s. The same is true in engineering: According to a recent National Science Foundation report, the number of engineers graduating from U.S. schools will continue to grow into the foreseeable future, outstripping the number of available jobs. Of these new engineers and Ph.D.s, an increasing number are foreign-born—but increasing even faster is the percentage of those who decide to stay in the United States. Federal research funding for scientific research and development has consistently risen in absolute terms and as a fraction of discretionary spending—and industry research dollars have risen dramatically on top of that, to the tune of 7 percent per year in real terms—according to calculations by the Consortium for Science, Policy and Outcomes at Arizona State University. (Alarmist media reports often use GDP, against which research spending has fallen, as a comparative baseline.) And countries that have "outperformed" the United States in educational studies for many years—a number of European countries top this list—still fail to rival the U.S. in any measure of research productivity. When Bill Gates and others seem to appeal for school reform in the U.S., perhaps they are merely providing their companies with political cover and a post hoc justification for employing foreign engineers who, while not better educated than U.S. workers, are often significantly cheaper.

Nevertheless, there remains good reason to worry about what the global economy portends for those American students who really are badly educated. In only one other OECD country (New Zealand) are internal educational inequalities worse than in the United States, according to a recent analysis by researchers in England and Italy. Where these inequalities lie is no mystery. The gap in test scores between white and ethnically Asian students on the one hand and black and Hispanic students on the other is a well-known attribute of U.S. schools and is noted ruefully in nearly all cross-national studies. Two University of Pennsylvania researchers recently aggregated scores from a number of cross-national studies and found that white students in the United States, taken alone, consistently outperform the predominantly white student populations of several other leading industrial nations. "There is compelling evidence," they write," that the low scores of [black and Hispanic students] were major factors in reducing the comparative standing of the U.S. in international surveys of achievement. If these minority students were to perform at the same level as white students, the U.S. would lead the Western G5 nations in mathematics and science, though it would still trail Japan." In PISA, for instance, white students performed above most European countries, whereas black students performed on par with students in Thailand. So while the performance of minority groups in the U.S. does refute the alarmist assertion regarding an across-the-board decline in U.S. schools, it does so in a particularly unfortunate way—namely, it suggests that some American minority groups will be shut out of high-paying jobs as companies look for better-educated workers overseas. Although the most recent TIMSS saw the white-black score gap close slightly, it is almost certain to remain shockingly large in the near future.

None of this is to say that other countries are not catching up technologically, nor that the United States is safe from competition in even a single technological sector. China is without doubt the most aggressive challenger. In the mid-twentieth century, Japan's economy grew 55-fold over the course of thirty years through stringent government control; observers of Japan's rise will remember the key role of its Ministry of International Trade and Industry, which employed many of the nation's brightest stars and guided the economy on a carefully directed path of technological growth. China's strategy has been similar, though its tremendous size has necessitated delegation of heavy-handed economic control to regional governments in what scholars have termed "local state corporatism." It has simultaneously harnessed the power of markets in a way Japan did not. Regional governments lavish tax breaks on high-tech industries (many of them funded from overseas) and pump millions into China's new universities—which are poised to graduate more Ph.D.s than the United States by 2010, according to some projections. Nearly all of China's top leaders are scientists and engineers by training: President Hu Jintao is a hydroelectric engineer, Premier Wen Jiabao is a geological engineer. Their predecessors, Jiang Zemin and Zhu Rongji, were both electrical engineers. The technocrats steering China's ship of state are working hard to modernize scientific education in their country.

But the United States need not worry—not yet. The U.S. is by no means in technological decline, though China and India will inevitably pose challenges in years to come. Although not a crisis, this competition should motivate the U.S. to improve its science and math education, especially for poor and minority students who might lose out in a globalized, high-tech economy. If sensationalists must take up a cause, it should be the plight of those students and not a hyped-up "threat" of China or the "impending decline" of technological innovation here at home.

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In Memoriam

Ruth Aaronson Bari, professor emeritus of mathematics at George Washington University, died on August 25. She was 87. Born in Brooklyn, NY, she learned to love mathematics at the local college, from which she received a bachelor's degree in 1939. Her plans to obtain her PhD at Johns Hopkins were delayed by World War II and the arrival of three daughters, but she returned to Johns Hopkins and eventually received her degree in 1966, at age 47. Her research work was in graph theory and was well received. She joined the GWU faculty that same year, and remained until her retirement in 1987. In addition to her mathematical research, she was deeply interested in mathematics teaching. She was a member of MAA for 38 years.

Hans Samelson, the well-known topologist and differential geometer who was at Stanford since 1960, died September 22 in Palo Alto. He was 89. Samelson was a student of Heinz Hopf at the ETH in Zurich. After coming to the Institute for Advanced Study, he taught at Wyoming, Syracuse, and Michigan before coming to Stanford. He retired in 1986, but remained active, publishing both new research and historical articles, most notably one on Brunellischi's dome in Florence. Samelson was the author of two popular textbooks, one on linear algebra and one on lie groups and algebras. In 1981-82 he served as Section Chair of the (then) Northern California Section of the MAA.

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How We Moved *Excel* to the Head of the Class

By Ed Carlin and John Holden

Picture this—

You want to teach your students a simple lesson in data handling by holding their attention long enough to look at correlations between the class members' hand spans and height. Your young charges (aged 14) are enthused by the exercise of taking measurements, and then sit quietly (for a while) as they await your blackboard demonstration of what the data looks like.

And they wait…

And wait…

Finally, your graphs are complete and you happily begin discussing the correlations shown in your carefully drawn box and whisker diagram and histogram, when the bell rings signaling the end of class.

That may happen once, you may think, but experienced teachers will know not to eat up valuable instruction time with drawing graphs such that they never get to the meat of the matter, i.e. the actual discussion of data interpretation.

What then does the more experienced teacher do? There certainly is no shortage of mathematical and statistical software packages that could be used to generate these diagrams in keystrokes. Alas, these software packages typically come not only with relatively hefty purchase prices but also time-consuming learning curves. More likely, the practical shortcut would be to omit the relatively exciting exercise of using such spontaneous data and to limit dataset size as much as possible. "But where's the fun in that?" you may ask, or likely your students will.

Why not use a much simpler tool like *Microsoft Excel*?

That's exactly the question that each of us came to ask, from our varying perspectives — one of us is a mathematics teacher on the front lines of instruction, and the other a manager of a worldwide company that develops cross-platform mathematical and statistical components, among other technical software products.

From the developers' perspective, it's apparent that teachers are not the only ones who are too time-pressed to master elaborate mathematics and statistics software packages. That's why the Numerical Algorithms Group (NAG) devoted many development hours in 1998 to create statistical software that is built into the widely familiar and easy-to-use *Excel* platform, the *NAG Statistical Add-Ins for Excel*, which enable the use of these powerful tools without any programming. All of the statistical algorithms could be accessed via the function wizard just like any other standard *Excel* function, with results being immediately updated whenever input cells were altered.

From the developers' perspective, it was quite delightful to learn that the NAG Statistical Add-Ins were being used in some local Oxford schools, and consultations were begun in the spring of 2004 on how to improve the product as an instructional tool. There was just one tiny problem — from the view of experienced instructors these Statistical Add-Ins for *Excel* were of only modest value as a teaching tool.

The completely different places that we were coming from made for some very interesting conversations. The developers were keen to add functionality and fished for input on the importance of improving the standard deviation functions, average functions, etc. However, from a teaching perspective, it was the presentations, not the functions, which were lacking and holding up the Statistical Add-Ins from being useful in the classroom.

For example, bar graphs drawn in *Excel* are simplistic visual representations of data that are not mathematically correct, and in fact, if students presented them at exam time, they would fail because they had left gaps between bars, or didn't properly indicate scales. Then there were a number of graphs critical to the curriculum that *Excel* could not generate at all — cumulative frequency graphs and box whisker diagrams, for example. What was needed was a way to teach *Excel* to draw correct continuous bar charts that teachers could use to demonstrate how to describe datasets. Similarly, scatter graph production in *Excel* needed to be changed so that two points marked in the same place would not overwrite each other, but rather appear with one point moved to the side. The software also needed to help teachers make the distinction between discrete and continuous data. It would need to generate output to a frequency table to save teachers 'tally-time'.

It was apparent from a teaching perspective what would be needed to make *Excel* a valuable teaching tool. Before collecting teachers' input, the key developers had imagined that it was important to have software that produced the algorithm but meticulously avoided giving the student an easy way to do the homework. It became obvious that while the development team could solve the problems, the teachers were the ones who knew how *Excel* functions would need to look and feel. Further, only the teachers knew whether the questions that the software helped ask were in the right sequence, from a teaching perspective, and whether they were helpful in terms of how students' minds usually work in grappling with the subject matter.

Earlier this year, the first result of these collaborations between developers and teachers was released to the wider world — *NAG Schools Excel Add-In* (N-SEA, http://www.nag.com/n-sea/), and was recently made part of the UK's "e-Learning Credits", which are funds set aside for UK schools to spend on educational software.

Although the curriculum (for ages 14–16) only requires that students learn with relatively small datasets, between 30 and

50, it is anticipated that as N-SEA becomes more widely used in the UK schools, there will be impetus to work with the potentially more meaningful and valuable interpretation of larger-sized datasets, particularly those now available through a UK initiative called the *CensusAtSchool* project (http://www.censusatschool.ntu.ac.uk). The CensusAtSchool project is part of an international effort to generate a worldwide database with data of particular interest to school-aged children such as student heights and weights, which can be used in Information and Communications Technology courses (ICT) to enhance instruction in data handling. It enables teachers to discuss datasets with many hundreds of thousands of datum, but practically speaking, can only be accessed with statistical instruction support software such as N-SEA.

Hopefully, members of the Mathematics Association of America will write the next chapter of this story. NAG's North American branch has recently released the *NAG Schools Excel Add-In* (N-SEA) to U.S. and Canadian instructors of high school advanced placement and introductory college-level courses, in hopes that they will find it as helpful as their UK counterparts have. There is reason to think that this will be the case. Instructors in the UK, US and Canada are similarly adept with *Excel* software and familiar with its limitations in the classroom. Moreover, the time pressures that teachers in the UK face are mirrored in North America, and these realities typically preclude the use of elaborate math, science and statistical software in the classroom.

However, N-SEA customization for the needs of MAA members is needed. Although the end point in mathematics, science and social science courses that provide statistical instruction are actually quite similar on both sides of the Atlantic, there are distinct approaches in various curricula. The Numerical Algorithms Group is poised to fine-tune N-SEA software to match the special needs of North American curricula, which are communicated by the first generation of North American N-SEA users. Based on input from UK teachers, the next generation of N-SEA will also include bubble sort algorithms and first fit bin packing algorithms. Equivalent input from US and Canadian N-SEA users is similarly welcomed. For more information, contact info@nag.com, 630–971–2337.

*Ed Carlin has been an Advanced Skills Teacher in Mathematics at the Wallingford School in Oxfordshire, UK for the past 7 years. John Holden is Sales Manager for NAG (*http://www.nag.com*), a 30-year-old company serving over 10,000 sites worldwide, including many leading academic centers. NAG is dedicated to providing cross-platform mathematical, statistical and data mining components and tools for developers as well as 3D visualization application development environments. It operates worldwide with offices in Chicago (USA), Oxford (UK), and Tokyo (Japan). Questions can be forwarded to Ed Carlin and John Holden via* info@nag.com.