FOCUS

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In this Issue

The Mathematical Association of America
1529 Eighteenth Street, NW
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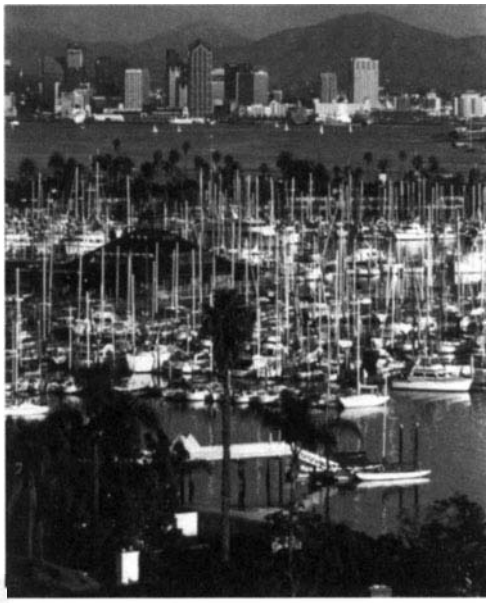
Joint Mathematics Meetings

San Diego, California

January 8–11, 1997



James Blank/San Diego Convention & Visitors Bureau

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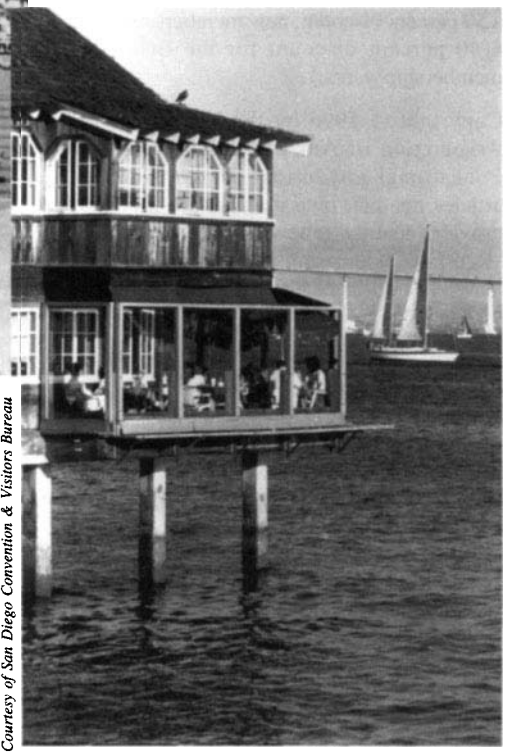
Details on page 13



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FOCUS

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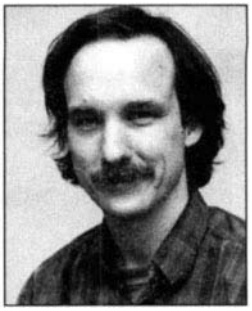
Editorial



David Brooks

In this issue, we have a deftly written guest editorial which first appeared in the Monday, May 6, 1996 edition of the Nashua and Southern New Hampshire Telegraph. *The author, David Brooks, is the newspaper's science editor. His column, "Science from the Sidelines," appears every week except the last Monday of each month. His e-mail address is news@telegraph-nh.com.*

Times that Try Mathematicians' Souls

The time has come for a manifesto, so here goes: Math lovers of the world, unite—you have nothing to lose but your reputation!

Those are strong words, I know, but the situation calls for strong action. Those of us who spent our college years reveling in the Queen of Sciences have been silent long enough. We need to stop hiding our delight at a well formed graph; our admiration for a clean, crisp proof; our realization that higher mathematics is one of the finest accomplishments of the human spirit.

It's time to stand on our desktops and shout to the world, "Say it out loud, I like math and I'm proud!"

All this was spurred, of course, by the Unabomber arrest.

Theodore Kaczynski is not only an alleged killer, but a major league weirdo whose sole positive traits are mathematical. He showed great promise—joining his high school math team, attending Harvard, teaching at Berkeley, and publishing papers on boundary functions—before retreating to Montana to do whatever it is he did there.

Since so few mathematicians make the news, Kaczynski's saga has led to a public linking of doing high-level math and being a dangerous oddball.

Well, speaking as a former math team member, I've had enough. Just because I know what a non-Abelian group is doesn't make me a loony-in-waiting. So back off, you pompous English majors.

Actually I shouldn't be surprised. Like any math major, I've listened to a lot of anti-science comments over the years. My favorite—if I can describe it that way—came a few years back, when a fellow editor saw that the Associated Press had sent out a photograph of some scruffy-looking fellow and commented offhand that, judging from his bizarre appearance, "He's either a scientist or a murderer."

What's the basis for this public alienation? It seems somehow linked to the way math is so removed from everyday life.

Just to explain what a non-Abelian group is, for example, would require piling abstraction on top of abstraction until you were moving in realms more suited to philosophy than addition. The conclusion of most people seems to be that anybody who moves in such an intellectual realm must be equally removed from life in other areas—social, moral, ethical.

This is where the error lies, because there's no connection between math thinking and life thinking. In fact, making such a connection is the underlying humor in virtually every mathematics joke I've ever heard, such as this one:

"A mathematician is captured by Martians who decide to test his problem-solving skills. First they give him a pile of dry leaves and two sticks, and lower the temperature in his

See *Editorial* on page 33

New Year, New Challenges

Prepare to meet professional challenges in mathematics by attending the 1997 Joint Mathematics Meetings in San Diego, January 8-11. You'll acquire new insights and learn innovative applications after attending the broad range of lectures, presentations, exhibits, and events. Here's a sampling:

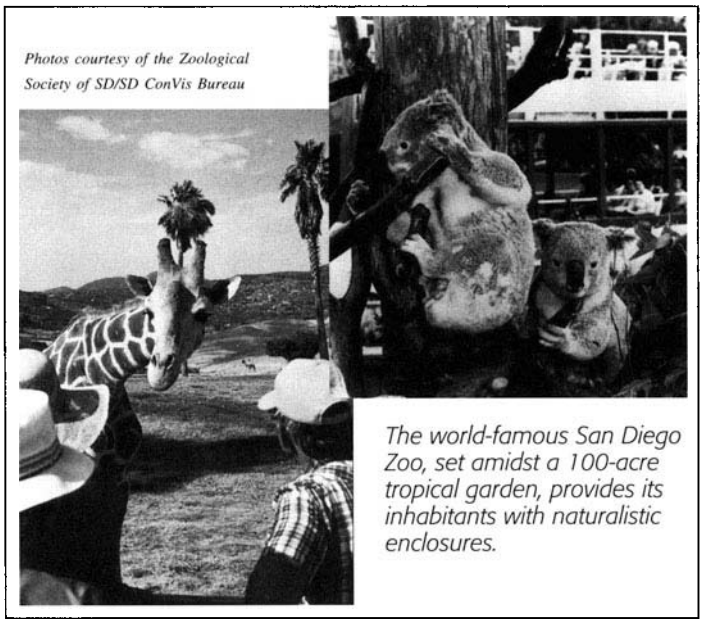
• Gain fresh perspectives on mathematics old and new through the **Invited Addresses.** With titles such as *A Half Century of Game Theory, Does Mathematics Need New Axioms?*, and *Automatic Differentiation: Computing Derivative Values Without Derivative Formulas*, and well-known speakers like Morris Hirsch, Michael H. Freedman, and Christine Shoemaker, these provocative talks will reinforce your love of learning and mathematics.

• Enhance your teaching methods by attending one or more of the 19 **MAA Minicourses.** Sessions related to teaching precalculus, calculus, linear algebra, and differential equations will give you new insights. Discover how you can effectively use calculators at sessions like *Mathematical Modeling and Forecasting with Calculators: the Differences, Interplay and New Role in Beginning Courses.* Full minicourse descriptions are provided later in this guide. Remember, these sessions are popular and enrollment is limited—so register early.

• Take advantage of the **Contributed Paper Sessions,** excellent settings for you to learn from your colleagues—established mathematicians, new professionals, and students. Experience the creativity and the degree of excellence evident in the mathematical sciences today by attending one or more of the 14 Contributed Paper Sessions.

Your schedule will be full, but take time to browse through the publications and products at the **Book Sales and Exhibits area**, attend social events, and explore beautiful San Diego. Register in advance and save up to 20% off on-site registration fees, obtain your choice of hotels, and a chance to win a free hotel room.

See you in San Diego!



Photos courtesy of the Zoological Society of SD/SD ConVis Bureau

The world-famous San Diego Zoo, set amidst a 100-acre tropical garden, provides its inhabitants with naturalistic enclosures.

MAA Invited Addresses

Carlos Imaz, CINESTAV del IPN, *Title to be announced*, Wednesday, 2:15 P.M. to 3:05 P.M. (MAA–SMM).

James Kaput, University of Massachusettes at Dartmouth, *The deepening impact of technology on mathematics and the means by which it can be learned and taught: The case of mathematics of change and variation*, Wednesday, 3:20 P.M. to 4:10 P.M.

Harold W. Kuhn, Princeton University, *A half century of game theory,* Wednesday, 9:00 A.M. to 9:50 A.M.

JOINT MATHEMATICS MEETINGS
San Diego
CALIFORNIA
January 8–11, 1997

Morris Hirsch, University of California at Berkeley, *Myth, meaning, and metaphor in mathematics,* Thursday, 9:00 A.M. to 10:55 A.M.

Christine Shoemaker, Cornell University. *Title to be announced,* Friday, 2:15 P.M. to 3:05 P.M.

Guershon Harel, Purdue University, *A fundamental principle of learning, and its application in modifying students' conceptions of mathematical proof,* Saturday, 9:00 A.M. to 9:50 A.M.

Dan Kalman, Mathematical Assocation of America, *Automatic differentiation: Computing derivative values without derivative formulas,* Saturday, 10:05 A.M. to 10:55 A.M.

AMS–MAA Invited Addresses

Solomon Feferman, Stanford University, *Does mathematics need new axioms?* Friday, 11:10 A.M. to noon.

Michael H. Freedman, University of California, San Diego, *Title to be announced,* Wednesday, 11:10 A.M. to noon.

AMS–MAA Sessions

Special Session on Mathematics and Education Reform, organized by William Henry Barker, Bowdoin College, Jerry L. Bona, University of Texas at Austin, Naomi Fisher and Philip D. Wagreich, University of Illinois at Chicago, Harvey B. Keynes, University of Minnesota, and Kenneth C. Millett, University of California, Santa Barbara. Wednesay morning and afternoon, Thursday morning.

Effective Job Search Strategies, Friday, 10:00 A.M. to 10:55 A.M. This presentation by Katy Piotrowski, Senior Career Advisor, Bernard Haldane Associates, is sponsored by the AMS–MAA–SIAM Joint Committee on Employment Opportunities.

Frank and Brennie Morgan Prize Recipient Lecture: The winner of this second annual prize as described in the Prize Session will give a lecture on the subject of his or her work, Friday, 7:30 P.M. to 8:00 P.M.

Joint Mathematics Meetings Schedule

Tuesday, January 7

8:30 A.M. – 4:00 P.M. MAA Board of Governors

9:00 A.M. – 5:00 P.M. AMS Short Courses

1:00 P.M. – 10:00 P.M. AMS Council

3:00 P.M. – 7:00 P.M. Joint Meetings Registration

3:00 P.M. – 5:00 P.M. MAA Minicourse #11: Part A *Teaching a course in the history of mathematics.*

3:00 P.M. – 5:00 P.M. MAA Minicourse #14: Part A *Training tools for TA training workshops.*

3:00 P.M. – 5:00 P.M. MAA Minicourse #17: Part A *On writing class notes and textbooks.*

3:00 P.M. – 5:00 P.M. MAA Minicourse #9: Part A *Interdisciplinary lively applications projects.*

6:00 P.M. – 10:00 P.M. MATHCHATS

7:00 P.M. – 9:00 P.M. MAA Minicourse #11: Part B *Teaching a course in the history of mathematics.*

7:00 P.M. – 9:00 P.M. MAA Minicourse #14: Part B *Training tools for TA training workshops.*

7:00 P.M. – 9:00 P.M. MAA Minicourse #17: Part B *On writing class notes and textbooks.*

7:00 P.M. – 9:00 P.M. MAA Minicourse #9: Part B *Interdisciplinary lively applications projects.*

Wednesday, January 8

7:30 A.M. – 4:00 P.M. Joint Meetings Registration

7:30 A.M. – 4:00 P.M. Mathematical Sciences Employment Register

8:00 A.M. – 10:55 A.M. AMS–MAA–MER Special Session on Mathematics and Education Reform, I

8:00 A.M. – 10:55 A.M. AMS Special Sessions

8:00 A.M. – 10:55 A.M. AMS Contributed Papers

8:00 A.M. – 10:00 A.M. MAA Minicourse #15: Part A *Learning to write good test items that allow or require the use of technology.*

8:00 A.M. – 10:00 A.M. MAA Minicourse #18: Part A *Combinatorics via functional equations.*

8:00 A.M. – 10:00 A.M. MAA Minicourse #5: Part A *Lowcost visualization training for multivariable calculus: Drawing.*

8:00 A.M. – 10:00 A.M. MAA Minicourse #8: Part A *Mathematical modeling and forecasting with calculators: The differences, interplay, and new role in beginning courses.*

8:00 A.M. – 10:55 A.M. MAA Contributed Paper Sessions

8:00 A.M. – 9:20 A.M. MAA Committee on Undergraduate Programs in Mathematics Panel Discussion NSF-funded projects under the DUE interdisciplinary initiative.

8:00 A.M. – 9:20 A.M. MAA Panel Discussion *Using real-world data to motivate the teaching and learning of mathematics.*

9:00 A.M. – 9:50 A.M. MAA Invited Address *A half-century of game theory.* Harold W. Kuhn

9:00 A.M. – 10:55 A.M. AMS Committee on Education Graduate Student Workshop *Obtaining employment as a mathematical scientist.*

9:30 A.M. – 10:50 A.M. MAA Panel Discussion *Advising in and about graduate school.*

9:30 A.M. – 10:50 A.M. MAA Committee on Undergraduate Programs in Mathematics Panel *Discussion Grass roots projects and interdisciplinary success stories.*

9:30 A.M. – 10:50 A.M. MAA Panel Discussion *Where will mathematics be when the sludge hits the fan?*

10:00 A.M. – 10:55 A.M. AMS Presentation *e-MATH on the World Wide Web.*

10:05 A.M. – 10:55 A.M. AMS Invited Address *Networks of neurons as dynamical systems: Biophysics and geometry.* Nancy J. Kopell

11:10 A.M. – 12:00P.M. AMS–MAA Invited Address *Title to be announced* Michael H. Freedman

1:00 P.M. – 2:00 P.M. AMS Colloquium Lectures *Title to be announced.* Daniel W. Stroock

1:00 P.M. – 5:00 P.M. Book Sales and Exhibits

2:15 P.M. – 3:05 P.M. SMM-MAA Invited Address *Title to be announced.* Carlos Imaz

2:15 P.M. – 6:05 P.M. AMS–MAA–MER Special Session On Mathematics and Education Reform, II

2:15 P.M. – 6:05 P.M. AMS Special Sessions

2:15 P.M. – 6:05 P.M. AMS Contributed Papers

2:15 P.M. – 4:15 P.M. MAA Minicourse #10: Part A *Environmental mathematics.*

2:15 P.M. – 4:15 P.M. MAA Minicourse #2: Part A *Developing units and projects for fundamental mathematics courses.*

2:15 P.M. – 4:15 P.M. MAA Minicourse #5: Part B *Lowcost visualization training for multivariable calculus: Drawing.*

2:15 P.M. – 4:15 P.M. MAA Minicourse #8: Part B *Mathematical modeling and forecasting with calculators: The differences, interplay, and new role in beginning courses.*

2:15 P.M. – 6:00 P.M. MAA Contributed Paper Sessions

2:15 P.M. – 4:15 P.M. AMS Committee on the Profession Presentation *Careers for mathematicians in industry, government, and business.*

3:20 P.M. – 4:10 P.M. MAA Invited Address *The deepening impact of technology on mathematics and the means by which it can be learned and taught: The case of mathematics of change and variation.* James J. Kaput

3:30 P.M. – 4:30 P.M. AWM Panel Discussion *What it takes to have*

a successful career in the mathematical sciences.

4:30 P.M. – 6:30 P.M. MAA Minicourse #16: Part A *Technology, modeling, cooperative learning: Putting it all together.*

4:30 P.M. – 6:30 P.M. MAA Minicourse #18: Part B *Combinatorics via functional equations.*

4:30 P.M. – 6:30 P.M. MAA Minicourse #3: Part A *The use of hand-held numerical, graphical, and symbolic algebra devices in the teaching and learning of calculus.*

4:30 P.M. – 6:00 P.M. AMS Committee on the Profession Panel Discussion *Beyond Rochester: Lessons for the future.*

4:30 P.M. – 6:30 P.M. MAA Section Officers

4:40 P.M. – 5:10 P.M. AWM Business Meeting

6:00 P.M. – 7:00 P.M Reception for First-time Participants

7:15 P.M. – 8:15 P.M. Young Mathematicians' Network Discussion *Concerns of young mathematicians: A town meeting.*

8:30 P.M. – 9:30 P.M. AMS Josiah Willard Gibbs Lecture *Title to be announced.* Persi Diaconis

9:30 P.M. – 11:00 P.M. AWM Reception

Thursday, January 9

7:30 A.M. – 4:00 P.M. Joint Meetings Registration

8:00 A.M. – noon AMS–MAA–MER Special Session On Mathematics and Education Reform, III

8:00 A.M. – noon AMS–MAA Special Sessions

8:00 A.M. - noon AMS Special Sessions

8:00 A.M. – noon AMS Contributed Papers

8:00 A.M. – 10:00 A.M. MAA Minicourse #1: Part A *Projects for pre-calculus.*

8:00 A.M. – 10:00 A.M. MAA Minicourse #2: Part B *Developing units and projects for fundamental mathematics courses.*

8:00 A.M. – noon MAA Contributed Paper Sessions

8:15 A.M. – 5:00 P.M. Mathematical Sciences Employment Register

10:00 A.M. – 6:00 P.M. Book Sales and Exhibits

10:05 A.M. – 10:55 A.M. MAA Invited Address *Myth, meaning, and metaphor in mathematics.* Morris Hirsch

11:10 A.M. – noon AMS Invited Address *Title to be announced.* Mary Silber

1:00 P.M. – 2:00 P.M. AMS Colloquium Lectures, Lecture ! *Title to be announced.* Daniel W. Stroock

2:15 P.M. – 3:05 P.M. AMS-SMM Invited Address *Title to be announced.* Jorge A. Ize

2:15 P.M. – 4:10 P.M. AMS Special Sessions

2:15 P.M. – 4:10 P.M. AMS Contributed Papers

2:15 P.M. – 4:15 P.M. MAA Minicourse #19: Part A *Getting students involved in undergraduate research.*

2:15 P.M. – 4:15 P.M. MAA Minicourse #1: Part B *Projects for pre-calculus.*

2:15 P.M. – 4:10 P.M. MAA Minicourse #3: Part B *The use of hand-held numerical, graphical, and symbolic algebra devices in the teaching and learning of calculus.*

2:15 P.M. – 4:10 P.M. MAA Contributed Paper Sessions

2:15 P.M. – 3:45 P.M. AMS Task Force on Excellence in Mathematics Scholarship Presentation *How mathematics can compete in the modern university.*

2:15 P.M. – 4:15 P.M. MAA Panel Discussions

2:15 P.M. – 4:10 P.M. MAA Student Workshop *Linking geometry and number theory.*

2:15 P.M. – 4:10 P.M. MAA Panel Discussions

3:20 P.M. – 4:10 P.M. AMS Retiring Presidential Address *Mathematics to the rescue: Some personal recollections.* Cathleen Morawetz

4:25 P.M. – 6:00 P.M. Joint Prize Session and Reception

5:45 P.M. – 7:00 P.M. MAA Reception for Two-Year Colleges

6:30 P.M. – 9:30 P.M. MER Banquet MAA

7:00 P.M. – 10:00 P.M. Contributed Paper Sessions

7:00 P.M. – 9:00 P.M. MAA Presentation Reunion for Calculus Reform Workshop.

7:00 P.M. – 8:30 P.M. MAA Presentation STATS Workshop participants' reunion.

Friday, January 10

7:00 A.M. – 8:00 A.M. Joint Pi Mu Epsilon and MAA Student Chapter Advisors' Breakfast

7:30 A.M. – 4:00 P.M. Joint Meetings Registration

8:00 A.M. – 10:55 A.M. AMS–MAA Special Sessions

8:00 A.M. – 10:55 A.M. AMS Special Sessions

8:00 A.M. – 10:55 A.M. AMS Contributed Papers

8:00 A.M. – 10:00 A.M. MAA Minicourse #10: Part B *Environmental mathematics.*

8:00 A.M. – 10:00 A.M. MAA Minicourse #16: Part B *Technology, modeling, cooperative learning: Putting it all together.*

8:00 A.M. – 10:00 A.M. MAA Minicourse #6: Part A *The geometry of multivariable calculus.*

8:00 A.M. – 10:00 A.M. MAA Minicourse #7: Part A *Linear algebra using an interactive text.*

8:00 A.M. – 10:55 A.M. MAA Contributed Paper Sessions

8:00 A.M. – 9:20 A.M. MAA Panel Discussion *Developing statistical indicators for monitoring and improving undergraduate mathematics education.*

8:00 A.M. – 10:55 A.M. MAA Presentation *Innovative programs using technology in mathematics service courses.*

8:00 A.M. – 9:20 A.M. SUMMA Workshop *Presentation on intervention projects for minority precollege students.*

8:15 A.M. – 5:00 P.M. Mathematical Sciences Employment Register

8:30 A.M. – 10:30 A.M. MAA Project NExT–Young Mathematicians' Network Poster Session presentations by new or recent Ph.D.s in the mathematical sciences.

9:00 A.M. – 9:50 A.M. AMS Invited Address *Title to be announced.* William T. Trotter

9:00 A.M. – 5:00 P.M. ASL Sessions

9:30 A.M. – 10:50 A.M. MAA CRAFTY Panel Discussion *A roundtable discussion with the client disciplines.*

9:30 A.M. – 10:50 A.M. MAA Panel Discussion *Women and mathematics: Case studies of intervention programs.*

10:00 A.M. – 10:55 A.M. AMS–MAA–SIAM Joint Committee on Employment Opportunities Presentation *Effective job search strategies.*

10:00 A.M. – 6:00 P.M. Book Sales and Exhibits

10:05 A.M. – 10:55 A.M. AMS Invited Address *Title to be announced.* Mikhail Shubin

11:10 A.M. – noon AMS–MAA Invited Address *Does mathematics need new axioms?* Solomon Feferman

1:00 P.M. – 2:00 P.M. AMS Colloquium Lectures: Lecture III *Title to be announced.* Daniel W. Strook

1:00 P.M. – 6:00 P.M. AMS Special Sessions

1:00 P.M. – 6:00 P.M. AMS Contributed Papers

1:00 P.M. – 3:00 P.M. MAA Minicourse #13: Part A *Active and interactive teaching techniques for the mathematics classroom.*

1:00 P.M. – 3:00 P.M. MAA Minicourse #4: Part A *Calculus connections: A multimedia adventure.*

1:00 P.M. – 3:20 P.M. MAA Contributed Paper Sessions

1:00 P.M. – 3:20 P.M. MAA Poster Session ILI projects.

2:00 P.M. – 3:20 P.M. MAA Panel Discussion *Careers for mathematics majors in financial risk management.*

2:15 P.M. – 3:05 P.M. MAA Invited Address *MAA Contributed Paper Sessions.* Christine A. Shoemaker

2:15 P.M. – 4:00 P.M. NAM Contributed Paper Session

2:15 P.M. – 4:10 P.M. RMMC Board of Directors

2:30 P.M. – 4:00 P.M. AMS Committee on Science Policy Panel Discussion *Public awareness of mathematics via the classroom.*

3:15 P.M. – 5:15 P.M. MAA Minicourse #12: Part A *Teaching differential equations using a dynamical systems perspective.*

3:15 P.M. – 5:15 P.M. MAA Minicourse #15: Part B *Learning to write good test items that allow or require the use of technology.*

3:20 P.M. – 5:00 P.M. MAA Presentation *Teaching awards presentations.*

3:45 P.M. – 6:15 P.M. AMS Special Sessions

4:00 P.M. – 7:00 P.M. MAA Undergraduate Research Session in Mathematics Poster Session

4:05 P.M. – 6:00 P.M. MAA Contributed Paper Sessions

4:20 P.M. – 5:10 P.M. NSF Invited Address *Title to be announced.* Neal Lane

4:40 P.M. – 6:00 P.M. MAA Panel Discussion *How to get a job at a two-year college.*

5:00 P.M. – 7:00 P.M. MAA Informal Session and Panel Discussion *Actuarial education*

6:00 P.M. – 9:30 P.M. NAM Banquet

7:00 P.M. – 8:00 P.M. MAA–Young Mathematicians' Network Panel Discussion *Teaching precollege mathematics.*

7:30 P.M. – 8:00 P.M. Frank and Brennie Morgan Prize Recipient Lecture

7:30 P.M. – 9:00 P.M. MAA Presentation *A chair's survival guide.*

7:30 P.M. – 9:00 P.M. MAA CRAFTY Panel Discussion *College algebra reform.*

8:10 P.M. – 9:00 P.M. MAA Student Lecture *When is an integer the product of two and three consecutive integers?* Edward F. Schaefer

9:00 P.M. – 10:00 P.M. Student Ice Cream Social

Saturday, January 11

7:30 A.M. – 2:00 P.M. Joint Meetings Registration

8:00 A.M. – 10:55 A.M. AMS Special Sessions

8:00 A.M. – 10:00 A.M. MAA Minicourse #7: Part B *Linear algebra using an interactive text.*

8:00 A.M. – 10:55 A.M. MAA Contributed Paper Sessions

8:30 A.M. – 10:00 A.M. AMS Committee on Education Panel Discussion *Third International Mathematics and Science Study (TIMSS).*

9:00 A.M. – 9:50 A.M. MAA Invited Address *A fundamental principle of learning and its application in modifying students' conceptions of mathematical proof.* Guershon Harel

9:00 A.M. – 5:00 P.M. ASL Sessions

9:00 A.M. – 5:00 P.M. AWM Workshop

9:00 A.M. – 10:00 A.M. NAM Panel Discussion

9:00 A.M. – 12:00 P.M. Book Sales and Exhibits

10:05 A.M. – 10:55 A.M. MAA Invited Address *Automatic differentiation: Computing derivative values without derivative formulas.* Dan Kalman

10:05 A.M. – 10:55 A.M. NAM Business Meeting

11:10 A.M. – 11:40 A.M. MAA Business Meeting

11:45 A.M. – 12:15 P.M. AMS Business Meeting

1:00 P.M. – 2:00 P.M. NAM William W.S. Claytor Lecture *Speaker and title to be announced.*

1:00 P.M. – 5:30 P.M. AMS Special Sessions

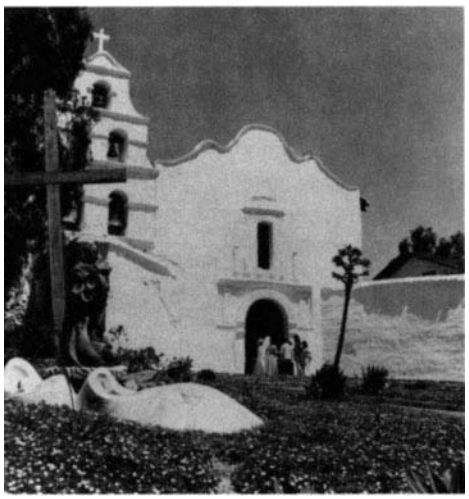
1:00 P.M. – 5:30 P.M.	AMS Contributed Papers
1:00 P.M. – 3:00 P.M.	MAA Minicourse #4: Part B *Calculus connections: A multimedia adventure.*
1:00 P.M. – 3:00 P.M.	MAA Minicourse #6: Part B *The geometry of multivariable calculus.*
1:00 P.M. – 2:50 P.M.	MAA Contributed Paper Sessions
1:00 P.M. – 5:30 P.M.	Interdisciplinary Courses-Integrating Mathematics and Other Disciplines
1:00 P.M. – 2:30 P.M.	AMS Committee on Education – AMS Committee on the Profession –Young Mathematicians' Network Panel Discussion *Continuing professional development.*
1:00 P.M. – 2:20 P.M.	MAA Panel Discussion *Advanced placement statistics.*
1:00 P.M. – 2:20 P.M.	MAA Presentation and Panel Discussion *Scientific visualization in undergraduate mathematical sciences education.*
2:00 P.M. – 3:00 P.M.	AMS Committee on Science Policy – Joint Policy Board for Mathematics Workshop *Meeting with members of Congress.*
2:15 P.M. – 3:05 P.M.	AMS Invited Address *Resolution of singularities.* Edward Bierstone
2:30 P.M. – 3:50 P.M.	MAA Presentation *Art, literature, music, and mathematics: Degrees of similarities.*
3:00 P.M. – 5:30 P.M.	MAA Contributed Paper Sessions
3:15 P.M. – 5:15 P.M.	MAA Minicourse #12: Part B *Teaching differential equations using a dynamical systems perspective.*
3:15 P.M. – 5:15 P.M.	MAA Minicourse #13: Part B *Active and interactive teaching techniques for the mathematics classroom.*
3:15 P.M. – 5:15 P.M.	MAA Minicourse #19: Part B *Getting students involved in undergraduate research.*
4:00 P.M. – 5:20 P.M.	MAA Presentation Report on ICME-8.
4:00 P.M. – 5:20 P.M.	MAA Presentation *Impact of information technology on undergraduate mathematical sciences education.*
6:30 P.M. – 10:00 P.M.	AMS Banquet

MAA Student Activities

Student Workshop, Thursday, 2:15 P.M. to 4:10 P.M., Jean J. Pedersen, Santa Clara University, *Linking Geometry and Number Theory.* A systematic procedure for folding paper to produce arbitrarily good approximations to regular convex and regular star polygons will be described. Strips of such polygons may be braided to produce models of well known polyhedra. Such models will be displayed, and members of the workshop will be given an opportunity to make one of the elementary models. A study of the consequences of the folding procedure will also reveal remarkable new results in number theory. One of these results gives us a proof that the fifth Fermat number is not prime, together with an extremely quick method of verifying the factors of any other Fermat number. The talk will be presented at a level appropriate for undergraduate mathematics students.

Joint Pi Mu Epsilon and MAA Student Chapter Advisors' Breakfast, Friday, 7:00 A.M. to 8:00 A.M., contact Aparna Higgins, University of Dayton.

Undergraduate Research in Mathematics Poster Session, Friday, 4:00 P.M. to 7:00 P.M., organized by Mario Martelli, California State University, Fullerton. This poster session is sponsored by the CUPM Subcommittee on Undergraduate Research in Mathematics. A panel of three experts will evaluate the posters and monetary prizes will be awarded *ex-equo* to the presenters of the three posters selected by the panel. Title and abstract (not to exceed half a page) of posters should be mailed to Prof. Mario Martelli, Mathematics Department, California State University, Fullerton CA 91711; (714) 773-3326 (office) 3631 (department); e-mail: mmartelli@ thuban.ac.hmc.edu. Please send both a hard copy and an electronic copy. All titles and abstracts will be collected in a booklet which will be available at the meeting. Deadline for submission is December 1, 1996. Please submit early!



Courtesy of San Diego Convention & Visitors Bureau

The Mission San Diego de Alcala is one of the best reminders of San Diego's Spanish heritage. In 1769, Padre Junipero Serra established the first link in his twenty-one mission chain at the Mission San Diego de Alcala.

Morgan Prize Lecture, Friday, 7:30 P.M. to 8:00 P.M.

Student Lecture, *When is an Integer the Product of Two and Three Consecutive Integers?* Friday, 8:10 P.M. to 9:00 P.M., organized by Edward F. Schaefer, Santa Clara University. In this talk we will solve the problem posed in the title, one first solved by Louis Mordell in the 1960s. More interesting than the question itself, perhaps, is the method of solution, which serves to introduce the beautiful subject of elliptic curves. This is a field of lively current research interest and the gateway to techniques used in the recently acclaimed proof of Fermat's Last Theorem and to problems of cryptography. **Followed by an Ice Cream Social, Friday, 9:00 P.M.**

Mathchats and Graduate Student Reception: On Tuesday evening wellknown mathematicians representing a wide range of disciplines will join interested graduate students for informal chats; all graduate students are invited. Complimentary food and beverages will be served. NOTE: This event is only for students who sign up on the Advance Registration/Housing (ARH) Form. There is no charge.

MAA Minicourses

Minicourse #1. Projects for Precalculus

Organized by Janet Andersen and Todd Swanson, Hope College.

Part A: Thursday, 8:00 A.M. to 10:00 A.M.

Part B: Thursday, 2:15 P.M. to 4:10 P.M.

Enrollment limit: 80. Cost: $45.

Participants will have hands-on experience with sample precalculus projects. The projects (developed with the support of an NSF grant) require students to write extensive explanations, make connections between various representations of functions, and use technology appropriately. Participants will receive a complete set of materials with solutions. Graphing calculators will be provided.

Minicourse #2. Developing Units and Projects for Fundamental Mathematics Courses

Organized by Linda R. Sons, Northern Illinois University.

Part A: Wednesday, 2:15 P.M. to 4:15 P.M.

Part B: Thursday, 8:00 A.M. to 10:00 A.M.

Enrollment limit: 80. Cost: $45.

The course will help participants develop material for use in a quantitative course for college students which meets the recommendations of the CUPM Committee on Quantitative Literacy Requirements. Participants will work in teams to devise units on managing your yard, reading news intelligently, and taking a vacation. The book *Mathematical Thinking in a Quantitative World* by L. Sons and P. Nicholls (Kendall/Hunt) serves as a reference. It will be assumed that participants have their own hand calculator available.

Minicourse #3. The use of Hand Held Numerical, Graphical, and Symbolic Algebra Devices in the Teaching and Learning of Calculus

Organized by Wade Ellis, West Valley College, Carl Leinbach, Gettysburg College, and Bert Waits, The Ohio State University.

Part A: Wednesday, 4:30 P.M. to 6:30 P.M.

Part B: Thursday, 2:15 P.M. to 4:10 P.M.

Enrollment limit: 60. Cost: $45.

Participants in this course will have the opportunity to gain hands on experience with a hand held computer algebra system that is built into a powerful graphing calculator. The course will contain examples from differential, integral, and multivariable calculus. It is expected that participants will have some experience with using a graphing calculator or a Computer Algebra System. Participants will be supplied with TI-92 calculators.

Minicourse #4. Calculus Connections—A Multimedia Adventure

Organized by Douglas Quinney, University of Keele.

Part A: Friday, 1:00 P.M. to 3:00 P.M.

Part B: Saturday, 1:00 P.M. to 3:00 P.M.

Enrollment limit: 30. Cost: $65.

Calculus Connections consists of twenty-four computer-based modules running under Windows and will be published with a lab manual by J. Wiley & Sons. It is designed to complement any computer and/or calculator laboratory component in mathematics courses by providing a rich, interactive environment where students can use modern technology as an investigative tool to ask, "What if...?" questions. Calculus Connections uses multimedia technology (video, sound, simulation, dynamic graphics and symbolic manipulation, etc.) to provide an active, motivational context for exploration, discovery, analysis and interpretation.

Minicourse #5. Lowcost Visualization Training for Multivariable Calculus: Drawing

Organized by Caspar Curjel, University of Washington, and Rose L. Pugh, Bellevue Community College.

Part A: Wednesday, 8:00 A.M. to 10:00 A.M.

Part B: Wednesday, 2:15 P.M. to 4:15 P.M.

Enrollment limit: 24. Cost: $65.

Students' 3-D visualization skills are strengthened by having them make and read drawings of geometrical objects. Such activities require drawing procedures which are within students' reach. Minicourse participants explore one set of such procedures by means of manipulative apparatus and start writing their own "visual" multivariable exercises.

Participants interested in attending a minicourse **should complete the MAA Minicourse Advance Registration Form on page14** and send it with payment directly to the MAA office prior to the November 15 **deadline. To check on availability for on-site registration after the deadline, call the MAA headquarters at** 800-741-9415. The MAA reserves the right to cancel **any minicourse which is undersubscribed. Should this occur, those registered in advance will be notified and** will receive a full refund.

Because of the popularity of the minicourse program and the number of courses available for this meeting, the MAA is offering four courses on Tuesday, one day prior to the opening session. Since attendance at these courses will require advanced planning, individuals wishing to enroll in Minicourses #9, 11, 14, and 17 must register in advance.

The MAA Minicourses are open only to persons who register for the Joint Meetings and pay the Joint **Meetings registration fee. If the only reason for registering for the Joint Meetings is to gain admission to** a minicourse, check the appropriate box on the MAA Minicourse Advance Registration Form. Then, if the **course is fully subscribed, a full refund will be made** of the Joint Meetings advance registration fee (otherwise subject to the 50% rule).

Minicourse #6. The Geometry of Multivariable Calculus

Organized by Yves Nievergelt, Eastern Washington University.

Part A: Friday, 8:00 A.M. to 10 A.M.

Part B: Saturday, 1:00 P.M. to 3:00 P.M.

Enrollment limit: 80. Cost $45.

Mathematicians from industry will demonstrate applications of mathematics at the level of multivariable calculus. The organizer will show several examples of such applications adapted to fit in any course in multivariable calculus, and such related courses as calculus, linear algebra, advanced calculus, complex and numerical analysis. Participants will receive copies of such applications and will have opportunities to start designing such material for their own classes in collaboration with the presenter.

Minicourse #7. Linear Algebra Using an Interactive Text

Organized by Eugene A. Herman, Grinnell College, Michael D. Pepe, Seattle Central Community College, and Robert T. Moore and James R. King, University of Washington.

Part A: Friday, 8:00 A.M. to 10:00 A.M.

Part B: Saturday, 8:00 A.M. to 10:00 A.M.

Enrollment limit: 30. Cost: $65.

Participants will use a new interactive linear algebra text written in Maple V, Release 4, and will become acquainted with the type of learning that its use can engender. We will also discuss several ways in which such a text can be used in teaching, ranging from an entirely laboratory-based course to a course with labs, to a lecture/demonstration course. The text comes from LAMP, the Linear Algebra Modules Project.

Minicourse #8. Mathematical Modeling and Forecasting with Calculators: the Differences, Interplay, and New Role in Beginning Courses

Organized by John Kenelly, Clemson University.

Part A: Wednesday, 8:00 A.M. to 10:00 A.M.

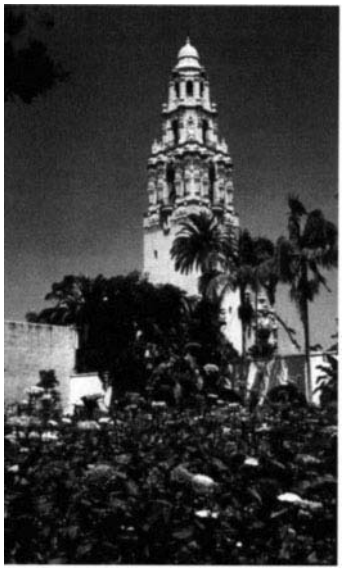
Part B: Wednesday, 2:15 P.M. to 4:15 P.M.

Enrollment limit: 60. Cost: $45.

Calculators have dramatically changed modeling and forecasting in elementary courses. We cover how the two activities differ and support each other. Natural models with basic constants that judge the validity of data, i.e., linear, quadratic, exponential, logistic, and sinusodial, will be covered on provided calculators. Calculator proficiency is not expected. Exponential smoothing and robust forecast methods will be combined with the models to enhancement of real world examples designed for elementary courses.

Minicourse #9. Interdisciplinary Lively Applications Projects

Organized by David C. Arney, United States Military Academy, and Frank Giordano, COMAP.



James Blank/San Diego Convention & Visitors Bureau

Balboa Park, a 17th Century Spanish town in the cultural heart of San Diego.

Part A: Tuesday, 3:00 P.M. to 5:00 P.M.

Part B: Tuesday, 7:00 P.M. to 9:00 P.M.

Enrollment limit: 32. Cost: $45.

Interdisciplinary appications can be used to weld mathematics with other disciplines to provide student growth in modeling and problem solving. This minicourse will discuss projects that can be used in a wide range of mathematics courses, with applications from problems in chemistry, biology, physics, engineering, economics, or social sciences. Projects are designed to take about four to five hours and can be done in groups or individually.

Minicourse #10. Environmental Mathematics

Organized by Ben Fusaro, Florida State University.

Part A: Wednesday, 2:15 P.M. to 4:15 P.M.

Part B: Friday, 8:00 A.M. to 10:00 A.M.

Enrollment limit: 30. Cost: $45.

The goal of this minicourse is to acquaint teachers with a calculus-free method for modeling environmental problems. This approach, which requires nothing beyond Algebra II, admits significant modeling applications into General Education courses. The material can also serve as a unit in a standard modeling course. The approach uses a five-step solution pattern that analyzes energy flows.

Minicourse #11. Teaching a Course in the History of Mathematics

Organized by Victor Katz, University of the District of Columbia, and V. Frederick Rickey, Bowling Green State University.

Part A: Tuesday, 3:00 P.M. to 5:00 P.M.

Part B: Tuesday, 7:00 P.M. to 9:00 P.M.

Enrollment limit: 60. Cost: $45.

Many colleges and universities are introducing courses in the history of mathematics and asking mathematicians without a strong background in history to teach them. This minicourse will assist those teaching history by introducing participants to numerous resources, discussing differing approaches and sample syllabi, providing suggestions for student projects, and, in general, giving those teaching such courses for the first time the confidence to master the subject themselves and to present the material to their students.

Minicourse #12. Teaching Differential Equations Using a Dynamical Systems Perspective

Organized by Robert Devaney and Paul Blanchard, Boston University.

Part A: Friday, 3:15 P.M. to 5:15 P.M.

Part B: Saturday, 3:15 P.M. to 5:15 P.M.

Enrollment limit: 80. Cost: $65.

This minicourse will give an overview of the NSF-sponsored Boston University Differential Equations Project. The BU project

involves a complete revamping of the sophomore-level ODE course. It includes more emphasis on qualitative and geometric methods as well as the incorporation of technology and numerical methods throughout. This course will be useful to college instructors wishing to restructure their ODE courses. Although the minicourse will include technology demonstrations using a Macintosh computer, the BU project is independent of any particular type of technology.

Minicourse #13. Active and Interactive Teaching Techniques for the Mathematics Classroom

Organized by Phyllis Chinn and Dale Oliver, Humboldt State University.

Part A: Friday, 1:00 P.M. to 3:00 P.M.

Part B: Saturday, 3:15 P.M. to 5:15 P.M.

Enrolllment limit: 40. Cost: $45.

Participants engage in a series of hands-on activities illustrating ways to engage students in learning mathematics actively. The mathematics includes ideas from geometry, logic, group theory, and discrete mathematics. Participants experience alternative teaching styles as learners. Techniques modeled include two-person interactive games to illustrate mathematics concepts, formal groups-of-four logic activities to motivate collaborative learning, and manipulative-based investigations to enhance mathematical understanding.

Minicourse #14. Training Tools for TA Teaching Workshops

Organized by Marilyn McCollum, North Carolina State University.

Part A: Tuesday, 3:00 P.M. to 5:00 P.M.

Part B: Tuesday, 7:00 P.M. to 9:00 P.M.

Enrollment limit: 80; registration fee: $45.

Most TA's in mathematics have little or no formal preparation in teaching. Broad training concepts have been shared at professional meetings. In this minicourse the participants will experience TA training with specific materials that can be easily used or adapted to any TA training program.

Minicourse #15. Learning to Write Good Test Items that Allow or Require the Use of Technology

Organized by Jan Vandever, South Dakota State University, and Kathy Layton, Beverly Hills High School.

Part A: Wednesday, 8:00 A.M. to 10:00 A.M.

Part B: Friday, 3:15 P.M. to 5:15 P.M.

Enrollment limit: 80. Cost: $45.

Content will include algebra, trigonometry, calculus, and statistics. Technology considered will include graphing calculators with symbolic manipulation capabilities. Participants will learn how to write test questions to assess whether or not students have learned certain concepts and skills taught in the classroom using graphing calculator activities. Participants will also write and critique test questions. Questions discussed and those written by participants will be sent to participants. Participants should bring their own graphing calculators.

Minicourse #16. Technology, Modeling, Cooperative Learning: Putting it all Together

Organized by Rosalie Dance and James T. Sandefur, Georgetown University.

Part A: Wednesday, 4:30 P.M. to 6:30 P.M.

Part B: Friday, 8:00 A.M. to 10:00 A.M.

Enrollment limit: 40. Cost: $45.

Participants will experience working in small groups on investigations that provide a context through which to teach topics in college algebra and precalculus courses. Using inexpensive materials, the groups will make a physical model to simulate a situation, and then develop a corresponding mathematical model within the context of the physical model. The model will then be analyzed using both algebraic techniques and technology. Contexts will include: the buildup of drugs in the bloodstream, the speed of light through water, and the area of "infinite" spirals and fractals. Bring a graphing calculator.

Minicourse #17. On Writing Class Notes and Textbooks

Organized by Raymond Coughlin, Temple University.

Part A: Tuesday, 3:00 P.M. to 5:00 P.M.

Part B: Tuesday, 7:00 P.M. to 9:00 P.M.

Enrollment limit: 80. Cost: $45.

A minicourse for those who want to learn the highs and lows, the ins and outs, and the exhilaration and the frustrations of the writing process.

Minicourse #18. Combinatorics via Functional Equations

Organized by Donald R. Snow, Brigham Young University.

Part A: Wednesday, 8:00 A.M. to 10:00 A.M.

Part B: Wednesday, 4:30 P.M. to 6:30 P.M.

Enrollment limit: 80. Cost: $45.

This approach starts by finding a simple functional equation that the function satisfies by noting what it describes. Then this functional equation is solved using appropriate initial conditions to get the function itself. It gives a method of obtaining the functions, studying their properties, obtaining generating functions, showing how all these functions are related, and giving new results. This approach yields generalizations of the Pascal property and hence generalizations of Pascal's Triangle. Although participants will receive the spreadsheet templates on disk, they might find it helpful to have a laptop computer with a spreadsheet program such as Quattro Pro 5.0, but this is certainly not necessary since these will be shown on the screen. Only a knowledge of calculus will be assumed.

Minicourse #19. Getting Students Involved in Undergraduate Research

Organized by Joseph Gallian, University of Minnesota at Duluth, and Aparna Higgins, University of Dayton.

Part A: Thursday, 2:15 P.M. to 4:15 P.M.

Part B: Saturday, 3:15 P.M. to 5:15 P.M.

Enrollment limit: 40. Cost: $45.

This course will discuss strategies and give examples for involving undergraduate students in doing research in mathematics. Examples will be presented of both summer research and research that can be conducted during the academic year.

MAA Contributed Paper Sessions

See the June 1996 issue of FOCUS, or *MAA Online* (www.maa.org/) for full descriptions of these sessions.

Innovations in Teaching Abstract Algebra, organized by Al Hibbard, Central College, Ellen Maycock Parker, DePauw University, and Krystina Leganza, Ball State University. Part 1: Wednesday, 8:00 A.M. to 10:55 A.M.; Part 2: Friday, 1:00 P.M. to 3:20 P.M.

Mathematics Departments and Administration: Cooperation or Conflict? organized by Lida K. Barrett, United States Military Academy, Morton Lowengrub, Indiana University, and Calvin C. Moore, University of California at Berkeley. Part 1: Wednesday, 8:00 A.M. to 10:55 A.M.; Part 2: Friday, 1:00 P.M. to 3:55 P.M.

Innovations in Teaching Linear Algebra, organized by David C. Lay (LACSG), University of Maryland, and Steven J. Leon (ATLAST), U. of Massachusetts at Dartmouth. Part 1: Wednesday, 2:15 P.M. to 6:00 P.M.; Part 2: Thursday, 7:00 P.M. to 10:00 P.M.; Part 3: Friday, 4:05 P.M. to 6:00 P.M.

New Directions in Student Assessment, organized by Richard Vandervelde, Hope College, and Jay M. Jahangiri, Kent State University. Part 1: Wednesday, 2:15 P.M. to 6:00 P.M.; Part 2: Thursday, 2:15 P.M. to 4:10 P.M.

The Use of Hand-held Technology in the Teaching and Learning of Mathematics, organized by Marcelle Bessman, Jacksonville University, V. J. Rammamurthy, Northern Florida State University, and Bert K. Waits, The Ohio State Unversity. Part 1: Thursday, 8:00 A.M. to 12:00 P.M.; Part 2: Saturday, 3:00 P.M. to 5:30 P.M.

Assessment for Better Learning: Assessing Teaching and Learning in a Climate of Change, organized by Bonnie Gold, Wabash College, Annalisa Crannell, Franklin & Marshall College, and Ahmed Zayed, University of Central Florida. Part 1: Thursday, 8:00 A.M. to 12:00 P.M.; Part 2: Saturday, 1:00 P.M. to 2:50 P.M.

Innovations in Courses Before Calculus: Implementing the Crossroads Standards, organized by Ray E. Collings, Dekalb College Central Campus, and Janet Ray, Seattle Central Community College. Part 1: Thursday, 2:15 P.M. to 4:10 P.M.; Part 2: Saturday, 3:00 P.M. to 5:30 P.M.

The Uses of History in the Teaching of Mathematics, organized by Florence Fasanelli, MAA, Victor J. Katz, University of the District of Columbia, and V. Frederick Rickey, Bowling Green State University. Thursday, 7:00 P.M. to 10:00 P.M.

Development Programs That Work, organized by Mercedes McGowen, William Rainey Harper College, and Jacqueline B. Giles-Giron, Houston Community College. Part 1: Friday, 8:00 A.M. to 10:55 A.M.; Part 2: Saturday, 1:00 P.M. to 2:50 P.M.

Teaching the Practice of Statistics at All Levels, organized by K. L. D. Gunawardena, University of Wisconsin–Oshkosh, Anne Sevin, Framingham State College, Chitra Gunawardena, U. of Wisconsin Center - Fox Valley. Part 1: Friday, 8:00 A.M. to 10:55 A.M.; Part 2: Saturday, 8:00 A.M. to 10:55 A.M.

Needed Connections: Preparation of Teachers K–12, organized by Mary Lindquist, Columbus College, Patrick Collier, University of Wisconsin–Oshkosh, and Albert Otto, Illinois State University. Part 1: Friday, 8:00 A.M. to 10:55 A.M.; Part 2: Saturday, 3:00 P.M. to 5:30 P.M.

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The Seaport Village is a reflection of San Diego's harbor a century ago. It is alive with sixty-five shops, four restaurants and several cafes. Not to mention spectacular views of the Pacific Ocean.

Establishing and Maintaining Undergraduate Research Programs in Mathematics, organized by Emelie Kenney, Siena College, and Joseph Gallian, University of Minnesota - Duluth. Part 1: Friday, 8:00 A.M. to 10:55 A.M.; Part 2: Saturday, 8:00 A.M. to 10:55 A.M.

Environmental Mathematics - Getting It into the Curriculum, organized by Ben Fusaro, Florida State University, and Patricia Kenschaft, Montclair State University. Part 1: Friday, 4:05 P.M. to 6:00 P.M.; Part 2: Saturday, 1:00 P.M. to 3:00 P.M.

Interdisciplinary Courses-Integrating Mathematics and Other Disciplines, organized by Agnes M. Rash and Sandra Fillebrown, St. Joseph's University. Saturday, 1:00 P.M. to 5:30 P.M.

Other AMS–MAA Events

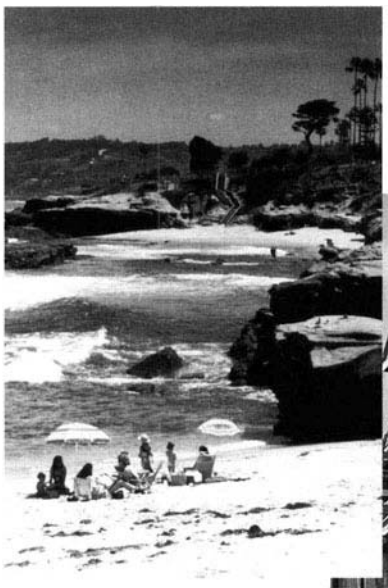
Reception for First-Time Participants: The AMS Committee on Membership and the MAA Committee on Membership are cosponsoring a social hour on Wednesday from 6:00 P.M. to 7:00 P.M. All participants (especially first-timers) are encouraged to come and meet some old-timers and pick up a few tips on how to survive the environment of a large meeting. Refreshments will be served.

Joint Prize Session and Reception: To showcase the achievements of the recipients of various prizes, the AMS and MAA are cosponsoring this event at 4:25 P.M. on Thursday. A cash bar reception will follow. All participants are invited to attend. The AMS will announce the recipient of the Leroy P. Steele Prizes. The AWM will present the Louise Hay Award for Contributions to Mathematics Education. MAA prizes include the Deborah and Franklin Tepper Haimo Awards for Distinguished College or University Teaching of Mathematics, the Chauvenet Prize, the Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics, and Certificates of Meritorious Service. Also to be awarded is the Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student, cosponsored by the AMS, MAA, and the Society for Industrial and Applied Mathematics.

Other Scientific Sessions

Other scientific sessions will include:

- Using Real-World Data to Motivate the Teaching and Learning of Mathematics
- NSF Funded Projects in the DUE Interdisciplinary Initiative
- Mathematics Teaching and the Learning Disabled Student
- Issues and Dilemmas in the Mathematical Preparation of K–12 Teachers
- Where will Mathematics be When the Sludge Hits the Fan?
- Advising In and About Graduate School
- Report on ICME-8
- Undergraduate Mathematics Education: Visions for the Future
- Innovative Programs Using Technology in Mathematics Service Courses
- And many others



San Diego boasts some of the loveliest beaches on the west coast.

The Gaslamp Quarter, a 16 1/2 block section of downtown San Diego, recreates its colorful past and the spirit of Victorian times.

103rd Annual Meeting of the AMS

The 103rd Annual Meeting of the AMS will include invited addresses by Edward Bierstone, University of Toronto; Persi Diaconis, Harvard University; Cathleen Morawetz, Courant Institute of Mathematical Sciences; Mary Siber, Northwestern University; and many others. Special sessions will cover topics ranging from Algebraic Combinatorics to Nonlinear Wave Equations. Full details of the AMS meeting, including descriptions of all sessions and registration and housing forms, can be found in the October issue of *Notices* and on *E-MATH*, the AMS's web site at www.ams.org.

AMS Short Courses

There will be two Short Courses held January 6–7, just before the Joint Mathematics Meetings. Complete descriptions, including synopses and reading lists provided by the speakers, are available from the AMS at RGC@AMS.ORG or AMS Short Course Coordinator, PO Box 6887, Providence, RI 02940.

The Mathematical Sciences Employment Register

The Mathematical Sciences Employment Register, held annually at the Joint Mathematics Meetings in January, provides opportunities for mathematical scientists seeking professional employment to meet employers who have positions to be filled. For complete information on the Employment Register, including registration forms, see *E-MATH*, http://www.ams.org/emp-reg/ or contact the Employment Register coordinator at 1-800-321-4267, x4105.

Other Events of Interest

Book Sales and Exhibits: All participants are encouraged to visit the book, educational media, and software exhibits from 1:00 P.M. to 5:00 P.M. on Wednesday, 10:00 A.M. to 6:00 P.M. on Thursday and Friday, and 9:00 A.M. to noon on Saturday. Books published by the MAA will be sold at discounted prices somewhat below the cost for the same books purchased by mail. These discounts will be available only to registered participants wearing the official meetings badge. Cash, checks, Visa and MasterCard will be accepted for book sale purchases at the meetings.

Social Events

It is strongly recommended that tickets for these events be purchased through advance registration, since only a very limited number of tickets, if any, will be available for sale on site. To get a 50% refund, returned tickets must be received by the Mathematics Meetings Service Bureau by December 20. After that date no refunds can be made. Special meals are available at all banquets upon advance request, but this must be indicated on the Advance Registration/Housing Form.

AWM Loether Lecturer Dinner: All pariticpants are invited to attend. A sign-up sheet will be located at the AWM table in the exhibit area.

AWM Reception: There is an open reception on Wednesday evening at 9:30 P.M. This has been a popular, well-attended event in the past.

MER Banquet: The Mathematicians and Education Reform (MER) Network welcomes all mathematicians who are interested in precollege, undergraduate, and/or graduate educational reform to attend the MER Banquet on Thursday at 6:30 P.M. There will be a cash bar beginning at 6:30 P.M. Dinner will be served at 7:30 P.M.Tickets are $46 each, including tax and gratuity.

NAM Banquet: The National Association of Mathematicians will host a banquet on Friday evening. A cash bar reception will

be held at 5:30 P.M., and dinner will be served at 6:00 P.M. Tickets are $27 each, including tax and gratuity.

AMS Banquet: The banquet will be held on Saturday with a cash bar reception at 6:30 P.M. and dinner at 7:30 P.M. Tickets are $27 each, including tax and gratuity.

Travel

USAir has been selected as the official airline for these meetings because of its generally convenient schedule to San Diego. For reservations call (or have your travel agent call) 800-334-8644 between 8:00 A.M. and 9:00 P.M. Eastern Standard Time. **Refer to Gold File Number 41380104.**

Ground Transportation: For each terminal at Lindbergh Field taxicabs are to be found at ground level across the one-way street in front of the terminal. The fare to the Convention Center is about $8.

There are many shuttle buses to various hotels; most operate without schedules. The Cloud Nine Shuttle has a scheduled run every thirty minutes; the cost is $4 to the Marriott Hotel and Marina, Convention Center, and the Hyatt Downtown. Other destinations can be requested. To make reservations, call 800-974-8885.

Driving Directions

Airport to the Convention Center: Take Harbor Drive North toward the southeast until it becomes Harbor Drive. After you pass Seaport Village, the Convention Center will be on your right. The trip takes about five minutes.

From the north: Take Interstate 5 south. Exit to Front Street (one way). Take a left onto Harbor Drive; the Convention Center is on the right.

From the south: Take Interstate 5 north. Take the "B and Pershing" exit and take a left onto B Street. Take a left at 8th Avenue; turn right onto Harbor Drive and continue as above.

From the east: Take Interstate 8 west. Exit onto 163 south. The highway becomes 10th Ave. Turn right onto Market Street, left onto 8th Avenue, then right onto Harbor Drive and continue as above.

Alamo Rent-A-Car is offering special low rental rates for the meetings, effective January 1—18, 1997. To take advantage of these special rates and to receive more information, call 1-800-732-3232. International reservation requests may be faxed to 1-305-527-4700. Reservations must be made at least twenty-four hours in advance. **The group ID# is 247733, rate code GR.**

Railway Transportation: There is frequent service from Los Angeles. For Amtrak information call 800-872-7245.

Additional Information

San Diego maintains a home page on the WWW. Visit it at http://www.sandiego.org.

Registering in Advance and Hotel Accommodations

The importance of advance registration cannot be overemphasized. Advance registration fees are considerably lower than the fees that will be charged for registration at the meeting. Participants who register by November 15 may elect to receive their programs, badges, and any tickets for social events through the mail before the meeting.

Early Advance Registration: Those who register by the EARLY deadline of October 31 will be included in a drawing to randomly select winners of complimentary hotel rooms in San Diego. Multiple occupancy is permissible. The location of rooms to be used in this lottery will be based on the number of complimentary rooms available in the various hotels. Therefore, the free room may not necessarily be in the winner's first choice hotel. The winners will be notified by mail prior to December 31. So register early! (See the list of the winners in Orlando found on page 18.)

Electronic Advance Registration: This service is available for advance registration, and housing arrangements if desired, by requesting the forms via e-mail from meetreg-request@ams.org, or by calling up web site http://www.ams.org/amsmtgs/2008_regform.text/ and looking for Advance Registration and Housing Form. VISA, MasterCard, Discover, and American Express are the ONLY methods of payment which can be accepted for electronic advance registration, and charges to credit cards will be made in U.S. funds. Completed electronic forms should be sent to meetreg-submit@ams.org.

All advance registrants will receive acknowledgment of payment prior to the meetings.

Win a free hotel room

Register by October 31, and you will be eligible for a drawing for complimentary hotel rooms for the meetings.

Joint Mathematics Meetings
MAA Minicourses

Advance Registration Form
San Diego, California
January 8–11, 1997

To register for MAA Minicourse(s), please complete THIS FORM or a PHOTOCOPY OF THIS FORM and return it with your payment to:

Minicourse Coordinator
MAA
1529 18th St., NW
Washington, DC 20036
(202) 387-5200 or 1-800-741-9415; e-mail: jheckler@maa.org
FAX: (202) 483-5450

After the deadline, potential participants are encouraged to contact the Minicourse Coordinator to check on availability. The MAA reserves the right to cancel any Minicourse which is undersubscribed. Should this occur, those registered in advance will be notified and will receive full refunds. MAA Minicourses are open only to persons who register for the Joint Mathematics Meetings and pay the regular registration fee.

Each participant must fill out a separate Minicourse Advance Registration Form. Enrollment is limited to two Minicourses.

Name: _____

Mailing Address: _____

_____

Telephone: _____ E-mail: _____

Registration

I would like to attend ❑ 1 Minicourse ❑ 2 Minicourses
Please enroll me in MAA Minicourse(s): #_____ and # _____
In order of preference, my alternatives are: #_____ and #_____

Payment

Make checks payable to the MAA. Canadian checks must be marked "US Funds." You may also charge this total to your VISA or MasterCard.

Check enclosed $_____ ❑ VISA ❑ MasterCard

Card number _____ Exp. Date _____

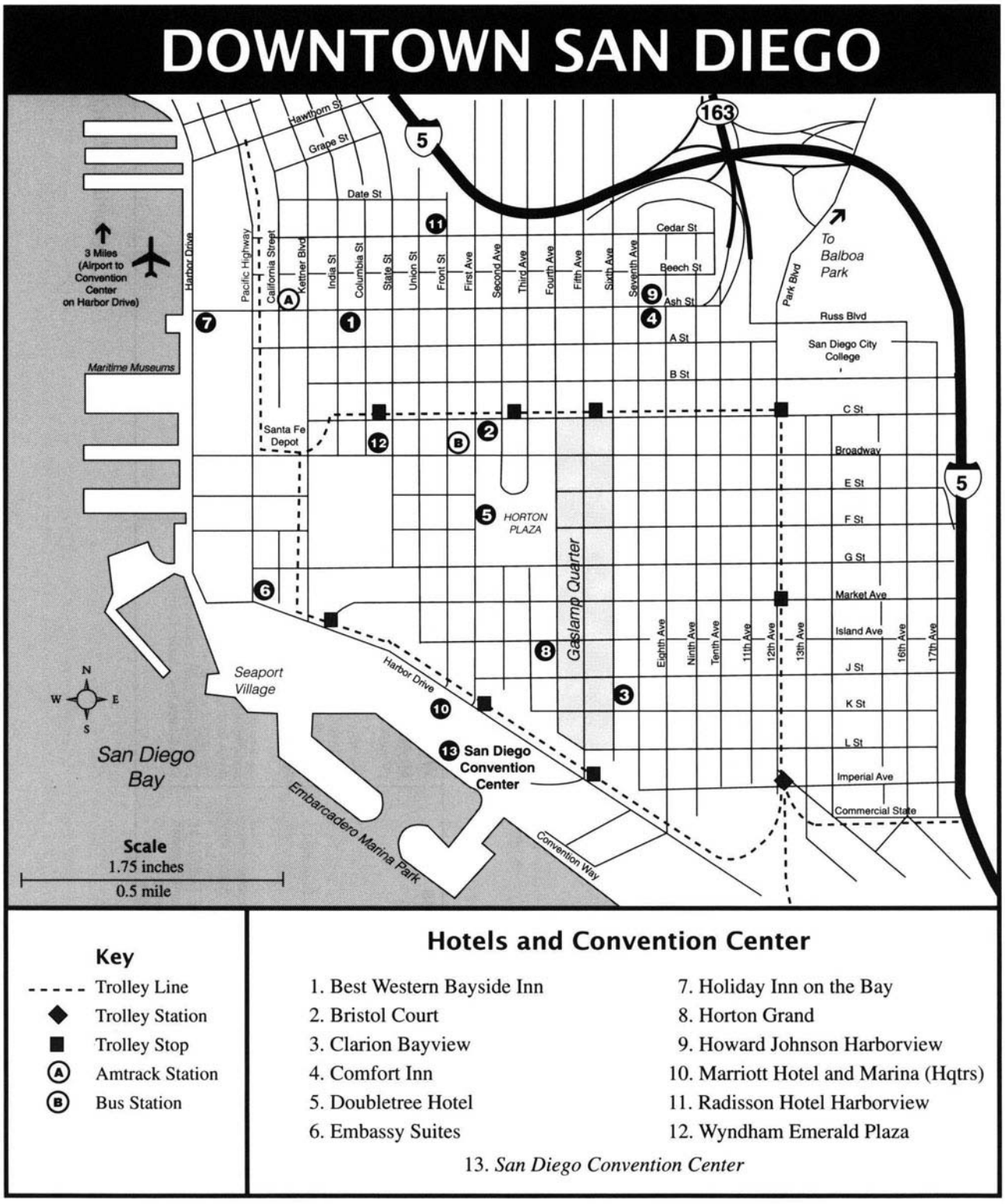
Signature _____

Deadlines

MAA Minicourse Advance Registration **November 15, 1996**
Cancellation in order to receive a 50% refund **December 20, 1996**

❑ I plan on registering for the Joint Mathematics Meetings ONLY in order to attend the MAA Minicourse(s). Should the course(s) of my choice be fully subscribed, a full refund of the Joint Mathematics Meetings advance registration fee will be made.

Minicourse	Fee
1. Projects for Precalculus	$45
2. Developing Units and Projects for Fundamental Mathematics Courses	$45
3. The Use of Hand Held Numerical, Graphical, and Symbolic Algebra Devices ...	$45
4. Calculus Connections—A Multimedia Adventure	$65
5. Lowcost Visualization Training for Multivariable Calculus: Drawing	$65
6. The Geometry of Multivariable Calculus	$45
7. Linear Algebra Using an Interactive Text	$65
8. Mathematical Modeling and Forecasting with Calculators: The Differences,...	$45
9. Interdisciplinary Lively Applications Projects	$45
10. Environmental Mathematics	$45
11. Teaching a Course in the History of Mathematics	$45
12. Teaching Differential Equations Using a Dynamical Systems Perspective	$65
13. Active and Interactive Teaching Techniques for the Mathematics Classroom	$45
14. Training Tools for TA Teaching Workshops	$45
15. Learning to Write Good Test Items that Allow or Require the Use of Technology...	$45
16. Technology, Modeling, Cooperative Learning: Putting it all Together	$45
17. On Writing Class Notes and Textbooks	$45
18. Combinatorics via Functional Equations	$45
19. Getting Students Involved in Undergraduate Research	$45


DOWNTOWN SAN DIEGO
3 Miles (Airport to Convention Center on Harbor Drive)
Harbor Drive
Maritime Museums
Pacific Highway
California Street
Kettner Blvd
India St
Columbia St
State St
Union St
Front St
First Ave
Second Ave
Third Ave
Fourth Ave
Fifth Ave
Sixth Ave
Seventh Ave
Hawthorn St
Grape St
Date St
Cedar St
Beech St
Ash St
A St
B St
C St
Broadway
E St
F St
G St
Market Ave
Island Ave
J St
K St
L St
Imperial Ave
Commercial St
Eighth Ave
Ninth Ave
Tenth Ave
11th Ave
12th Ave
13th Ave
16th Ave
17th Ave
Park Blvd
To Balboa Park
Russ Blvd
San Diego City College
Santa Fe Depot
HORTON PLAZA
Gaslamp Quarter
Seaport Village
Harbor Drive
San Diego Bay
San Diego Convention Center
Embarcadero Marina Park
Convention Way
5
163
N
W
E
S
Scale
1.75 inches
0.5 mile
Key
Trolley Line
Trolley Station
Trolley Stop
Amtrack Station
Bus Station
Hotels and Convention Center
1. Best Western Bayside Inn
2. Bristol Court
3. Clarion Bayview
4. Comfort Inn
5. Doubletree Hotel
6. Embassy Suites
7. Holiday Inn on the Bay
8. Horton Grand
9. Howard Johnson Harborview
10. Marriott Hotel and Marina (Hqtrs)
11. Radisson Hotel Harborview
12. Wyndham Emerald Plaza
13. San Diego Convention Center

How to Obtain Hotel Accommodations

Room Lottery Winners: The following participants received complimentary hotel rooms in the Orlando room lottery (see the *How to Register in Advance* section to learn how to qualify for this year's lottery):

Larry Anderson, Deane Arganbright, Bill Caldbeck, Deb Cotton, David Cruz-Uribe, Jim DeFranza, Hongming Ding, Susan Foege, Deb Frantz, Elise Hernandez Saborio, Warren Hickman, Jay Jahangiri, Nancy King, B. Liu, Bill Martin, Betty Mayfield, Daisy McCoy, Ruth Michler, Walter Mientka, K. Muthuvel

General Instructions: Participants must register in advance in order to obtain hotel accommodations through the Mathematics Meetings Service Bureau (MMSB). Special meeting rates at the hotels listed below can be obtained only by making reservations through the MMSB. Reservations mistakenly taken by hotels directly may be subject to an increased rate. Participants interested in suites are urged to call the hotels directly for details on configurations, prices, etc.; however, all hotel reservations can only be made by completing the Housing section of the Advance Registration/Housing (ARH) Form by November 15. Reservations, based on availability, will be accepted by hotels directly after December 18.

Rates:

- subject to 10.5% sales/occupancy tax
- include $6 fee to offset general meeting expenses (see *How to Register in Advance* section for explanation)
- only certified students or unemployed mathematicians qualify for listed student rates
- see ARH Form for detailed rate structure of each property

Room Payments/Cancellations:

- all major credit cards
- personal checks with personal ID and/or credit card backup
- 48-hour cancellation policy for all hotels except Radisson (24-hour cancellation policy)
- $350 penalty at Holiday Inn for rooms cancelled less than 48 hours before scheduled arrival date

Guarantee Requirements:

- one night deposit by check
- credit card: VISA, MC, AMEX (cards may be charged one night deposit)

Hotel Information:

- children free, where appropriate, in existing beds only
- limited nonsmoking rooms
- check-in: 3 or 4 p.m. / check-out: 11 a.m. or noon
- distances to Convention Center (CC) indicated under each caption

Special Services:

- all hotels, with the exception of historical hotels, are working toward being in compliance with the Americans with Disabilities Act (ADA)
- special needs should be clearly indicated on the ARH form

Deadlines:

- room lottery qualification: **October 31**
- reservations through MMSB: **November 15**
- changes/cancellations through MMSB: **December 9**
- convention rates based on availability only **after December 18**

Marriott Hotel & Marina

(headquarters - next door to CC)

333 West Harbor Drive
San Diego, CA 92101-7700
(619) 234-1500
bayview single/double - $140
cityview single/double - $120
student (cityview) single/double - $100

restaurants, lounges, pub, fitness center (incl. outdoor heated pool, game room, tennis club), bakeshop, parking - $9, windows in rooms open, desks, servi bars, three phone lines in all rooms, children free-under 18 yrs.

Embassy Suites

(.5 miles to CC)

601 Pacific Highway
San Diego, CA 92101
(619) 239-2400
single/double - $128
student single/double - $118 (limited availability)

rates include full cooked-to-order breakfast daily, all rooms are one-bedroom suites with refrigerators, coffee makers, ironing boards/irons, microwaves, servi bars, two phone lines in all rooms, parking - $7, complimentary airport shuttle, children free - under 14 yrs., **strongly recommended for students**

Wyndham Emerald Plaza Hotel

(.9 miles to CC)

400 West Broadway
San Diego, CA 92101
(619) 239-4500
single/double - $112
student single/double - $102

restaurants, lounge, servi bars, irons/ironing boards, coffee makers, hair dryers in all rooms, fitness club, outdoor heated pool with jacuzzi, complimentary airport shuttle, glass elevators, parking - $11, children free - under 13 yrs.

Doubletree Hotel

(.5 miles to CC)

910 Broadway Circle
San Diego, CA 92101
(619) 239-3082
single/double - $108
student single/double - $95 (limited availability)

restaurant, lounge, health club, heated pool, coffee makers, ironing boards/irons, hair dryers, two phone lines in all rooms, parking - $10, windows in rooms open, children free- under 17 yrs.

Clarion Hotel Bay View

(.25 miles to CC)

660 K Street
San Diego, CA 92101
(800) 766-0234, (619) 696-0234
single/double - $99
student single/double - $89

restaurant, lounge, bar, health spa, ironing boards/irons, hair dryers in all rooms, servi bars and balconies with sliding glass doors in some rooms, dataports in all rooms (but have to unplug phone), parking - $8, children free - under 18 yrs.

(Continued on next page)

How to Obtain Hotel Accommodations (Continued)

Horton Grand Hotel
(.4 miles to CC)

311 Island Avenue
San Diego, CA 92101
(800) 542-1886, (619) 544-1886
single/double - $99

historic hotel with Victorian ambiance, restaurant, bar, lounge, one queen-sized bed and antiques in each room, some rooms have windows that open, luggage handling - $4, valet parking ($8) only, children free -under 12 yrs., **two-person limit per room**

Bristol Court Hotel
(.6 miles to CC)

1055 First Avenue
San Diego, CA 92101
(619) 232-6141
single/double - $83
student single/double - $79

daily complimentary continental breakfast, restaurant, pub, health club, refrigerators and two phone lines in rooms, windows in rooms open, valet parking ($10) only, children free - under 12 yrs.

Holiday Inn on the Bay
(.9 miles to CC)

1355 North Harbor Drive
San Diego, CA 92101
(800) 877-8920, (619) 232-3861
single - $79, double - $89
(guaranteed bayview - additional $20)

restaurant, lounge, outdoor heated pool, laundry facilities, ironing boards/irons, coffee makers in all rooms, king-bedded rooms have sofa beds, dataports (have to unplug phone) in rooms, sliding doors in rooms, complimentary airport shuttle, parking - $10, children free - under 12 yrs.

Radisson Hotel Harborview
(.9 miles to CC)

1646 Front Street
San Diego, CA 92101
(619 239-6800
single/double - $72
student single/double - $62

restaurant, lounge, outdoor pool, health club, coffee makers and dataports (have to unplug phone) in some rooms, windows in rooms open, complimentary airport shuttle,
parking - $6, children free - under 19 yrs.

Best Western Bayside Inn
(1 mile to CC)

555 W. Ash Street
San Diego, CA 92101
(619) 233-7500
single/double - $75
student single/double - $65

restaurant (closed for dinner on weekends), lounge, outdoor pool, dataports (have to unplug phone) in rooms, complimentary coffee/tea in lobby, free parking, complimentary airport shuttle, children free - under 13 yrs.

Howard Johnson Harborview
(1.25 miles to CC)

1480 Seventh Avenue
San Diego, CA 92101
(800) 404-6835
single/double - $69

daily complimentary continental breakfast, restaurant, laundromat, outdoor pool, coffee makers, balconies, and dataports (have to unplug phone) in some rooms, free parking, complimentary airport shuttle, shuttle to Convention Center can be pre-arranged, children free - under 18 yrs.

Comfort Inn Downtown
(1.25 miles to CC)

719 Ash Street
San Diego, CA 92101
(800) 228-5150
(619) 232-2525
single/double - $59

daily complimentary continental breakfast, laundromat, free parking, children free - under 18 yrs.

Alternative Housing

The following are clean lower-priced properties that can be called directly. They are all located more than 2 miles (with exception of dowtown properties) from the CC and offer rates ranging from $29 to $59 single/double, based on availability.

Days Inn Downtown
1449 Ninth Avenue
San Diego, CA 92101
(619) 239-9113

Days Inn Harbor View*
1919 Pacific Highway
San Diego, CA 92101
(800) 822-2820

Travelodge (Embarcadero Harbor)
1305 Pacific Highway
San Diego, CA 92101
(619) 233-0398

Rodeway Inn*
833 Ash Street
San Diego, CA 92101
(800) 228-2000

Thriftlodge Downtown
1345 Tenth Avenue
San Diego, CA 92101
(619) 234-6344

Travelodge (Balboa Park)
840 Ash Street
San Diego, CA 92101
(800) 255-3050

Parkside Inn
Eleventh & A Street
San Diego, CA 92101
(619) 232-7601

Chula Vista Travelodge
394 Broadway
Chula Vista, CA 91010
(800) 578-7878

*** Strongly recommended by the MMSB**

Attention Students!

As another alternative to housing choices listed above and for your convenience, we list two student hostels located in San Diego:

Hostel on Broadway (in YMCA Bldg.)
(1 mile, 4 blocks to CC)
500 West Broadway
San Diego, CA 92101
(619) 525-1531

Elliott Hostel (Point Loma)
(5 miles to CC, on bus route to and from downtown)
3790 Udall Street
San Diego, CA 92107-2414
(619) 223-4778

Rates range from $12 to $14 per person. Please call the numbers listed above for further information.

Visit the MAA Book Sale in San Diego

VITA MATHEMATICA

Save 20% off member prices only at the MAA Book Sale

Vita Mathematica

Historical Research and Integration with Teaching

Series: MAA Notes

Ronald Calinger, Editor

The use of the history of mathematics in the teaching of mathematics at all levels is an idea whose time has come, as V. Frederick Rickey demonstrated in this volume in his article "the Necessity of History in Teaching Mathematics." Also shown in detail by Reinhard Laubenbacher and David Pengelley in their report on their courses taught entirely using original sources.

But to use history in the teaching of undergraduate mathematics, the instructor must be familiar with the history as well as the mathematics. *Vita Mathematica* will enable college teachers to learn the relevant history of various topics in the undergraduate curriculum and help them incorporate this history in their teaching.

Vita Mathematics contains numerous articles dealing not only with calculus, but also with algebra, combinatorics, graph theory, and geometry, as well as more general articles on teaching courses for prospective teachers. This volume demonstrates that the history of mathematics is no longer tangential to the mathematics curriculum, but in fact deserves a central role.

Catalog Code: NTE-40/FOC
350pp., 1996, Paperbound
ISBN 0-88385-097-4
List: $34.95 MAA Member: $29.00

Look for these new books at the MAA Book Sale

- *101 Careers in Mathematics*, Andrew Sterrett, Editor
- *A Primer of Real Functions*, Ralph P. Boas, Revised and Updated by Harold P. Boas
- *Julia: A Life in Mathematics*, Constance Reid
- *Which Way did the Bicycle Go?* Joseph E. D. Konhauser, Dan Velleman, and Stan Wagon
- *Laboratory Experiences in Group Theory*, Ellen Maycock Parker
- *Penrose Tiles to Trapdoor Ciphers*, Martin Gardner

$1 off any book

Bring this coupon to the MAA Book Sale at the Joint Mathematics Meetings and receive

$1.00 off any purchase of $20 or more at the MAA Book Sale

Limit one coupon per person. This offer is good only for the Joint Mathematics Meetings in San Diego, California, January 8–11, 1997.

Edyth May Sliffe Awards for Distinguished High School Mathematics Teaching

The American Mathematics Competitions (AMC), a program of the MAA, with a total annual enrollment of over 600,000 participants, has been administered since 1955. In 1988, the AMC, whose examinations include the American Junior High School Mathematics Examination, the American High School Examination, and the U.S.A. Mathematical Olympiad, was given added impetus and recognition as a consequence of a generous bequest to the MAA from a former high school teacher. The name of the teacher is Ms. Edyth May Sliffe, who was an outstanding teacher at Emery High School in Emeryville, California. She recognized that AHSME was an excellent examination, administered it for many years, and wanted to recognize teachers whose students do well on the exam.

The Edyth May Sliffe award program is designed to recognize and reward outstanding teachers for their efforts in the development of mathematical talents of high school students. Nominations for this award are made by the three highest scoring students of the highest scoring teams on the annual American High School Mathematics Examination (AHSME). The teachers are selected from over 6000 who annually administer the AHSME.

Since 1989, when the issuance of the Edyth May Sliffe Awards for Distinguished High School Mathematics Teaching began, 186 teachers from both public and private schools in the U.S., the District of Columbia, APO schools, and the Canadian provinces have been selected by the MAA Sliffe Committee as winners of this award.

In 1995 the program was expanded to recognize annually fifty junior high school teachers whose students excel on the annual American Junior High School Mathematics Examination. Award winners receive a cash award, an elaborate MAA

See *Sliffe* on page 34

James Tattersall Elected Vice-President of History of Mathematics Organization

James Tattersall of Providence College in Rhode Island has been elected vice-president of the Canadian Society for History and Philosophy of Mathematics. This is the first time an American has been elected an officer of the society since its inception twenty-two years ago. Tattersall is a well known speaker on the history of mathematics and is familiar to members of both the MAA and AMS for, among other things, his involvement in the organization of the Joint Annual Meetings.

Since its founding, the society had been subsidized by the Canadian government through its Social Sciences and Humanities Research Council. For this reason it was felt appropriate to have officers of the society be Canadians and to make no special effort to recruit members outside Canada, even though there are more members residing in the U.S. than in Canada. The subsidy has now ended, and as a result the society felt free to nominate as vice-president someone from outside the country. The new president of the society is Robert Thomas of the University of Manitoba.

The CSHPM has gradually grown to be a significant presence in the history-of-math field. Its main event is an annual meeting in May or June at which papers on the history and philosophy of mathematics (mainly history) are presented. This meeting is almost always held in some Canadian city near the border with the U.S. Next year will be an exception with the June meeting being held in St. John's, Newfoundland. The society publishes two journals. *Historia Mathematica*, founded in 1974, is its historical journal. *Philosophia Mathematica* was founded in the U.S. in 1964 but was taken over by the society in 1993.

Persons interested in joining or in the journals (which can be subscribed to independently) should visit the society's web site (http://www.kingsu.ab.ca/~glen/cshpm/home.html) or inquire to Secretary/Treasurer Glen Van Brummelen, King's University College, 9125 50th St., Edmonton, Alberta, Canada T6B 2H3; (403) 465-3500; fax: (403) 465-3534; e-mail: gvanbrum@kingsu.ab.ca.

Authors Needed for 1999 NCTM Yearbook

Developing Mathematical Reasoning

The Educational Materials Committee (EMC) invites manuscripts for the 1999 yearbook *Developing Mathematical Reasoning, K–12*. The editor of the volume is Lee V. Stiff, associate professor of mathematics education at North Carolina State University. He is currently completing a Fulbright Scholarship at the University of Ghana at Legon, in Ghana, West Africa.

The purpose of the yearbook is to create a forum for current thinking and practice on the meaning, understanding, and development of mathematical reasoning at all levels of mathematics education. In particular the yearbook editorial panel is interested in papers addressing ways of developing and manifesting mathematical reasoning in various contexts both in school and out of school. Brief articles are also encouraged that detail classroom experiences in which developing mathematical reasoning is central.

Guidelines for authors are available that include a complete description of topics to be addressed and instructions for preparing manuscripts. For a copy, write to General Editor Frances R. Curcio, Department of Teaching and Learning, School of Education, New York University, 239 Greene St., Washington Square, New York, NY 10003; e-mail: curcio@is2.nyu.edu. The guidelines may also be obtained from the NCTM home page (http://www.nctm.org) under "Educational Materials/1999 Yearbook."

Decisive Mathematics for Risk Management

John Price

Thousands of times every day, national and international companies use mathematics to measure and control financial risks—and not just the typical school or college mathematics (although these are there as well), but advanced mathematics that has been developed only in recent years.

The benefits for a company of insuring against the risk of fire are well known. These same companies are now recognizing that they need to insure against other risks that are potentially even more damaging and certainly more frequent.

Although these risks have always been there, it is only recently they have reached such significant levels. Now mathematical techniques are available that allow treasurers and risk managers to measure them precisely and to make rational decisions to reduce and control them.

Consider the case of a company exporting computers to Germany. Suppose that in a year it will receive one million marks which it will need to convert immediately to U.S. dollars to pay for manufacturing expenses. This means in effect that the company will spend one million marks buying dollars at whatever the rate is in a year's time. If the dollar appreciates against the mark, the company will get fewer dollars. Conversely, if the dollar depreciates, the dollar profit will be greater.

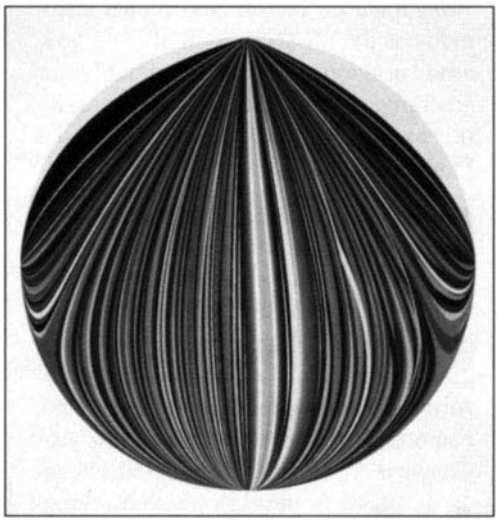
In the past, profit margins were generally large enough to cover the possibility of adverse movements of exchange rates. Now, with national and international competition at record highs, rarely does a company have this luxury. Companies that don't cut their prices to the minimum find their sales dropping away.

A similar situation holds for mining companies. The viability of a copper mine, for example, depends not just on current copper prices, but also on what prices and production costs will be over the next years.

Interest rates are another example. Suppose you are in charge of funding the construction of a shopping complex. Every month for the next three years, millions of dollars will need to be borrowed to complete the project. If this can be done for, say, eight percent interest, then the center will be within its budget. If not, the whole project may be a financial failure.

The solution in all these cases is the careful and systematic use of options. An option gives the right to a specific financial transaction in the future without any obligation to carry it out.

Consider the exchange rate case above and suppose that the current exchange rate is 0.68 dollars per mark. The exporter could purchase an option that gives the right to buy one million marks worth of dollars in a year's time for the rate of, say, 0.70.



Artwork courtesy of John Price

The exporter now knows that the company will never have to pay more than 0.70 marks per dollar—if the exchange rate is less than this, the marks can be purchased on the open market, and if it is more, then the option is "exercised" and the marks are purchased at the agreed strike price.

Similar scenarios are possible for mine and construction companies. Options can be bought that guarantee their final costs will never be above a certain limit. Also, the option still leaves open the possibility of profiting from favorable movements in copper prices and interest rates.

It seems that options were first traded in the seventeenth century in Holland during a period of extreme speculation in the prices of tulip bulbs. In the U.S.A., options in agricultural commodities were available from the eighteenth century. But the option market was fragmented and irregular until 1973 when the Chicago Board Options Exchange began trading standardized option contracts on stocks.

In the same year, two American mathematics professors by the names of Fischer Black and Myron Scholes published a paper that revolutionized option markets around the world. Before their work, it was thought option prices would depend on the opinions of the buyers and sellers as to whether prices would increase or decrease.

It came as a surprise to everyone when Black and Scholes proved mathematically that there was a rational price for options independent of any views of market direction. Further, if the option were traded at a price different from this, then a certain profit could be made.

There is now a bewildering array of different types of options available to treasurers and risk managers through exchanges and financial institutions: averaging, barrier, quanto, digital, and so on. Even though they all trace their origins back to the ideas of Black and Scholes, the theories and techniques that are now used go far beyond this pioneering work.

Today's decisions in risk management involving millions, sometimes billions of dollars, depend crucially on mathematics developed over the past few years—and more importantly on mathematicians continuing to develop powerful theories and techniques which can be implemented throughout the industry.

John Price teaches in the Department of Mathematics at Maharishi University of Management in Fairfield, Iowa. His e-mail address is 75444.1465@compuserve.com.

What? More Standards?

Susan L. Forman and Lynn Arthur Steen

By now most mathematicians have heard about the NCTM *Standards* for school mathematics, and most probably also know—at least from newspaper headlines—that these standards are part of a movement to develop standards in all academic disciplines. These subject-matter standards are rapidly becoming part of guidelines for state frameworks and local assessments.

But wait! More standards are on the way. Even as educators campaign for academic standards, industrial leaders have been developing occupational skill standards in diverse industry clusters ranging from printing to photonics, from retailing to hazardous waste disposal. Some standards are expressed via lists:

- Photonics technicians need to
  - (a) make and read scale drawings
  - (b) set up and use spreadsheets and image analysis software
  - (c) control quality in a manufacturing process
  - (d) employ half-life time constants for exponentially increasing or decreasing systems.
- Hazardous materials management technicians are expected to
  - (a) solve problems related to proportions and concentrations including parts per billion (PPB)
  - (b) simplify and solve equations
  - (c) understand the role of chance in the prediction of events
  - (d) construct and interpret control charts.

Others are embedded in typical workplace tasks or scenarios:

- Given the dimensions of a plywood form at a construction site, cement workers must be able to use ratios and mental arithmetic to estimate within half a cubic yard the amount of concrete needed to fill the form.
- Bioscience technicians are expected to know how to calibrate laboratory instruments at the beginning of a shift and how to reestablish operation within control limits when a new reagent is added.

Occupational skill standards are motivated by both political and economic considerations. Work is changing, so prospective employees need different preparation than in the past. Today's "high performance" workplace requires quantitative, leadership, and managerial skills not only of white-collar managers but of all employees. These new workplace skills are summarized in a widely cited report, *What Work Requires of Schools*, known informally as the SCANS report after its government acronym. The skill standards now emerging supplement SCANS by providing particular requirements for specific industries.

The mobility of today's workforce and the globalization of international markets make performance standards an essential feature of competitive employment. As politicians advocate "world-class" standards in education, so they also urge occupational standards to ensure transportable, competitive credentials. Indeed last year Congress established a National Skill Standards Board to develop a voluntary national system of occupational skill standards.

Mathematics, Education, and Employment

Since virtually all occupations require mathematics, all skill standards include some mathematics. However, the mathematics that appears in these standards is, to a mathematician, very limited: mostly middle school topics (ratios, percentages, areas) with a bit of pre-algebra (applying formulas) and measurement geometry (areas, volumes, right triangles). Indeed workplace tasks typically rely on elementary mathematics embedded in sophisticated multidisciplinary contexts in ways that are rarely taught in school. In sharp contrast to typical school experiences, workplace skills place a premium on problem identification and formulation, on recognizing and dealing with the unexpected, and on synthesis of information from many different sources.

Although the academic standards in mathematics (and other subjects) aim for career development and lifelong learning, most occupational skill standards emphasize only requirements of entry-level jobs. Thus these standards do not embrace mathematics at anywhere near the level recommended by the NCTM *Standards*, but they do espouse an approach to problem formulation, integrated thinking, and communication skills that goes well beyond what is in any of the disciplinary standards.

Most of the standards—academic and occupational—can be divided into general "process" standards (e.g., reasoning, communication, problem-solving) and specific "content" standards (e.g., volume and area calculations, statistical process control). It is much easier to find common ground in the realm of process standards than when focusing on content—when one asks, for instance, whether it is important for students to learn about quadratic equations or matrix multiplication.

Much of the discussion surrounding the occupational skill standards is embedded in a resurgent national movement to reinvent vocational education through Dewey-like "education through occupations" or through integration of academic and applied programs in order to join the "cunning hand" with the "cultured mind." School-to-career, education for employment, and tech-prep are but a few of the banners under which this reform effort is advancing.

For mathematics, embracing this "new vocationalism" would mean restructuring much of school mathematics—replacing context-free mathematics with rich, complex, authentic problems in which standard high school mathematics often plays only a minor role. High school teachers will face a real challenge finding ways to engage students in high quality mathematics through context-rich problems that can be approached in many different ways. Similar challenges will face mathematics faculty in postsecondary institutions.

Implications and Opportunities

Many people, especially employers, believe that the educational system should prepare students for employment. In this

view, much of the burden of preparing students to meet occupational standards falls on the K–12 system and community colleges. But four-year colleges and universities are neither secure from these pressures nor absolved of responsibility for constructive engagement. The movement for national occupational skill standards has the potential to affect all mathematicians and mathematics educators:

Student Expectations As high schools experiment with integrated academic and vocational programs, postsecondary educators will need to find ways of furthering the education of students who arrive with rich educational experiences that are much different than those provided by traditional text- and class-based education.

Access Too often career preparation and vocational programs are seen as a convenient track to separate from college-bound students those who are perceived as not having the potential for higher education. Since high performance jobs require higher education, in this new environment all students need to be well prepared both for college and for work.

Teacher Preparation The mathematical preparation of teachers will need to change to reflect the need to prepare students for work. Teachers who have lived their whole lives in educational institutions have little experience with the kinds of problems that are common in the workplace.

Business and Industry State and local discussions of how to prepare graduates for employment will give mathematicians a new and important forum for helping business leaders understand the role of mathematics. In particular, mathematicians face a major challenge demonstrating to business leaders the continuing importance of specific parts of traditional high school mathematics.

State Frameworks Mathematicians and mathematics educators who are working with state policy leaders to embed the NCTM Standards into curriculum frameworks will need to think about means of incorporating the essential elements of the occupational skill standards—not as a checklist of topics, but as an approach to context-sensitive multidisciplinary problem solving.

Curriculum Future workers will need a strong background in mathematics that is a hybrid of the academic standards as expressed by the NCTM and the skill standards as expressed by the occupational clusters. Few examples can be found today that illustrate this blend of expectations.

Accountability Mathematics educators need to find new means of accounting to the public that will (1) convince business leaders that students will learn in their mathematics courses what they will need as future employees and (2) convince parents (as well as college and university faculty) that high school graduates will have sufficient mathematical preparation to succeed in postsecondary education.

Although the occupational skill standards carry risks for mathematics education—in particular that elementary skills will be seen as sufficient for all but a few—they also contain the seeds of enormous opportunity to demonstrate the power of mathematics in realistic, work-based problem situations. If mathematicians don't accept this challenge, no one else will.

Resources

Curriculum and Evaluation Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics, 1989.

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Forman, S. and Steen, L. A. "Mathematics for Work and Life," *Prospects for School Mathematics: Seventy-five Years of Progress*. Iris M. Carl, editor. Reston, VA: National Council of Teachers of Mathematics, 1995.

Crossroads in Mathematics: Standards for Introductory College Mathematics Before Calculus. Memphis, TN: American Mathematical Association of Two-Year Colleges, 1995.

Mathematical Preparation of the Technical Work Force. Mathematical Sciences Education Board. Washington, DC: National Academy Press, 1995.

Academic and Occupational Standards. EXTEND Resources Web Site; http://www.stolaf.edu/stolaf/other/extend/Resources/resources.html#Standards

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This report summarizes issues arising at a series of workshops on the academic and occupational standards movement sponsored during the past two years by the National Governors' Association (NGA) and the National Center for Research in Vocational Education (NCRVE). The authors, Susan L. Forman of Bronx Community College and Lynn Arthur Steen of St. Olaf College, were formerly on the staff of the Mathematical Sciences Education Board, one of the organizations engaged in this continuing dialogue. Professor Forman's e-mail address is sforman@danany.dana.org. Professor Steen's e-mail address is steen@stolaf.edu.

Contributed Paper Sessions

The MAA Committee on Sessions of Contributed Papers selects topics and organizers for contributed paper sessions at national meetings. The committee would be delighted to hear from MAA members who would like to organize such a session or who have suggestions for topics. All that is required is a title, name(s) and address(es) of organizer(s), and a short two- or three-sentence description.

Planning is now underway for the August 1997 summer meeting (tentative site, Atlanta) and the January 1998 meeting in Baltimore. The deadline for receipt of proposals for the 1997 summer meeting is November 15, 1996; deadline for receipt of proposals for the Baltimore meeting is January 1, 1997 (Friday, January 10, 1997 if by e-mail or in person at the San Diego meeting). Information should be sent to the chair of the committee, Elizabeth Teles, 11501 Chantilly Ln., Mitchellville, MD 20721; work: (703) 306-1668; home: (301) 262-9586; fax: (703) 306-0445; e-mail: eteles@nsf.gov.

Secrets of My Success

Thomas F. Banchoff

Remarks on receiving the MAA's 1995 Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics, Orlando, Florida, January 1996.

There really isn't much secret to what counts as success in teaching. You are teaching well when your students are involved, working hard, and learning worthwhile things that can help them throughout their lives. So what can a teacher do to foster that?

In my experience, students will get involved if they see that the teacher is involved. They will work hard if the teacher does. And they will believe that what they are learning is worthwhile if the teacher shows that it is worthwhile in his or her own life and in the lives of former students.

Giving a brief talk about a thirty-year career is a challenge, and perhaps the best way is to present a scrapbook of anecdotes and images (even though the written version will miss out on the slides and videotapes). As I prepare for this, it becomes clear how much my teaching has changed and continues to change. We are always telling our students that we can't teach them the mathematics they will need in the next century, but we can only teach them how to keep learning. Until recently I had not realized how much that advice also applies to us as teachers.

To illustrate the great changes, I wish I could immediately switch to an interactive presentation on the Internet. Within a very few years, every convention center will be outfitted with such technology, and anywhere in the world it will be possible to have access to resources from everywhere else. What a change that will make in the audio-visual scene. Throughout my career, I have collaborated with computer science colleagues and students to produce graphics for my courses, my research, and my lectures. Three decades ago, it was hard enough to locate a working 16 mm projector, or a tray that would fit all slide projectors. For a few years, in order to show a videotape, you had to bring with you the equipment it was recorded on, but then almost overnight the VHS standard became universal. Technology continues to improve and to become more accessible at incredible rates, and the Internet promises to accelerate that process. It is already changing my teaching and my lecturing in ways I could not have anticipated.

But that is the future, and I promised some scrapbook items from the past. Now I routinely teach college students one-third my age, but when I started, I had one memorable student three times as old as I was. Sr. Adelicia was in an NSF summer biology program at Notre Dame in 1960 when I stayed on after graduation to be an assistant for Dr. Arnold Ross in his program for high school teachers and very bright high school students. My assignment was a recitation section for assorted students from other departments trying to get a required math credit by taking elementary number theory. Most of my students had a terrible time with the first exam, and I called them in one at a time to go over the results. Sr. Adelicia had received a score of 20, and when she arrived, before she had a chance to say anything, I showed her how she almost had the right answer in a couple of problems and how she could organize things to make headway on some of the others—I was sure she could improve. "Do you really think so?" she asked and she went on her way.

When the next exam grades came out, everyone had improved, but no one as much as Sr. Adelicia, up to a low passing grade. Everyone in the section applauded when I announced that she had more than doubled her previous score, and she was as proud as could be. She came to my office and said, "I did it for you."

"What?" I asked.

She continued, "When I came to your office after the first test, it wasn't to ask for help. I had decided to drop out of the whole program and go back home, but you had faith in me. You gave me the confidence to give it one more try. I did it for you."

I was flabbergasted. This was my first experience teaching and I was getting the kind of affirmation I thought only came at the end of a long career. I seriously wondered if it was all going to be downhill from then on. Maybe I should quit while on top.

The next anecdote is about the worst course evaluation I ever received from a student. I wish I could say it came when I was naive and inexperienced, but it was this past semester. Almost all of the students in my differential geometry course appreciated it very much, but one was unhappy nearly all of the time. Everything that worked for the others turned him off. I emphasized group projects, and he only wanted to work alone. The class delighted in coming up with conjectures, writing up their ideas each day, and then discussing them when I handed them back with comments the following class; but the kind of homework he wanted was lists of problems from the book, assigned several weeks in advance. Open-ended problems on take-home exams? No thanks. Interactive visualizations in the weekly computer laboratories? It might work for other people, but it didn't do anything for him. Never before had I seen an evaluation with the lowest possible rating in every category, except for his own effort.

What do you do about that kind of outlier? You just have to accept the fact that you can't please everybody, especially if you want to be open to trying new things. As a teacher, you have to strive to challenge almost everyone in the class, trying to keep the quickest ones from getting bored and the slowest from getting lost. But you can't abandon the whole flock to chase after one who doesn't want to go along. You have to remember that good teaching is not identical with perfect ratings.

Assessment is a constant theme for teachers, and I want to share a device that works for me: the Two-Phase Hour Exam. It came about many years ago thanks to the inventiveness of one freshman student, Nick Nickerson. I gave a midterm in the calculus class on the day before Thanksgiving, and, with his suitcase waiting for him in the back of the room, he wrote a miserable exam. I could see how frustrated he looked as he rushed off for his train. As I graded his test, I could see why—his errors and

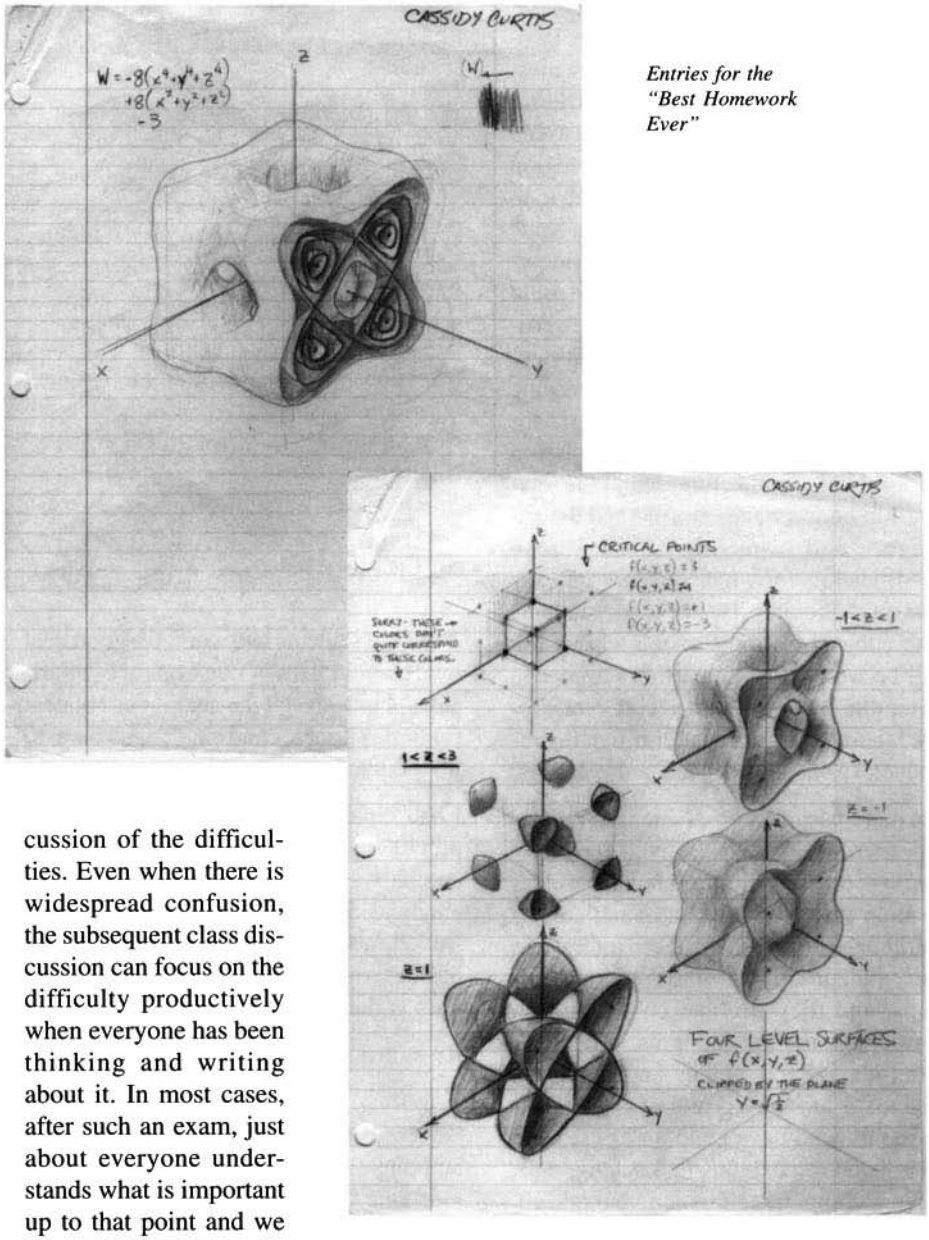
omissions made it quite difficult to determine whether he knew anything at all. But the day after Thanksgiving, I received in the mail a packet from Nick saying that he had sat down immediately in the train and in one hour he had written answers to all of the exam questions, perfectly as it turns out. He told me he had studied very hard and he knew the material, but he just got flustered at the beginning of the exam and he never got back on track. He wasn't trying to make an excuse, he said, and he had no idea what I might want to do with his second effort, but he did want me to know that that hour exam did not represent how well he knew the material in the course.

I thought quite a bit about Nick's letter. I realized that I had learned two things: how well Nick could do in a pressure situation, and how well he could do when he had more time to think carefully. Both pieces of information are important.

From that time onward, whenever I give a timed exam in a course, I instruct everyone to do what Nick did instinctively. Phase I: After one hour of an in-class exam, they hand in their exam book and it will be graded before the next class. Phase II: Take the exam questions home and do the same test carefully and completely, and hand it in at the next class period. On the second phase, students can use notes and books and any kind of computer, but they are not to discuss the test with anyone.

I did not originally anticipate all the effects of this procedure, and I am convinced that it is beneficial in quite a few ways. For one thing, I no longer get students crowding around the desk at the end of the exam complaining that it was too long, and that they could have done so much better with just a little more time. They have an opportunity to show me what they can do on the next phase.

And they do show me. It is easy to evaluate the second part because just about everyone does very well, but some students will do very well indeed, coming up with elegant solutions and catching the subtleties that are easy to miss in the hour exam pressure. It is also clear which students are still fundamentally confused, and both phases can form the basis for a discussion of the difficulties. Even when there is widespread confusion, the subsequent class discussion can focus on the difficulty productively when everyone has been thinking and writing about it. In most cases, after such an exam, just about everyone understands what is important up to that point and we are ready to go on to the next topic.



Entries for the "Best Homework Ever"

Invariably students ask how I "count" the two phases, and I always answer that I will take both into consideration in making up my evaluation. I am much more interested in where they end up in the course than in their showing in the preliminaries. Phase I identifies the mathematical sprinters and Phase II, the middle distance runners. Both aspects are important, and we ignore a great deal of mathematical talent if we only look at the one measure of performance. I wonder how many potential deep-thinking mathematicians were weeded out in the time trials of yesteryear?

Students almost always consider my exams challenging, since I try to design them so that only one or two of them, working very quickly and accurately, will be able to do the in-class part perfectly in an hour. I am very disappointed if no one does the test very well, and equally disappointed if anyone finishes early. I always put in one or two extra credit problems so no one gets bored, and for some students, the chance to work on these more interesting problems during the second phase is the most satisfying part of the course. After two or three of these tests, students begin to catch on and performance on both phases improves. On the three-hour final, equivalent in length to about two hour exams, people do have time to finish—there isn't any Phase II in the Last Judgment.

An example of a benefit from the Two-Phase experience occurred this past semester in the midterm of my honors multivariable calculus course. I had asked the students to find the centroid of a region bounded by a quadrilateral symmetric to the x-axis, and in the hour test, even some of the best students jumped to the (incorrect) conclusion that the centroid would always be the vector average of the vertices. On Phase II, a number of students recognized that the problem was more subtle and came up with alternate strategies for solving it. In subsequent class discussion we formulated conjectures about the relationship between the centroid and the average, and we identified those quadrilaterals for which the centroid was outside the region. Two of those students who contributed most to this discussion will be working with me this summer to adapt our multivariable calculus interactive laboratory materials for use in my introductory calculus sequence this fall.

The pattern from this past semester repeats an experience I have enjoyed for many years—students in an elementary class become turned on to mathematical research, they follow up their interest in independent studies or summer internships, and they become co-workers in developing new pedagogies, especially using computer graphics and hypertext systems. I am very proud of the student assistants who have gone on to graduate school and to positions in teaching, publishing, computer animation, and design.

One more scrapbook item that does demand an illustration even in a printed version is the Best Homework Ever. Every teacher probably has a candidate for this award, and I think that my entry will stand up against any of them. I always ask my students to learn to draw, especially in the two-variable calculus course where so much of the intuition comes from exploring representations of function graphs in three-dimensional space. I have had some fine artists in my classes, none so impressive as Cassidy Curtis. Ten years ago, as a freshman in my third-semester calculus course, he excelled from the beginning, choosing just the right viewpoint, shading, and coloring for rendering surfaces in three-space. He was equally good with colored pencils and with computer graphics.

After the students had worked a good deal with contour lines of functions of two variables, I introduced the analogous concept for three variables and challenged them to investigate contour surfaces.

I had a particular example in mind. The previous summer, in a lecture series on complex algebraic surfaces at the Mathematical Sciences Research Institute in Berkeley, Professor Friedrich Hirzebruch had described a polynomial in three complex variables

$$f(x, y, z) = (8x^4 - 8x^2 + 1) + (8y^4 - 8y^2 + 1) + (8z^4 - 8z^2 + 1).$$

One level set had a large number of singular points, and although he talked about its algebraic and analytic properties, he regretted he did not have any pictures to show the geometry of the surface. I phoned back to Brown and one of my undergraduate assistants used our implicit function renderer (a senior project of the previous year) to produce some slides of the real part of the surface. Professor Hirzebruch was delighted to use them in his next lecture three days later.

When I introduced contour surfaces to Cassidy's class, I had planned to lead up to this story after a couple of weeks of preparation, but I made the mistake of writing the equation on the board without telling the class how difficult the problem was. The very next class, two days later, Cassidy Curtis said, "I figured out what your surface looks like. I decided to show a whole set of levels, sitting inside a cube, and I removed one face of the cube so it is easier to see the structure." I was astounded to see a perfect image of the surface we had rendered with such labor. I was even more impressed when he showed the next page where he had stacked all the color-coded surfaces together, something our computer could not do at the time!

I have shown these images in many, many lectures. I claim that not only is this the best overnight homework I have ever received from a freshman—this is the best homework that anybody has ever received in any course at any level in any subject at any place, ever ever ever. That may be an exaggeration, but I am still waiting for someone to produce a counterexample.

One final anecdote is especially appropriate for this award presentation. I remember many of the students from the first calculus course I ever taught, as a Benjamin Peirce Instructor at Harvard in 1964, and I was pleased that two of them wrote supporting letters when I was considered for this award. One was Zara Haimo. I knew her parents before they were my colleagues, so I am so very pleased to receive this award named in honor of Debbie and Frank Haimo.

So many teachers and so many students have influenced me over the years. Whatever success I have had comes from working with them, all trying to do our best. What lies ahead to challenge us as teachers? I don't know, but I'm looking forward to it.

Tom Banchoff teaches at Brown University in Providence, Rhode Island. His e-mail address is tfb@cs.brown.edu.

Become an MAA Visiting Mathematician

Have a sabbatical coming up? Recently retired? Looking for a new challenge? Consider spending a year as a visiting mathematician at the MAA headquarters in Washington, DC. Visiting mathematicians work on a variety of projects and programs, depending on their areas of expertise and the needs of the office. Recent VMs have made significant contributions to publications, electronic services, student programs, career information, professional development programs, and public policy issues. Appointments are generally for the academic year. Shorter or longer time periods are possible.

Candidates should mail or fax a statement of your background and interests, your curriculum vitae, and the names of at least three references to Marcia P. Sward, Executive Director, MAA, 1529 18th St. NW, Washington, DC 20036; fax: (202) 387-5948. Interviews will be conducted at the Joint Mathematics Meetings in San Diego, California in January. Candidates who are unable to attend the meetings may be interviewed by phone. The deadline for receipt of applications is November 15, 1996. It is expected that the selection process will be completed by mid February.

Can Mathematics Majors Become Engineers?

Jim Fink

Once upon a time many years ago, I thought I wanted to be an electrical engineer, and I even started college with that career in mind. However, shortly after beginning my first engineering job as part of my college's cooperative program, it quickly became clear that my interests lay elsewhere. I was much more intrigued by the underlying theory than in practical product design, and so I switched my major to physics and ultimately to mathematics.

I mention this little anecdote because, although it took place some time ago, it suggests a fundamental difference between the two cultures of mathematics and engineering which remains valid today. The principal goal of engineering is to design a process or a product someone else will use. Design involves working in teams with other engineers, and mathematics students hoping to make a successful transition to engineering need to prepare for a nontrivial change in mindset. This adjustment may be the major obstacle for mathematics majors considering careers in engineering because practical design experience is not found in most mathematics curricula. Nevertheless it is an essential prerequisite to becoming an engineer, and practicing engineers consider design to be at the heart of their profession.

A time-proven good bet for an undergraduate mathematics major who wants to enter the engineering profession is the familiar 3–2 program. But other approaches to engineering for mathematics students are possible, too, provided students plan and prepare well. Here we will explore a few engineering graduate school opportunities for undergraduate mathematics majors who do not participate in a 3–2 program.

Virtually all mathematics majors can have the necessary mathematics background for graduate work in engineering provided their coursework includes such applied topics as, for example, special functions, vector analysis, transforms, Fourier series, and the solution of partial differential equations. In addition, any student considering engineering needs to know laboratory and hardware fundamentals; physics laboratory courses are especially good in providing such skills.

Given the basics, how easy it is to make the transition from an undergraduate mathematics curriculum to a graduate engineering curriculum depends heavily on the engineering field and to some extent on the specialty within the engineering field. The transition is obviously easiest in the more mathematical areas of engineering, such as systems engineering and certain parts of electrical engineering. In other areas it can become a little more complicated. Let's look at a few specific examples.

A mathematics student with a strong physics background should be able to make the transition to electrical or mechanical engineering fairly easily. In civil engineering, a mathematics student should have no difficulty if the graduate specialty is transportation engineering consisting mostly of operations research work but might experience difficulty in structural engineering. A good chemistry and biology background is needed for environmental engineering. Courses in physics and computer science should go a long way toward improving a mathematics student's prospects for computer engineering. The toughest nut to crack might be chemical engineering. Without a background in chemical engineering, a student likely would need at least a full semester or even a year of undergraduate catch-up work.

A caveat to be considered by undergraduate mathematics students thinking about graduate study in engineering is the issue of professional certification. All states have strict requirements for registering as a Professional Engineer (PE), and anyone who wants to practice engineering as a consulting engineer must register as a PE. State requirements vary considerably, but in about half the states, a degree from an engineering school accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET) is required before one can even sit for the PE examinations. Interestingly most undergraduate engineering programs are ABET accredited, but most graduate engineering programs are not. Thus an undergraduate mathematics major who goes on to earn a graduate engineering degree will not be able legally to be an engineering consultant in about half the states.

Being eligible to register as a PE may be important for some students; for others, it is not. In most states, designing public structures like buildings and bridges must be done under the direction of a PE, and the more stringent states make essentially no distinction between practicing engineering and practicing law or medicine. On the other hand, for engineering-type work such as designing systems for a large computer company, professional certification may not be a factor at all.

So there is a ray of light emanating from the door to engineering. Graduate engineering schools do appear to welcome mathematics majors into their programs provided they are willing and able to make the necessary adjustments. As with any worthwhile venture, careful planning and preparation are needed, and waiting until the senior year may be too late. In addition to assuring that they take appropriate background courses, students need to learn about the different culture of engineering and to prepare well to work with engineers.

Taking the right courses may be less of a problem than learning about the culture of engineering itself. A good source of information and advice can be found in the Society for Industrial and Applied Mathematics (SIAM) report *Mathematics in Industry*. The report can be accessed online through the WorldWide Web. The URL is http://www.siam.org/mii/miihome.html. Also see the editorial and article covering the report in the August 1996 issue of FOCUS.

This article on advising mathematics majors about opportunities for graduate study in engineering is the fourth in a series of articles by members of the MAA Committee on Advising. I am grateful to the applied mathematicians and engineers who provided me with advice and information.

Jim Fink is a member of the MAA Advising Committee and teaches at Gettysburg College in Gettysburg, Pennsylvania. His e-mail address is jfink@gettysburg.edu.

PERSONAL OPINION

The Part That's Not as Easy

Phyllis Chinn and Dale Oliver

Recent editorials in FOCUS have addressed the issue of college faculty responsibility for the narrow view of mathematics and the methods for teaching mathematics that still pervade many K–12 classrooms. Keith Devlin wrote in "A World of Melissas" (October 1995, p. 2), "As a community of mathematicians, we face a problem, and it is only by pulling together and cooperating that we have any chance of moving forward. If there are mathematics teachers in the classrooms who do not have a real sense of what mathematics is, then we need to ask ourselves who taught those teachers their mathematics.... If large numbers of school mathematics teachers think that mathematics is mainly about learning and performing algorithms and has little or nothing to do with concepts and creativity and connections to other parts of life, then we—the teachers of the teachers—surely must bear our share of the blame." If generations of students continue to be turned off to mathematics because of what they are taught and how they are taught, then we must be willing to recognize the ways we have contributed to this problem and consider the ways we can contribute to its solution. As Devlin hinted in his editorial, laying (and even accepting) some of the blame for the problem is the easy part. In this article we urge you to explore the part that is not as easy—accepting responsibility for solutions.

Who Needs Mathematicians?

The immediate result of the "problem" just described is continued reinforcement of public perception that mathematics is irrelevant for most citizens. Positive PBS shows notwithstanding, we as mathematicians know that this perception is as strong as ever. How many of us have been at a party and a person who has just learned that you are a mathematician comments, "Oh, I hated math in school. I can't even balance my checkbook." Perhaps what this person is intending to communicate (beyond his or her distaste for math class) is that he or she is successful without any of the skills that mathematics teachers had to offer. In other words, except for a few scientists and engineers, who needs you!

Comments like these reflect our own failures to prepare teachers to have a broader view of mathematics and its role in the world, as well as to provide them with an experiential base of a variety of ways to teach so that more of their students find relevance and creativity in mathematics. Our challenge at the college and university level is to rethink the role we play in K–12 mathematics education through the work we do with future teachers of mathematics. One of the most influential places to engage in the rethinking process is in mathematics courses for elementary school teachers. (Remember that all elementary school teachers are mathematics teachers.) How can we create new teachers who have a real sense of what mathematics is?

Mathematics Courses for Prospective Elementary Teachers

How are we dealing with the mathematical preparation of elementary teachers? Often we are faced with communicating basic mathematical ideas clearly to students who want to know enough to teach third grade math but have little interest in the deeper connections underlying the elementary content. We do our best to motivate the students to appreciate the elegance and beauty of math and to enhance the basic competence of these students to recognize and apply some important skills to solving fairly routine problems. While we would love to kindle greater mathematical curiosity in our students, we often abandon them to the level of understanding they seek, reserving our energy for other students who are more receptive to what we want to teach them of mathematics. In fact, as budget constraints have forced us to lose permanent faculty positions, we have often left the teaching of these courses to graduate students or part-time faculty.

In the past, perhaps we could afford to be complacent in the knowledge that prospective elementary teachers would teach from a math textbook that told them what to tell their students and provide ample opportunities for the students to master computation and algorithmic skills. Most traditional textbooks in use across the country are written in what is often called a two-page spread. A new idea is introduced, some sample problems are worked out, and a large number of similar problems are presented for the teacher to assign as homework. The teacher's guide gives some background into the concept currently being taught and the teacher has little doubt what skill(s) the student should be learning in this particular section of the book. Superficially there appears to be no need for the teacher to help the students make deeper connections, understand the relevance of topics, nor for the teacher or students to display mathematical creativity. However, when the problem stated at the beginning of this article is considered, it is clear that reliance on rote learning of skills in math classes leads to many students who do not understand or enjoy math and have no idea how, when, or where to use it in their adult lives.

Implications of a Teacher-led Revolution

When we recognize the work that school teachers and the broader mathematics education community are doing to revolutionize mathematics instruction in K–12 classrooms, we see the case for deeper connections, relevance, and creativity even more clearly. The philosophy and expectations of this revolution is described in the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989), state frameworks like the *California Mathematics Framework* (1985 and 1992) and the NCTM *Professional Standards for Teaching Mathematics* (1991). Despite a public that occasionally refers to this revolution as the "new new math" (in reference to the "new math" movement of the 1960s which touted mathematical rigor as a means to raise up new scientists and engineers), the current revolution is motivated by classroom teachers who are faced with increasing numbers of students who are not interested in learning math for its

own sake. These documents suggest a broader content and a greater variety of learning opportunities for all students.

What began as a revolution of a core of motivated and energetic teachers and educators is now defining new expectations for all teachers in some school districts. Beyond the calls for reform of the state and national documents above, which can be ignored as long as the textbooks and exams don't change, there are now many "reform" textbooks being adopted by school districts across the country. While teacher leaders are providing what they can by way of inservice to the current teaching faculty, the success of this phase of the revolution depends on new teachers entering the profession ready to meet the new expectations.

A big part of the new expectations for teachers is to create opportunities for their students to do mathematics (explore, analyze, conjecture, and test hypotheses; construct models; collect, organize, and represent data; present arguments; and solve problems) thereby experiencing mathematics as a rich and creative field for exploration. The new textbooks are written with this emphasis in mind, and thus often suggest open-ended projects for students to explore. While these projects are in mathematically rich settings, it is not clear that students on their own will be able to apply suitable problem-solving, communicating and reasoning skills, nor to make desirable mathematical connections. To move the explorations beyond the superficial stages, teachers are recognizing their need to build their own sense of what mathematics is so that they can be skillful guides for their students. They are likely to be most successful in facilitating learning in open-ended problem-solving situations if they have learned some significant mathematics in comparable settings.

Working with Math Reform

Now is an ideal time to redesign mathematics courses for prospective teachers to prepare new teachers to meet the expectations of mathematics reform through broader content and greater variety of learning opportunities. Our students, motivated by school district expectations for new teachers, are ready to see value in discovering deeper mathematical connections, learning of the relevance of mathematical ideas and techniques, and experiencing mathematics as a creative endeavor.

During the summers 1993, 1994, and 1995, approximately 165 mathematicians from around the country participated in one or more workshops of the NSF supported Project PROMPT (Professors Rethinking Options in Mathematics for Prospective Teachers). The workshops and ongoing follow-up opportunities were designed to bring mathematics faculty together to consider how and what we should be teaching in courses for prospective elementary school teachers. More specifically, the faculty who attended committed two weeks of their professional time and energy to experience a variety of learning experiences for themselves, discuss the implications of the major components of mathematics education reform, and collaborate on ways to better prepare teachers for the new expectations of mathematics education reform.

Central to the workshop program were the learning experiences which provided a common framework for the discussions and collaboration. These experiences included: exploring mathematical ideas in small group settings; investigating questions motivated by various manipulatives like geoboards, Cuisenaire rods, and attribute blocks; keeping a journal on aspects of the rethinking process; and engaging in discussions on mathematical connection, relevance, and creativity. All of these techniques were designed to allow participants the time to experience learning mathematics in a way that the students of their students are expected to learn mathematics. As a result of these experiences and the collaboration that followed, many of the participants are now engaging their students in more long-term projects and in group work both inside and outside of class, having students explain their reasoning as well as displaying answers, and using more hands-on activities involving math manipulatives to motivate mathematical thinking.

Many of the PROMPT participants are also adding a variety of assessment techniques to the standard tests and quizzes, including having students keep journals, complete portfolios, turn in write-ups of group projects, etc. It seems to have been easier for the participants to make such changes in their teaching because they have experienced and enjoyed learning some mathematics themselves using similar techniques. As faculty we are not appreciably different from the teachers in the K–12 setting of whom Uri Treisman said, "They are being asked to teach things they have never learned in ways they have never experienced."

Contribute to the Cause

The most noteworthy aspect of participation by faculty in Project PROMPT is the commitment of professional time and energy that these faculty made to begin (or extend) their efforts to improve mathematics education. Such commitment should be recognized and rewarded, as these faculty are addressing the issues related at the beginning of this article. The PROMPT participants, who are becoming more visible at mathematical meetings and on the Internet, will be organizing opportunities for faculty to join them in the rethinking process, and will be providing college classroom ideas and resources to all who are interested.

While lecture discussions remain an important part of the teaching in many PROMPT participants' classrooms, these faculty are ready to include a greater variety of learning experiences in their courses, and are now more likely to reach students with a variety of preferred learning styles and talents. The goal is to affect the teaching of these students in their future classrooms. Perhaps then more of the Melissas in our schools will be able to bring their own styles of mathematical thinking into classes and be appreciated and encouraged by teachers who have learned to accept divergent ways of thinking about problems.

Phyllis Chinn and Dale Oliver are both faculty members in the Department of Mathematics at Humboldt State University in Arcata, California. They are co-directors of Project PROMPT and of the Redwood Area Mathematics Project (an inservice program for K–12 teachers of mathematics). Their e-mail addresses are drol@axe.humboldt.edu (Oliver) and pzcl@axe.humboldt.edu (Chinn).

Newton's Method—Or Is It?

Dan Alexander

One of the most enduring numerical algorithms in mathematics is Newton's method, which is customarily formulated as

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}.$$

Newton's method is best known for its ability to quickly generate approximate solutions to equations of the form $f(x) = 0$. One begins with a reasonably close approximation to a solution, x_0. Repeated application of the above algorithm yields a sequence $\{x_0, x_1, x_2, \ldots\}$ which, if all goes well, converges to a solution.

Newton's method is perhaps the most elegant numerical algorithm we have. Because it is iterative—that is, the output of one step becomes the input of the next—its simplicity makes it very easy to program and apply. If a starting point is properly chosen, it converges rapidly to a solution. Since it involves calculus and is attached to one of the biggest names in mathematics, it appeals to educators, hence it's a familiar object to most mathematicians.

The history of Newton's method, however, has often been shrouded in misconception. One reason is its name: attach the name "Newton" to something and the natural reaction is to think that Newton himself is chiefly responsible for it. Two very interesting recent articles, one by Ypma in the December 1995 *SIAM Review*, and another by Kollerstrom in the 1992 *British Journal of Historical Science*, as well as a delightful lecture by William Dunham at the 1995 joint AMS–MAA meetings, make it clear that Newton had significantly less to do with the development of the algorithm

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

than one might suspect.

Before discussing what Newton did and did not do, I should point out that my use of the phrase "Newton's method" refers to the standard formulation given at the beginning of this article, and not to Newton's use of it. I will use "Newton's algorithm" when referring to something Newton actually did.

The big question is, did Isaac Newton (1642–1727) invent Newton's method? According to the articles by Ypma and Kollerstrom, the answer is not at all a clear-cut "yes." Certainly no one before him used Newton's method. And we can algebraically describe an algorithm Newton used to solve equations, relabel it, and after a few routine calculations, transform it into the standard version of Newton's method,

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}.$$

However, Newton evidently never wrote down a formula for his algorithm which even remotely resembles the standard version. Newton's algorithm is also much more cumbersome to apply. One of the nice things about the standard version of Newton's method is that we can iterate it. Newton's algorithm was not even iterative—each step generated an entirely new subsidiary equation which in turn necessitated extensive calculations. Finally, both authors demonstrate that Newton's conception of the algorithm did not even involve calculus.

To a casual reader, what Newton did would hardly be recognized as Newton's method. Nonetheless, one might be tempted to argue that Newton's algorithm was really the same Newton's method that we use, except that he went about things a little differently. Perhaps. But the fact that Newton's algorithm was neither iterative nor rooted in calculus suggests the differences are fundamental.

Despite their excellent discussion of Newton's role in the development of Newton's method, both papers neglect to observe that Newton had bigger fish to fry with his algorithm than solving equations for their numerical solutions. It is no exaggeration to say that Newton's principal application of his algorithm was to invert power series. For example, after illustrating it on a simple equation, $x^3 - 2x - 5 = 0$, whose solution he approximated to within eight decimal places, Newton used his algorithm to solve for y in the equation

$$y + \frac{1}{6}y^3 + \frac{3}{40}y^5 + \frac{5}{112}y^7 + \frac{35}{1152}y^9 + \frac{63}{2816}y^{11} + \cdots - x = 0$$

which those of you who really know your trig will recognize as the Maclaurin series for the arcsine. What he obtained was

$$y = x - \frac{1}{6}x^3 + \frac{1}{120}x^5 - \frac{1}{5040}x^7 + \frac{1}{362880}x^9 + \cdots,$$

the Maclaurin series for the sine. In fairness to the two authors, Newton's use of his method to find power series seems to have escaped almost everyone else's notice as well, although C. H. Edwards' *The Historical Development of the Calculus* contains a very nice passage on the subject (see pp. 201–206).

This is all very interesting, you say, after all, one would expect Newton to do something spectacular, but let's get back to the matter at hand: if Newton did not conceive of his algorithm in terms of calculus, who did? And who was the first to write it in the standard form? Based upon the articles by Ypma and Kollerstrom, it was—depending on your point of view—either the British mathematician Thomas Simpson (1710–1761) of Simpson's rule fame, or the French mathematician Joseph Fourier (1768–1830).

It was, however, Joseph Raphson (1648–1712?), a contemporary of Newton's, who first simplified the application of Newton's algorithm around 1690. Raphson formulated a different version of the algorithm, and Ypma includes a quotation from Raphson which suggests he may have developed his procedure without knowledge of Newton's algorithm. Nevertheless, Raphson certainly recognized the similarities between the two methods, and demonstrated his procedure by greatly improving upon Newton's own approximation of the solution of $x^3 - 2x - 5 = 0$.

In any event, Raphson's procedure can also be described and transformed into the standard version of Newton's method. Obviating the need for Newton's subsidiary equations at each step, Raphson in effect turned Newton's algorithm into an iterative process. Ypma argues convincingly that Raphson, like Newton, did not conceive of the algorithm in terms of calculus.

Simpson's version of the algorithm, which he discussed in 1740 without referring to either Newton or Raphson, was the first to incorporate calculus, and in a verbal description of his algorithm

included in Ypma's paper, Simpson came very close to the standard form. The reason he did not do so exactly, has as much to do with the Newton-Leibniz priority dispute as it does with Simpson's description of his algorithm.

At the risk of gross oversimplification, Continental mathematicians, who tended to side with Leibniz in the priority dispute, viewed differentiation much as we do today. To differentiate $x^3 - 2x - 5 - y = 0$, for example, one would solve for y and then express the derivative as $dy/dx = 3x^2 - 2$. The British, on the other hand, adhered to the Newtonian point of view which was similar in spirit to implicit differentiation since x and y were viewed as somewhat independently varying qualities. An apt metaphor for the British view of things in the 1700s would be to think of x and y as variables which are parameterized by a third variable t, and then differentiate $x^3 - 2x - 5 - y = 0$ with respect to t, obtaining $3x^2x' - 2x' - y' = 0$, where x', y' are derivatives with respect to t. The standard Leibnizian derivative dy/dx could then be found by isolating the quotient y'/x'. What Simpson in essence said was that $x_{n+1} = x_n - y'/x'$. There is really no difference between this formulation of Newton's method and the standard one, aside from those implied by the differing views towards differentiation.

At this point the question of who was the first to write Newton's method as

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

becomes rather anti-climatic. According to both authors, Fourier gets this honor in a paper published posthumously in 1831.

Given its evolution, one might wonder how the algorithm came to be called Newton's method. One answer is that even in the present day, it isn't always called Newton's method, except perhaps in calculus texts. Moreover, there seems rarely to have been a clear-cut consensus on what to call it. Kollerstrom observes that even in the 1700s, some British mathematicians thought that Raphson's conception was superior to Newton's; perhaps for this reason, many English speakers over the years have referred to it as the Newton-Raphson method, and this terminology is found in many current books and articles. Non-English speaking mathematicians such as Fourier, as well as some of the other French and German mathematicians who studied Newton's method in the late nineteenth and early twentieth century, tend to call it Newton's method. This isn't surprising since often only the most prominent names associated with a mathematical object pass through the barriers imposed by language. Perhaps there's an analogous barrier with textbooks, since most of the standard calculus texts refer to it as Newton's method.

But it goes by other names as well. Ypma suggests the Newton-Raphson-Simpson method. Cayley called it the Newton-Fourier method, and others have followed suit. Given the contributions of each, the most historically correct name might be the Newton-Raphson-Simpson-Fourier method, giving the process the rare distinction of having four names attached to it. However, as is the case with some "N-correct" terms, things become a little too unwieldy if we behave too slavishly towards some idea of linguistic accuracy, so I prefer calling it simply "Newton's method," if only to have an excuse to launch into a story about how deceiving that title really is.

Dan Alexander teaches mathematics at Drake University in Des Moines, Iowa. His e-mail address is da0231r@acad.drake.edu.

Mathematician Joins National Science Board

Mathematician Richard A. Tapia, the Noah Harding Professor of Computational and Applied Mathematics at Rice University, is one of eight scientists recently appointed by President Clinton to serve on the National Science Board.

The board was established by the National Science Foundation Act of 1950. It has twenty-four members appointed by the president with the advice and consent of the Senate. Members serve six-year rotating terms and eight members are appointed every two years. Board members are drawn from industry and academia; they represent a variety of science and engineering disciplines. They are selected for their distinguished service in research, education, or public service. The board recommends broad national policies for promoting basic research and education in the sciences and engineering.

Dr. Tapia is an expert in the field of computational and applied mathematics, and he has received numerous awards for his significant contributions to minority education and his public service. He formerly served on the National Board of Directors of the Society for Advancement of Chicanos and Native Americans in Sciences, and he is a member of the National Academy of Engineering. Dr. Tapia earned his Ph.D. from the University of California, Los Angeles.

Editorial from page 2

room. After considerable effort, he makes a fire by rubbing the two sticks together. Then they give him a pile of dry leaves and a burning torch. He promptly blows out the torch and breaks it in two over his knee, thereby reducing the problem to one that has already been solved."

This not-quite-a-knee-slapper depends on moving mathematical thinking (altering new problems so they resemble solved problems is standard operating procedure) into the real world. Mathematicians don't do this, so it's funny to say that they do.

Or maybe not so funny if it leads you to ridicule math and those who like it.

So those of you who brag about not being able to balance your checkbook, stop nodding your head over the Kaczynski saga and saying, "I knew I was right to drop out of that Algebra for Humanities Majors class."

Participating in the long intellectual search for the patterns of the universe is one of the great joys of being human. It's a shame to let a possibly dangerous loner deprive you of it.

Sliffe from page 22

certificate, a one-year membership in the National Council of Teachers of Mathematics, or in the MAA a Sliffe lapel pin, and national recognition.

To further recognize these outstanding teachers, the names of the 1995–96 AHSME winners are given below.

1996 AHSME Edyth May Sliffe Award Winners

Public Schools

William Bisset, University of Toronto Schools, Toronto, Ontario, Canada

Dot Doyle, North Carolina School of Science & Mathematics, Durham, NC

Paul Guyer, Lyons Township High School, La Grange, IL

Diana Lossner, Alan C. Pope High School, Marietta, GA

Warren Manhard, Newton South High School, Newton Center, MA

Barbara Martin, Woburn Collegiate Institute, Scarborough, Ontario, Canada

Mike McBride, Radnor High School, Radnor, PA

James Meier, J. P. Taravella High School, Coral Springs, FL

Suzanne Moll, Emmaus High School, Emmaus, PA

Steffi Nathan, Earl Haig Secondary School, North York, Ontario, Canada

Jim Parker, St. Charles High School, St. Charles, IL

George Simcoe, Lisgar Collegiate Institute, Ottawa, Ontario, Canada

Annabelle Treacy, Flintridge Preparatory School, La Canada, CA

Steve Wilson, Hinsdale Township Central High School, Hinsdale, IL

Kay Yamane, Palos Verdes Peninsula High School, Rolling Hills Estates, CA

Patricia Zeran, Nova High School, Fort Lauderdale, FL

Private Schools

Donald Barry, Phillips Academy, Andover, MA

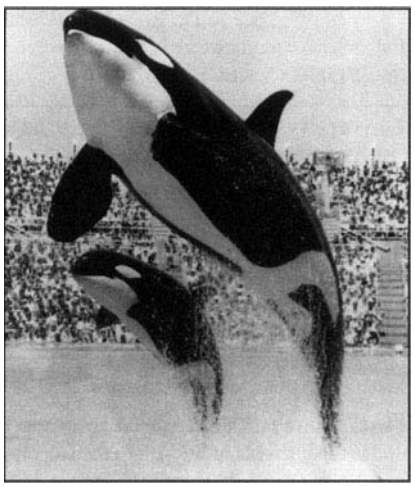
ZuMing Feng, Phillips Exeter Academy, Exeter, NH

Christine Langley, Detroit Country Day School, Beverly Hills, MI

Steve Sigur, The Paideia School, Atlanta, GA

MAA Governor Honored

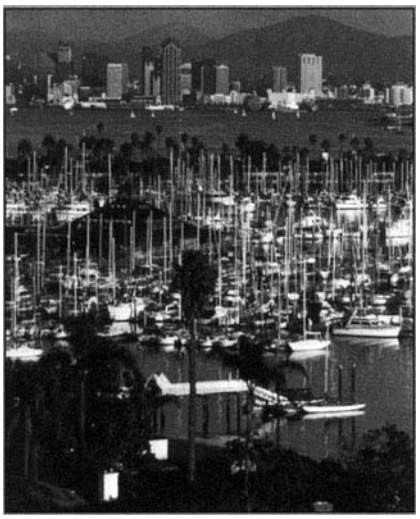
MAA Governor Genevieve Knight of Coppin State College has been named Wilson H. Elkins Professor for the 1996–97 academic year. This is a University of Maryland system-wide award and is regarded as a great honor. Professor Knight won the MAA Section Teaching Award from the MD–DC–VA Section in 1993.



Don't miss the Joint Mathematics Meetings

San Diego, California
January 8–11, 1997

Details on page 3



James Blank/San Diego Convention & Visitors Bureau

NATIONAL RESEARCH COUNCIL TEACHING/ RESEARCH POSTDOCTORAL AWARDS IN MATHEMATICAL SCIENCES AT THE UNITED STATES MILITARY ACADEMY

The United States Military academy (USMA) and the Army Research Laboratories (ARL) invite applications for postdoctoral teaching and research associateship awards to be administered by the National Research Council (NRC). Applicants who are considered by USMA as qualified for teaching appointments in mathematical sciences will be invited to choose a research project and develop a proposal based on NRC approved research opportunities at ARL. Awards will be for 3 years and include part-time research during the academic year and full-time research in the summers. The teaching requirement at West Point includes two sections per semester of undergraduate mathematics courses (calculus, differential equations, probability and statistics, linear algebra, etc.). The awards to begin July 1, 1997, include a beginning annual stipend of $40,000, reimbursement for initial relocation to West Point, an allowance for professional travel and subsidized health insurance. Applicants must be U.S. citizens and have earned a Ph.D. in mathematical sciences within the 5 year period preceding July 1, 1997. Applicants should send a curriculum vitae, transcripts, a statement of teaching philosophy and career goals, and 3 letters of recommendation by November 1, 1996 to:

Department of Mathematical Sciences
ATTN: Personnel Officer
United States Military Academy
West Point, New York 10996-1786

Employment Opportunities

Rates for FOCUS Employment Advertisements are **$95.00** per column inch (one inch minimum), billed to the nearest 1/2 inch.

All advertisements are set with a one-line headline, centered, boldface, consisting of the institution name, unless additional headline information is provided.

All invoices include a tear sheet. Advertising Copy Deadlines: The first of the month, two months prior to publication. FOCUS is published in February, April, June, August, October, and December.

Advertisers should contact: Joseph Watson, The Mathematical Association of America, 1529 18th St., NW, Washington, DC 20036; (202) 387-5200; fax: (202) 265-2384; e-mail: jwatson@maa.org

Continuing Position
Department of Mathematics
Southern Illinois University at Carbondale
Carbondale, Illinois 62901

Applications are invited from qualified candidates for a tenure track position at the assistant professor level beginning on August 16, 1997. Ph.D. in mathematics required at the time of application. Preference will be given to applicants in the areas of algebra, combinatorics, ordinary or partial differential equations, probability and stochastic analysis. Candidates must have demonstrated excellence in research. All applicants must provide evidence of excellence in teaching and evidence of the ability to teach in English effectively. Send letter of application, resume and three letters of recommendation to:

Continuing Position
c/o Ronald B. Kirk, Chair
Department of Mathematics
Southern Illinois University at Carbondale
Carbondale, Illinois 62901

The closing date is October 15, 1996 or until the position is filled. SIUC is an equal opportunity/ affirmative action employer. Women and minorities are particularly encouraged to apply.

San Francisco State University Chair, Department of Mathematics

San Francisco State University invites applications for the position of Chair, Department of Mathematics. Included in the College of Science and Engineering, the Department has 23 full time tenure-track faculty. We offer Bachelor's degrees in Mathematics, Applied Mathematics, and Statistics, a Master's in Mathematics, provide mathematics components for many other majors, and support the University's general education and teacher preparation programs. Faculty research and development projects include work in pure and applied mathematics and statistics, mathematics education, and software engineering. We seek a leader to strengthen ties with other disciplines and our community, and to promote and facilitate faculty scholarship and professional development.

The successful candidate should qualify for appointment as full professor with tenure. He or she should demonstrate these qualifications: a Ph.D. in a mathematical science, and a continuing record of teaching, research, and program development and organization; leadership, compassion for students and faculty, and good interpersonal skills; and the ability to communicate effectively with scientific, industrial, and urban educational communities. Salary will reflect qualifications and experience.

We are a comprehensive urban university with about 20,000 FTE students, whose average age is 25. This Pacific Rim city is the center of major academic, commercial, and high-tech industry activity. Through its Advisory Board, the College is pursuing closer ties with local industry. The interests, aspirations, and diversity of our students reflect San Francisco's uniquely dynamic multi-culturalism. As an Affirmative Action/Equal Opportunity employer, we encourage and expect qualified applicants from all segments of our society.

Applications must include a complete vita, a brief statement of academic leadership philosophy, and names and addresses of or letters from 4 references. They should arrive by 15 November 1996 to receive full consideration. Address: Mathematics Chair Search Committee, Dean's Office, College of Science and Engineering, San Francisco State University, 1600 Holloway Avenue, San Francisco, CA 94132.

Virginia State University

Virginia State University is seeking applicants for the position of *Assistant/Associate Professor, #FO036, Mathematics. The successful candidate teaches a minimum of 12–15 semester hours of primarily undergraduate courses in computer science and mathematics (or as designated by department chairperson). Serves on departmental/university committees and as academic student advisor. Possible summer teaching. Qualifications are: Demonstrated teaching experience at a comparable level. Evidence of scholarly achievement; commitment to excellence in teaching, competence and interest in research and publication desired. Ph.D. in Computer Science or Mathematics preferred. Candidates from all areas of Mathematics and Computer Science will be considered with a minimum requirement of M.S. degree in Computer Science. Salary: Commensurate with education and experience. Interested persons should submit a letter of interest, resume/vita, unofficial transcripts, and three (3) letters of reference to Virginia State University, Office of Human Resources, Box 9412, Room 104, Virginia Hall, Petersburg, Virginia 23806. Applications will be accepted until position is filled. Additional documentation, including a Commonwealth of Virginia Application for Employment and official transcripts will be required prior to employment.

* CONSIDERATION FOR PLACEMENT AT A HIGHER ACADEMIC RANK WILL BE GIVEN TO PERSONS WITH MORE TEACHING/RESEARCH EXPERIENCE. VIRGINIA STATE UNIVERSITY IS AN EQUAL OPPORTUNITY EMPLOYER.

BARD COLLEGE

Assistant (or Associate) Professor of Mathematics — The Division of Natural Sciences and Mathematics invites applications for a full time, tenure track position starting Fall 1997 (possibly earlier). The areas of analysis, differential equations, dynamic systems, numerical analysis, and probability are of particular interest but highly qualified candidates from all areas will be considered. The position requires a Ph.D. in Mathematics, demonstrated excellence in teaching (including the ability to mentor undergraduates in senior projects), and an ongoing program of scholarly activity. Bard is a prestigious liberal arts college located in the Hudson Valley in upstate New York, approximately two hours north of NYC. Applicants should submit a letter of application expressing professional goals, curriculum vitae, and three letters of recommendation to: Professor Mark D. Halsey, c/o Office of Human Resources, Bard College, Annandale-on-Hudson, NY 12504. Application deadline is January 1, 1997. Bard College is an equal opportunity/affirmative action employer. Women and minority candidates are especially encouraged to apply.

Mathematics Department Southern Connecticut State University 501 Crescent Street New Haven, CT 06515

Tenure track position at Assistant Professor rank beginning 8/27/97 to teach undergraduate/graduate courses in Mathematics Education and mathematics, and supervise secondary school student teachers. Teaching load: 12 hours/sem. Salary range: $36,000 to $52,000. Qualifications: doctorate in mathematics education with a strong mathematics background or doctorate with substantially equivalent credentials; evidence of quality teaching experience preferred. Send letter of application, vita, transcripts (unofficial ok), three letters of reference to Dr. Robert M. Washburn. Full consideration given to applications received by 12/15/96. (AA/EOE)

University of Illinois at Chicago, Dept. of Mathematics, Statistics, and Computer Science

The Department has active research programs in all areas of pure mathematics, computational and applied mathematics, combinatorics and computer science, statistics, and mathematics education. See http://www.math.uic.edu for more information. Applications are invited for the following positions, effective August 21, 1997.

First, tenure track or tenured positions. Candidates in all areas of interest to the Department will be considered. The positions are initially budgeted at the Assistant Professor level, but candidates with a sufficiently outstanding research record may be considered at higher levels. Applicants must have a Ph.D. or equivalent degree in mathematics or a related field, an outstanding research record, and evidence of strong teaching ability. Salary negotiable.

Second, a Research Assistant Professorship. This is a non-tenure track position normally renewable annually to a maximum of three years. The position carries a teaching load of one course per semester, with the requirement that the incumbent play a significant role in the research life of the Department. The salary for AY 97-98 for this position is expected to be $40,000. Applicants must have a Ph.D. or equivalent degree in mathematics, computer science, statistics, mathematics education or related field, and evidence of outstanding research potential.

Send vita and direct 3 letters of recommendation, indicating the position being applied for, to Henri Gillet, Head; Dept. of Mathematics, Statistics, and Computer Science; University of Illinois at Chicago; 851 S. Morgan (M/C 249); Chicago, IL 60607. To ensure full consideration, materials must be received by November 22, 1997. Minorities, persons with disabilities, and women are particularly encouraged to apply. UIC is an AA/EEO employer.

Three Year Lecturer Positions Department of Mathematics University of Arizona Tucson, Arizona

The Department of Mathematics at the University of Arizona has openings for three year, non-tenure track teaching positions of professional training. These positions are similar to post doctorate positions in research except here the emphasis is on teaching and scholarly activities pertaining to teaching. These positions are intended primarily for individuals with a career track in teaching. Documentation of interest and accomplishments that show evidence or potential of providing quality instruction and creativity in the classroom will be the primary consideration used in offering these lectureships.

Applicants must have a minimum of a masters degree in mathematics/mathematics education with two years teaching experience, or preferred is a Ph.D. in mathematics/mathematics education. Teaching duties include most lower division courses from college algebra to differential equations. These positions offer excellent opportunities for individuals to work with other faculty members in an innovative learning environment. Lecturers enjoy all the benefits and privileges that are available to other University employees.

We encourage early application. Review of applications begins November 15, 1996. Correspondence regarding job description, qualifications and application procedures should be sent to:

Entry Level Teaching Positions
Department of Mathematics
University of Arizona
Tucson, Arizona 85721, USA

The University of Arizona is an Affirmative Action/Equal Opportunity/ADA Employer.

Pepperdine University

Pepperdine University invites applications for a possible tenure-track position in mathematics at the rank of assistant professor. In exceptional cases, a more advanced rank may be considered. A Ph.D. in mathematics is required, as is strong promise in teaching and research. Although the area of research specialization is open, the ability to teach statistics or to assist in the initiation of an undergraduate research program will be viewed favorably. Responsibilities include effective teaching, conducting original research, and performing service activities in a 2:1:1 ratio. The teaching load is three courses (typically 4 units per course) in each of the fall and spring semesters.

Pepperdine University is located in the picturesque Santa Monica Mountains overlooking the Pacific Ocean. The Natural Science Division—one of the seven academic divisions in Seaver College of Letters, Arts, and Sciences—includes biology, chemistry, computer science, mathematics, nutritional science, physics, and sports medicine, and currently employs four full-time mathematicians. Committed to the encouragement of Christian faith and values among faculty and students, Pepperdine is an independent Christian university religiously affiliated with the Churches of Christ. The governing authority is vested in a self-perpetuating Board of Regents. Pepperdine gives preference to candidates whose faith and religious commitment are consistent with the denominational affiliation of the university. Pepperdine is an equal opportunity employer. Women and minorities are encouraged to apply.

To apply for the position, please send the following materials ONLY: cover letter, vita, and names and addresses of three references. Applicants are encouraged to include in their cover letter a statement addressing their appropriateness for the position in light of the mission of the university, which may be accessed on the world-wide web at "http://www.pepperdine.edu/mission.htm". Please send materials to Dr Randy Maddox, Natural Science Division, Pepperdine University, 24255 Pacific Coast Hwy, Malibu, CA 90263. Applications received by December 1 will receive full consideration.

Hope College

Hope College Department of Mathematics invites applications for a tenure-track position at the assistant professor level beginning Fall 1997. The ideal candidate will possess a PhD in mathematics by the time of appointment, research potential (including potential for research with undergraduates), and a record of teaching ability.

Hope College is a selective liberal arts college with a student body of 2900. The college is affiliated with the Reformed Church in America and seeks candidates who are committed to a liberal arts education within the context of the Christian faith. Each of the 9 full-time faculty members teaches 3 courses per semester. (See http://www.hope.edu).

A complete application includes a vita, a statement of teaching philosophy, and three letters of recommendation, at least one of which addresses the applicant's teaching ability. Please indicate in your letter whether or not you will be attending the AMS/MAA meetings in San Diego in January. Applications received by December 15, 1996 will be given full consideration. Applications should be sent to Professor Janet Andersen (andersen@math.hope.edu), Department of Mathematics, Hope College, Holland, MI 49422-9000.

Hope College complies with federal and state requirements for non-discrimination in employment. Applications are strongly encouraged from women and persons of color.

Hope College Chairperson

Hope College invites applications for the position of Chairperson of the Department of Mathematics beginning Fall 1997. The ideal candidate will possess: a Ph.D. in mathematics; a strong and consistent research record; a commitment to excellent teaching; a working knowledge of proposal writing; and familiarity with undergraduate mathematics reform.

The responsibilities of the chairperson include: teaching two courses each semester; supervising nine faculty members; leading in scholarly activity including student research; and supervising curriculum development.

Hope College is a selective liberal arts college with a student body of 2900. The college is affiliated with the Reformed Church in America and seeks candidates who are committed to a liberal arts education within the context of the Christian faith. (See http://www.hope.edu.)

A complete application includes a vita, a statement of educational and leadership philosophy, and four letters of recommendation, at least two of which address the applicant's potential and/or background for serving as a department chair. Screening of completed applications will begin on December 15, 1996, and will continue until the position is filled. Applications should be sent to Professor John Van Iwaarden (vaniwaarden@math.hope.edu), Department of Mathematics, Hope College, Holland, MI 49422-9000.

Hope College complies with federal and state requirements for non-discrimination in employment. Applications are strongly encouraged from women and persons of color.

MACON COLLEGE GEORGIA'S NEWEST SENIOR COLLEGE

With a faculty of 125 and an enrollment of 3500, Macon College is located 90 miles south of Atlanta on Interstate 475 in a metropolitan area of more than 250,000. Robins Air Force Base, the State's largest employer is 20 miles from the campus. The College has been a unit of the University System of Georgia since its founding in 1968 and was authorized by the Board of Regents of the University System of Georgia on July 9, 1996, to become a senior college and begin developing initial baccalaureate programs.

Chair of Division of Natural Sciences and Mathematics.

Responsibilities: To give leadership to thirty faculty in biology, chemistry, physics, mathematics, engineering, and engineering technology and to administer 17 transfer associates degrees. **Qualifications:** An earned doctorate, teaching experience, and leadership ability. **Salary:** Commensurate with education and experience and includes all benefits of the University System of Georgia. Starting Date: Negotiable - preferably April 1, 1997, but no later than July 1. **Application:** Application should be completed by December 31, 1996. A completed application consists of a letter of application, Macon College Bio-Data Sheet, three letters of recommendation, and official transcripts. **Apply to:** Dr. Robert T. Trammell, Vice President of Academic Affairs and Dean of the Faculty, Macon College,100 College Station Drive, Macon, GA 31297; FAX: (912) 471-2846; e-mail: rtrammel@cennet.mc.peachnet.edu

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Calendar

National MAA Meetings

January 8–11, 1997 Eightieth Annual Meeting, San Diego, CA. Board of Governors Meeting January 7, 1997

January 7–10, 1998 Eighty–first Annual Meeting, Baltimore, MD. Board of Governors Meeting January 6, 1998

Sectional MAA Meetings

ALLEGHENY MOUNTAIN April 4–5, 1997, Westminster College, New Wilmington, PA

–April 1998, Clarion University of Pennsylvania, Clarion, PA

EASTERN PA & DELAWARE – October 26, 1996, Delaware State University, Dover, DE

FLORIDA – Feb 28–March 1, 1997, Florida State University, Tallahassee, FL

INDIANA – October 26, 1996, Rose–Hulman Institute of Technology, Terre Haute, IN

–March 14–15, 1997, Franklin College, Franklin, IN

–October 18, 1997, Wabash College, Crawfordsville, IN

INTERMOUNTAIN – April 4–5, 1997, Utah State University, Logan, UT

IOWA – April 1997, Iowa State University, Ames, IA

KANSAS – April 1997, Pittsburg State University, Pittsburg, KS

KENTUCKY – March 28–29, 1997, Western Kentucky University, Bowling Green KY

LOUISIANA–MISSISSIPPI – Feb 28–March 1, 1997, Millsaps College, Jackson, MS

- March 6–7, 1998, University of New Orleans, LA

MD–DC–VA – November 1–2, 1996, Hood College, Frederick, MD

- April 18–19, 1997, William & Mary, Williamsburg, VA

METRO. NEW YORK – May 3, 1997, Mercy College, Dobbs Ferry, NY

MISSOURI – April 11–12, 1997, Missouri Western State College, St. Joseph, MO

- Spring 1998, Southwest Missouri State University, Springfield, MO

NEBRASKA–SOUTHEAST SOUTH DAKOTA – April 18–19, 1997, Wayne State College, Wayne, NE

NEW JERSEY – November 9, 1996, Lucent Technologies, Murray Hill, NJ

- April 1997, Middlesex County College

NORTH CENTRAL – October 18–19, 1996, University of Minnesota, Duluth

- April, 1997, Mankato State University, Mankato, MN

NORTHEASTERN – November 22–23, 1996, Univ. of Massachusetts–Boston, Boston, MA

NORTHERN CALIFORNIA – Feb 22, 1997, Univ of San Francisco, CA

SOUTHERN CALIFORNIA – October 19, 1996, California State University, Fullerton, CA

- March 8, 1997, Occidental College, Los Angeles, CA

OHIO – October 25–26, 1996, Denison University, Granville, OH

OKLAHOMA–ARKANSAS – April 4–5, 1997, University of Central Oklahoma, Edmond, OK

- March 27–28, 1998, University of Arkansas–Little Rock, AR

- Spring 1999, Southern Nazarene University, Bethany OK

PACIFIC NORTHWEST – June 19–21, 1997, Western Washington University, Bellingham, WA

SOUTHEASTERN – March 13–15, 1997, Georgia Institute of Tech/Spelman College, Atlanta, GA

- March 13–14, 1998, College of Charleston, SC

SOUTHWESTERN – April 1997, New Mexico

- Spring 1998, Southern Methodist University, Dallas, TX

SEAWAY – November 8–9, 1996, SUNY College at Geneseo, Geneseo, NY

- April 18–19, 1997, Broome Community College, Binghamton, NY

- November, 1997, Siena College, Albany, NY

TEXAS – April 3–5, 1997, Texas Lutheran College, Sequin, TX

- Spring 1998, Southern Methodist University, Dallas, TX

- Spring 1999, Southwest Texas State University, San Marcos, TX

WISCONSIN – April 11–12, 1997, University of Wisconsin–River Falls, River Falls, WI

- April 17–18, 1998, University of Wisconsin–Stevens Point, Stevens Point, WI

Other Meetings

November 14–17, 1996 22nd Annual American Mathematical Association of Two-Year Colleges (AMATYC) Conference, Long Beach, CA. Keynote speakers: Glenda Lappin and Wade Ellis, Jr. Contact AMATYC office; (901) 383-4643; e-mail: amatyc@stim.tec.tn.us.

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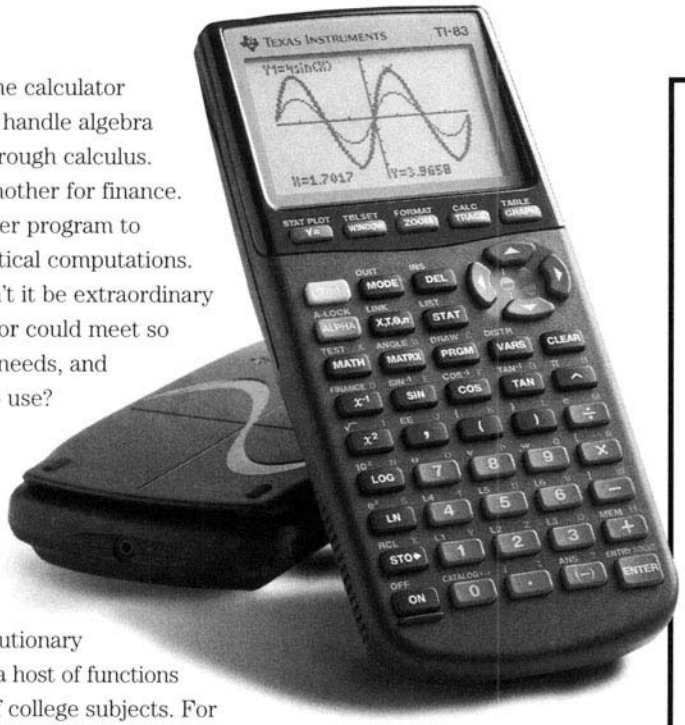

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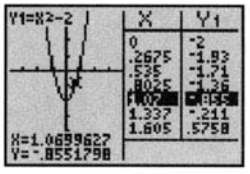

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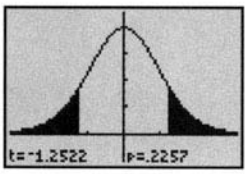

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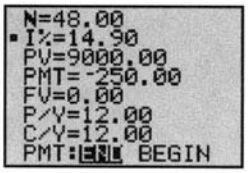

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