FOCUS

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In this Issue

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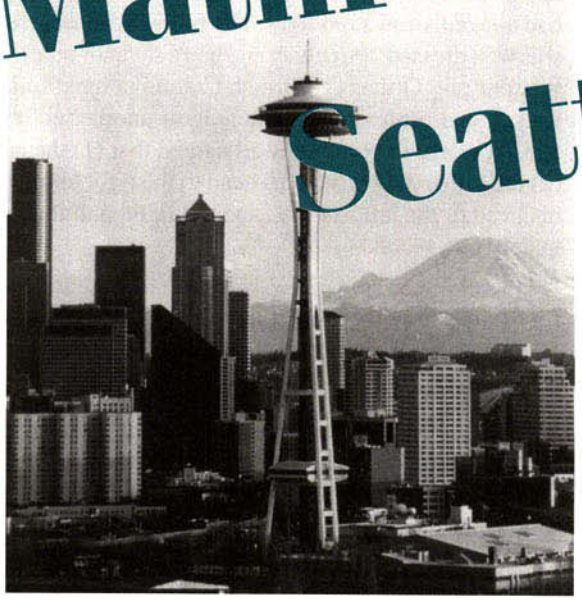
MathFest 1996 Seattle



Seattle
Mathfest 1996

University of Washington August 9–12, 1996

MATHEMATICS AWARENESS WEEK 1996, APRIL 21–27
NOTE THE DATE. TAKE PART. SEE PAGE 21

FOCUS

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Editorial

Court Without a Calculator

My editorial in the December issue of FOCUS, "The Myth of Scientific Literacy," *brought the following response from a reader.* FOCUS *does not have a 'proof without words' section, but with this letter, we come very close to an 'editorial without the editor's words.' Enjoy.*

–Keith Devlin

Dear Keith,

Another nice editorial! Your article brought to mind a funny story in connection with the matter of remembering the last time one did, say, nontrivial long division, or etc. Not long ago, I spent an entire afternoon in court, where I observed a case involving someone who had allegedly run a red light. The fellow who was defending himself against this charge was well dressed, articulate, and had a sheaf of notes. The officer who had given the ticket was present. Officers in British Columbia have college education; the officer was well spoken and professional. The judge—another college-educated, distinguished personage. At a certain point, they all agreed that (1) the car was moving 50 km per hour, and (2) the officer had turned his head to the right to see the car coming, and then had turned his head to the left to notice the red light, and that turning his head had taken approximately one second.

All three were in agreement that answering the following question was crucial to the case for the appeal of the violation (worth $200 to one of them): "How far does a car moving 50 km per hour travel in one second?"

At this point, I had the paranoid feeling that the fates had set me up to witness this true-life drama of genuine junior high school arithmetic; that somehow my being there, the only person in the courtroom besides the judge, the gentleman, the officer, and the court recorder, was cosmic in some way. I was then witness to the most marvelous spectacle.

The eloquent gentleman: "I don't have this worked out. Surely the court has a calculator?"

The judge: "The court does not have a calculator. This is not the business of the court. If this is pertinent to your defense then perhaps you should have prepared a bit more."

The gentleman: "It would only take a second. I'd like to ask if the officer has a calculator."

The officer: "No, I don't have a calculator."

The gentleman: "It seems preposterous to me that the court doesn't have a simple calculator."

The judge: "It is incumbent upon the defendant to supply a calculator if a calculator is needed for the defense."

After several go-rounds like this, they basically all agreed that under these circumstances the question was completely inscrutable. There was no attempt on anyone's part to estimate, or multiply and divide, none whatsoever, not even a suggestion in these directions. They seemed to have no idea whether the answer would be 10 m or 100 m.

I'm very much in agreement with the ideas expressed in your editorial. None of them even thought to ask whether there was a mathematician in the courtroom!

Best regards,

Mike Fellows
Department of Computer Science, University of Victoria
Victoria, British Columbia, Canada

Editor's note: The December editorial argued that in the case of college level education for non-science majors, science awareness is a more realistic goal than scientific competence. Fellows' final comment seems to address that issue.

MathFest 1996

Seattle Celebrates Mathematics!

Reserve August 10–12 for MathFest 1996! Whether you're a professional or student you'll want to join your colleagues at this joint AMS–MAA conference. The schedule is packed with activities appealing to a variety of interests– from a *keynote address* by **U.S. Secretary of Defense William J. Perry** (a Ph.D. in Mathematics) to a *contributed paper session* on "Reformed Calculus in Performance." Sessions on advanced topics, programs specially designed for students, social events, and special Seattle area tours will keep every attendee's schedule full.

Choose from over 14 invited addresses, 6 MAA Minicourses, and over 40 contributed paper sessions, scientific sessions, and special symposiums and workshops. And you'll want to devote any spare moments viewing the new publications and products in the Book Sales and Exhibits area. Make your time at **MathFest 1996** as rewarding as possible by planning your schedule today.

Review the in-depth descriptions of the MathFest 1996 activities in the following pages. Register by using the forms on page 14. We look forward to celebrating mathematics with you in Seattle.

AMS–MAA Invited Addresses

William J. Perry, Secretary of Defense, has been invited to give the keynote address on Saturday evening at 8:30 P.M. Secretary Perry has a Ph.D. in Mathematics and has been a professor of engineering at Stanford.

Alan C. Tucker, SUNY Stony Brook, *Title to be announced*, Saturday, 8:30 A.M.

Colin C. Adams and **Edward B. Burger**, Williams College, *Casting about: About casting*, Saturday, 10:40 A.M. This one-act play presents serious mathematical results in topology in an unusual and often humorous manner.

Robert Moses, The Algebra Project, *Title to be announced*, Sunday, 8:30 A.M.

Joel Hass, University of California at Davis, *The double bubble conjecture*, Sunday, 10:40 A.M. Moderator Frank Morgan, Williams College, and panelists Jenny Kelley, Rutgers University, Helen E. Moore, Bowdoin College, and Jean E. Taylor, Rutgers University, will add their "two cents worth" after Hass speaks.

Sylvain E. Cappell, Courant Institute, New York University, *New geometrical approaches to comparing discrete summation and integration*, Monday, 8:30 A.M.

Gian-Carlo Rota, Massachusetts Institute of Technology, *The many lives of binomial coefficients*, Monday, 10:40 A.M.

The beautiful campus of the University of Washington is the site for the 1996 MathFest.

Special Addresses

Richard A. Askey, University of Wisconsin, Madison, **MAA Earle Raymond Hedrick Lectures** *The binomial theorem and some extensions.* Lecture 1: *Some of the history of the binomial theorem and its extensions*; Lecture 2: *Refined counting and a noncommutative version of the binomial theorem*; Lecture 3: *Integral analogues of the binomial theorem, orthogonal polynomials and education.* Saturday, Sunday, and Monday, 9:35 A.M.

Atle Selberg, Institute for Advanced Study, **MAA-American Institute of Mathematics Lecture,** *The History of the Prime Number Theorem,* Monday, 5:00 P.M.

Deborah Hughes Hallett, Harvard University, and **Daniel Kennedy**, Baylor School (Chattanooga), **MAA-Mu Alpha Theta Lecture**, *The role of secondary schools in calculus reform*, Saturday, 3:05 P.M.

Johnny L. Houston, Elizabeth City State University, **National Association for Mathematicians David Blackwell Lecture**, *An update on the no-three-in-line-problem*, Sunday, 3:05 P.M.

J. Kevin Colligan, National Security Agency, **Pi Mu Epsilon J. Sutherland Frame Lecture**, *Nets, sieves, and money: Number theory's rubber hits the I-way road*, Sunday, 8:30 P.M.

Karen E. Smith, Massachusetts Institute of Technology, **Association for Women in Mathematics Lecture**, *Title to be announced*, Monday, 3:05 P.M.

Kenneth A. Ross, University of Oregon, **MAA Student Lecture**, *The mathematics of card shuffling*, Monday, 4:00 P.M.

The 1996 Seattle MathFest Timetable

Friday, August 9

9:00 A.M.– 5:00 P.M.	MAA BOARD OF GOVERNORS
12:00 P.M.– 4:00 P.M.	JOINT MEETINGS REGISTRATION
1:00 P.M.– 6:30 P.M.	AMS COUNCIL
3:00 P.M.– 6:00 P.M.	AMS COMMITTEE ON THE PROFESSION PRESENTATION Preparing ourselves and our students for careers in mathematics.
4:00 P.M.– 6:00 P.M.	MAA SECTION OFFICERS
5:30 P.M.– 6:30 P.M.	MAA-PME STUDENT RECEPTION
6:30 P.M.– 10:00 P.M.	RECEPTION AND OPENING BANQUET/PRIZES

Saturday, August 10

8:00 A.M.– 4:00 P.M.	JOINT MEETINGS REGISTRATION
8:30 A.M.– 9:20 A.M.	AMS–MAA INVITED ADDRESS Title to be announced. Alan Tucker
9:00 A.M.– 5:00 P.M.	EXHIBITS AND BOOK SALES
9:00 A.M.– 5:00 P.M.	MAA STUDENT HOSPITALITY CENTER
9:00 A.M.– 12:00 P.M.	OPTIONAL TOUR: SEATTLE CITY HIGHLIGHTS
9:35 A.M.– 10:30 A.M.	EARLE RAYMOND HEDRICK LECTURES: LECTURE I Some of the history of the binomial theorem and its extensions. Richard Askey
10:40 A.M.– 11:30 A.M.	AMS–MAA INVITED ADDRESS Casting about: About casting. Colin C. Adams and Edward B. Berger
11:40 A.M.– 12:10 P.M.	AMS BUSINESS MEETING
12:15 P.M.– 12:45 P.M.	AMS–MAA RESEARCH SESSION ON COMMUTATIVE ALGEBRA SPECIAL ADDRESS
12:15 P.M.– 2:50 P.M.	PME COUNCIL
1:00 P.M.– 2:50 P.M.	MAA MINICOURSE #1: PART A Low cost visualization training for multivariable calculus: Drawing.
1:00 P.M.– 2:50 P.M.	MAA MINICOURSE #2: PART A Computability and computational complexity: What is this all about?
1:00 P.M.– 2:50 P.M.	AMS–MAA SESSION ON A TOUR THROUGH APPLICATIONS TO THE SOCIAL SCIENCES, I
1:00 P.M.– 2:30 P.M.	AMS–MAA SESSION ON INTEGRATING CALCULUS AND PHYSICS COURSES: THREE CASE STUDIES
1:00 P.M.– 1:30 P.M.	AMS–MAA–SIAM FRANK AND BRENNIE MORGAN PRIZE FOR OUTSTANDING RESEARCH IN MATHEMATICS BY AN UNDERGRADUATE STUDENT LECTURE Title to be announced. Kannan Soundararajan
1:30 P.M.– 2:30 P.M.	AMS–MAA–SIAM FRANK AND BRENNIE MORGAN PRIZE RECEPTION
1:00 P.M.– 2:55 P.M.	AMS–MAA GRADUATE STUDENT SESSIONS
1:00 P.M.– 2:50 P.M.	MAA CONTRIBUTED PAPER SESSIONS
3:00 P.M.– 4:00 P.M.	AMS COMMITTEE ON MEETINGS AND CONFERENCES DISCUSSION What makes a good talk?
3:05 P.M.– 3:50 P.M.	MAA–MU ALPHA THETA LECTURE The role of secondary schools in calculus reform. Deborah Hughes Hallett and Daniel Kennedy
4:00 P.M.– 5:50 P.M.	MAA MINICOURSE #3: PART A Technology, modeling, cooperative learning: Putting it all together.
4:00 P.M.– 5:50 P.M.	MAA MINICOURSE #4: PART A How to test mathematics taught using graphing calculators.
4:00 P.M.– 5:50 P.M.	MAA CONTRIBUTED PAPER SESSIONS
4:00 P.M.– 5:50 P.M.	MAA STUDENT PAPERS

4:00 P.M.– 5:50 P.M. PME CONTRIBUTED PAPER SESSIONS

4:00 P.M.– 5:50 P.M. MAA COMMITTEE ON THE PARTICIPATION OF WOMEN PANEL DISCUSSION Women and mathematics: Case studies of intervention programs.

4:00 P.M.– 5:50 P.M. AMS–MAA PRESENTATION The research mathematician as an educator: How do we use the mathematics that we create to motivate students? Part I

4:00 P.M.– 5:40 P.M. AMS COMMITTEE ON EDUCATION PANEL DISCUSSION How can you defend your graduate program in mathematics?

4:10 P.M.– 5:45 P.M. AMS–MAA RESEARCH SESSION ON COMMUTATIVE ALGEBRA, I

6:00 P.M.– 8:00 P.M. LUAU

8:30 P.M.– 9:30 P.M. AMS–MAA INVITED ADDRESS Title to be announced. William J. Perry

9:30 P.M.– 11:00 P.M. SPECIAL RECEPTION

SUNDAY, AUGUST 11

7:00 A.M.– 8:20 A.M. BREAKFAST FOR MAA STUDENT CHAPTER FACULTY ADVISORS, SECTION COORDINATORS, AND PME ADVISORS

8:00 A.M.– 4:00 P.M. JOINT MEETINGS REGISTRATION

8:30 A.M.– 9:20 A.M. AMS–MAA INVITED ADDRESS Title to be announced. Robert Moses

9:00 A.M.– 5:00 P.M. EXHIBITS AND BOOK SALES

9:00 A.M.– 5:00 P.M. MAA STUDENT HOSPITALITY CENTER

9:35 A.M.– 10:25 A.M. EARLE RAYMOND HEDRICK LECTURES: LECTURE II Refined counting and a noncommutative version of the binomial theorem. Richard Askey

10:00 A.M.– 1:00 P.M. OPTIONAL TOUR: CRUISE THE LOCKS AND SEATTLE HARBOR

10:40 A.M.– 11:45 A.M. AMS–MAA INVITED ADDRESS The double bubble conjecture. Joel Hass

12:15 P.M.– 12:45 P.M. AMS–MAA RESEARCH SESSION ON COMMUTATIVE ALGBEBRA SPECIAL ADDRESS, II

1:00 P.M.– 2:50 P.M. MAA MINICOURSE #5: PART A Dynamic geometry lab with Sketchpad.

1:00 P.M.– 2:50 P.M. MAA MINICOURSE #6: PART A Projects for precalculus.

1:00 P.M.– 2:50 P.M. AMS–MAA SESSION ON A TOUR THROUGH APPLICATIONS TO THE SOCIAL SCIENCES, II

1:00 P.M.– 2:55 P.M. AMS–MAA GRADUATE STUDENT SESSIONS

1:00 P.M.– 2:50 P.M. MAA CONTRIBUTED PAPER SESSIONS

1:00 P.M.– 2:50 P.M. MAA STUDENT PAPERS

1:00 P.M.– 2:50 P.M. PME CONTRIBUTED PAPER SESSIONS

2:00 P.M.– 2:50 P.M. AMS–MAA SESSION ON MATHEMATICS AS PERFORMANCE ART, PART I How NOT to excite people about mathematics: A live demonstration.

3:05 P.M.– 3:50 P.M. NAM DAVID BLACKWELL LECTURE An Update on the no-three-in-line problem,Johnny L. Houston .

4:00 P.M.– 5:00 P.M. MAA MINICOURSE #1: PART B Lowcost visualizatin training for multivariable calculus: Drawing.

4:00 P.M.– 5:50 P.M. MAA MINICOURSE #2: PART B Computability and computational complexity: What is this all about?

4:00 P.M.– 5:00 P.M. AMS PRESENTATION e-MATH and the World Wide Web.

4:00 P.M.– 6:50 P.M. AMS–MAA RESEARCH SESSION ON COMMUTATIVE ALGEBRA, II

4:00 P.M.– 5:50 P.M. MAA CONTRIBUTED PAPER SESSIONS

4:00 P.M.– 5:00 P.M. MAA STUDENT PAPERS

4:00 P.M.– 5:00 P.M. PME CONTRIBUTED PAPER SESSIONS

4:00 P.M.– 5:50 P.M. MAA CUPM PANEL DISCUSSION Promoting interdisciplinary activities: Mathematics across the curriculum.

4:00 P.M.– 5:50 P.M. AMS–MAA PRESENTATION The research mathematician as an educator: How do we use the mathematics that

we create to motivate students?, Part II

5:00 P.M.– 5:50 P.M. AMS–MAA SESSION ON MATHEMATICS AS PERFORMANCE ART, PART 2A Discovering the performer in you: An improv teaching workshop

6:30 P.M.– 8:15 P.M. PME BANQUET

8:30 P.M.– 9:30 P.M. PME J. SUTHERLAND FRAME LECTURE Nets, sieves, and money: Number theory's rubber hits the I-way road J. Kevin. Colligan

MONDAY, AUGUST 12

8:00 A.M.– 12:00 P.M. JOINT MEETINGS REGISTRATION

8:30 A.M.– 9:20 A.M. AMS–MAA INVITED ADDRESS New geometrical approaches to comparing discrete summation and integration. Sylvain Cappell

8:30 A.M.– 5:00 P.M. OPTIONAL TOUR: WHIDBEY ISLAND

9:00 A.M.– 5:00 P.M. EXHIBITS AND BOOK SALES

9:00 A.M.– 5:00 P.M. MAA STUDENT HOSPITALITY CENTER

9:35 A.M.– 10:25 A.M. EARLE RAYMOND HEDRICK LECTURES: LECTURE III Integral analogues of the binomial theorem, orthogonal polynomials and education. Richard Askey

10:40 A.M.– 11:30 A.M. AMS–MAA INVITED ADDRESS The many lives of binomial coefficients. Gian-Carlo Rota

11:40 A.M.– 12:10 P.M. MAA BUSINESS MEETING

1:00 P.M.– 2:50 P.M. MAA MINICOURSE #3: PART B Technology, modeling, cooperative learning: Putting it all together.

1:00 P.M.– 2:50 P.M. MAA MINICOURSE #4: PART B How to test mathematics taught using graphing calculators.

1:00 P.M.– 2:50 P.M. AMS–MAA SESSION ON A TOUR THROUGH APPLICATIONS TO THE SOCIAL SCIENCES, III

1:00 P.M.– 2:55 P.M. AMS–MAA GRADUATE STUDENT SESSIONS

1:00 P.M.– 2:50 P.M. MAA CONTRIBUTED PAPER SESSIONS

1:00 P.M.– 2:50 P.M. MAA STUDENT WORKSHOP

1:00 P.M.– 2:50 P.M. AMS–MAA PANEL DISCUSSION Innovations in teaching introductory logic and proof, I.

1:00 P.M.– 1:50 P.M. AMS–MAA PANEL DISCUSSION Providing mathematics over the Internet: What's been done? What's to do?

1:00 P.M.– 1:50 P.M. AMS–MAA SESSION ON MATHEMATICS AS PERFORMANCE ART, PART 2B Discovering the performer in you: An improv teaching workshop.

2:00 P.M.– 2:50 P.M. AMS–MAA POSTER SESSION Providing Mathematics over the Internet: What's been done? What's to do?

3:05 P.M.– 3:50 P.M. AWM INVITED LECTURE Title to be announced. Karen E. Smith

4:00 P.M.– 5:50 P.M. MAA MINICOURSE #5: PART B Dynamic geometry lab with Sketchpad.

4:00 P.M.– 5:50 P.M. MAA MINICOURSE #6: PART B Projects for precalculus.

4:00 P.M.– 6:00 P.M. AMS–MAA RESEARCH SESSION ON COMMUTATIVE ALGEBRA, III

4:00 P.M.– 5:50 P.M. MAA CONTRIBUTED PAPER SESSIONS

4:00 P.M.– 4:50 P.M. MAA STUDENT LECTURE The mathematics of card shuffling, Kenneth A. Ross

4:00 P.M.– 5:00 P.M. AMS–MAA PANEL DISCUSSION What's the focus at DIMACS for 1996–97?

4:00 P.M.– 5:50 P.M. AMS–MAA PANEL DISCUSSION Innovations in teaching introductory logic and proof, II

4:00 P.M.– 5:50 P.M. AMS–MAA PANEL DISCUSSION AND WORKSHOP Multivariable calculus and industrial applications

4:05 P.M.– 6:00 P.M. AMERICAN INSTITUTE OF MATHEMATICS INVITED ADDRESS The history of the prime number theorem. Atle Selberg

6:00 P.M.– 9:30 P.M. MAA RECEPTION AND BANQUET FOR 25-YEAR MEMBERS

7:00 P.M.– 10:00 P.M. AMS–MAA SESSION ON COMPUTATIONS IN COMMUTATIVE ALGEBRA

MAA Contributed Paper Sessions

Innovative Teaching in First-year College Mathematics Courses

Saturday and Sunday afternoons. Howard L. Penn, * Department of Mathematics, 572 Holloway Rd., U.S. Naval Academy, Annapolis, MD 21402-5002; phone: 410-293-6768; fax: 410-293-4883; e-mail: hlp@usna.navy.mil; and Aaron I. Stucker, Washburn University.

Reformed Calculus in Performance: What Works, What to Fix.

Saturday and Sunday afternoons. Walter G. Kelley, * Department of Mathematics, University of Oklahoma, Norman, OK 73019; phone: 405-325-3782; fax: 405-325-7484; e-mail: wkelley@uoknor.edu; and Curtis C. McKnight, University of Oklahoma.

Mathematicians in the K-8 Classroom

Saturday and Monday afternoons. Una M. Bray,* Department of Mathematics and Computer Science, Skidmore College, Saratoga Springs, NY 12866-1632; phone: 518-584-5000 ext. 2246; e-mail: ubray@skidmore.edu; and R. Daniel Hurwit, Department of Mathematics and Computer Science, Skidmore College.

Innovations in Mathematics Courses Beyond Linear Algebra

Saturday and Sunday afternoons. Janet L. Beery,* University of Redlands, Department of Mathematics, 1200 E. Colton Ave., Redlands, California 92373; phone: 909-793-2121; fax: 909-793-2029; e-mail: beery@ultrix.uor.edu; and Steven W. Morics , University of Redlands.

Teaching and Learning Mathematics as a Laboratory Science

Sunday and Monday afternoons. Marcelle Bessman,* Department of Mathematics, Jacksonville University, Jacksonville FL 32211; phone: 904-745-7300; fax: 904-745-7573; e-mail: mbessma@junix.ju.edu; and David A. Smith, Duke University.

The organizers listed above solicit contributed papers pertinent to their sessions; summaries should be directed no later than April 22 to the organizer whose name is followed by an asterisk (*). For additional instructions and complete descriptions see the April *NOTICES* or February FOCUS.

Graduate Student and Research Programs

Commutative Algebra Sessions: Co-organized by Sylvia M. Wiegand, University of Nebraska, and William J. Heinzer, Purdue University. There will be thirty-minute expository lunch talks from 12:15 P.M. to 12:45 P.M. on Saturday and Sunday. Twenty-minute talks will be presented 4:10 P.M.—5:45 P.M. Saturday, 4:00 P.M.-7:00 P.M. Sunday, and 4:00 P.M.—6:00 P.M. Monday.

Sessions By and For Graduate Students: Four areas will be represented: Combinatorics, organized by Andrew J. Radcliffe, University of Nebraska; Commutative Algebra, organized by Roger A. Wiegand, University of Nebraska; Group Representation Theory, organized by Benjamin J. Ford, University of Washington, and George J. McNinch, University of Oregon; and Optimization, organized by Paul Tseng, University of Washington. The sessions will be held 1:00 P.M.-2:55 P.M. Saturday, Sunday, and Monday.

Undergraduate Student Activities

Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student Lecture and Reception: Saturday, 1:00 P.M.-2:30 P.M. The first winner of this award, Kannan Soundararajan, Princeton University, will give a description of his work. There will be a reception in his honor following the talk.

MAA Student Paper Sessions: Saturday, 4:00 P.M.-5:50 P.M., and Sunday, 1:00 P.M.-2:50 P.M. and 4:00 P.M.-5:00 P.M. For information and/or nomination forms, interested students should contact Ronald F. Barnes, Dept. of Computer/Math Sciences, University of Houston-Downtown, 1 Main St., Houston, TX 77002; barnes@dt.uh.edu. Partial travel support is available through a grant from the Exxon Education Foundation. Nominations should include a brief abstract; deadline for receipt is July 5 . A program of MAA student talks will be available at the Registration Desk at the MathFest.

PME Student Paper Sessions: Saturday, 4:00 P.M.-5:50 P.M., and Sunday, 1:00 P.M.-2:50 P.M. and 4:00 P.M.-5:00 P.M. These sessions consist of fifteen-minute talks by student members of Pi Mu Epsilon. Chapter advisors should submit nominations for speakers along with brief abstracts by July 5 to J. Douglas Faires, Dept. of Math, Youngstown State Univ., Youngstown, OH 44555; faires@macs.ysu.edu. Partial travel support for student speakers is available. For further information and/or nomination forms contact Robert M. Woodside, Secretary-Treasurer, Dept. of Math, East Carolina Univ., Greenville, NC 27858. A program of PME student talks will be available at the Registration Desk at the MathFest.

MAA Student Workshop: Monday, 1:00 P.M.-2:50 P.M., "Matrices—Windows to Information and Behavior," David R. Hill, Temple University.

MAA-PME Student Reception: Friday, 5:30 P.M.-6:30 P.M.

MAA Student Hospitality Center: Open Saturday, Sunday, and Monday, 9:00 A.M.-5:00 P.M. The Student Hospitality Center is a place for students to meet informally and enjoy a complimentary refreshment; where packets for students giving talks will be available; and where information on activities of interest for students can be found. Undergraduates can try their hand at some sample GRE problems—and perhaps win a t-shirt—or try solving some of the many mathematical puzzles available.

Breakfast for MAA Student Chapter Advisors, Section Coordinators, and PME Chapter Advisors: Sunday, 7:00-8:30 A.M.

Minicourses and contributed paper sessions provide the opportunity for the open exchange of ideas.

MAA Minicourses

Minicourse #1. Low Cost Visualization Training for Multivariable Calculus: Drawing

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

Part A: Saturday, 1:00-2:50 P.M.
Part B: Sunday, 4:00 P.M.-5:50 P.M.

Enrollment limit: 24; registration fee: $45.

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 will explore one set of such procedures by means of manipulative apparatus and start writing their own "visual" multivariable exercises. The procedures presented are in use at the University of Washington, at Bellevue Community College, and in NSF workshops for college instructors. Participants will receive written materials.

Minicourse #2. Computability and Computational Complexity: What is This All About?

Organized by William A. Marion, Valparaiso University.

Part A: Saturday, 1:00-2:50 P.M.
Part B: Sunday, 4:00-5:50 P.M.

Enrollment limit: 80; registration fee: $45.

NP-complete, Turing machines, algorithm, tractable and intractable problems, the Halting problem—these terms appear frequently in today's mathematical literature. They are part of a coherent body of knowledge, known as the theory of computation. This minicourse will provide the participants with an overview of this theory by addressing the following two questions from the perspective of Turing machines: "What can be computed?" and "What can be computed in a reasonable amount of time?" Examples and proofs will be illustrated, group exercises will be assigned, a software tool will be demonstrated, a list of readings will be provided, and relevance to undergraduate mathematics will be discussed.

Minicourse #3. Technology, Modeling, Cooperative Learning: Putting it All Together

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

Part A: Saturday, 4:00-5:50 P.M.
Part B: Monday, 1:00-2:50 P.M.

Enrollment limit: 40; registration fee: $45.

Participants will experience working in small groups on a variety of investigations. They will simulate a model using inexpensive materials, and then develop corresponding mathematical models in the context of the physical model they have constructed. Finally, the model will be analyzed using both algebraic techniques and technology. Models will include: studying the buildup of drugs in the bloodstream; finding the speed of light through water; and computing the area of "infinite" spirals and fractals. Bring a graphing calculator.

Minicourse #4. How to Test Mathematics Taught Using Graphing Calculators

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

Part A: Saturday, 4:00-5:50 P.M.
Part B: Monday, 1:00-2:50 P.M.

Enrollment limit: 60; registration fee: $45.

Issues related to writing good test items that allow or require the use of technology will be discussed. Content considered will include algebra, trigonometry, calculus, and statistics. Technology considered will include graphing calculators with symbolic manipulation capabilities. Participants will write and critique test questions. Questions discussed and those written by participants will be provided. Participants should bring a graphing calculator.

Seattle's downtown waterfront *(above) offers a colorful array of marine activity, shops, resturants, and recreational opportunities.*
Pike Place Market *(below) is one of the oldest working farmers' markets in the country, offering fresh seafood, produce, and handcrafted art from the Pacific Northwest.*

Minicourse #5. Dynamic Geometry Lab with Sketchpad

Organized by James R. King, University of Washington.

Part A: Sunday, 1:00-2:50 P.M.;
Part B: Monday, 4:00-5:50 P.M.

Enrollment limit: 30; registration fee: $65.

Dynamic geometry software opens up new avenues for discovering and learning geometry. In this hands-on course, participants will use Geometer's Sketchpad software to construct figures, trace loci, animate models using transformations, and link dynamic graphs to geometry. New approaches to standard topics will be illustrated, and implications for teaching will be discussed. The course will be based on modular activities that will allow some individual choices of topic in geometry or visualization.

Minicourse #6. Projects for Precalculus

Organized by Janet Lynn Andersen and Todd M. Swanson, Hope College.

Part A: Sunday, 1:00-2:50 P.M.
Part B: Monday, 4:00-5:50 P.M.

Enrollment limit: 40; registration fee $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. Sample topics include determining the accuracy of a radar gun, using logarithms to analyze risk, and investigating the difficulty of kicking a field goal. Participants will receive a complete set of materials with solutions. Graphing calculators will be provided.

Register early for Minicourses!
Registration form on page 13.

MAA CRAFTY Workshop on Calculus: The Dynamics of Change

August 8–9

Organized by A. Wayne Roberts, Macalester College, and Donald B. Small, United States Military Academy

Under the same title, the Calculus Reform and the First Two Years (CRAFTY) committee put forth its recent description of a modern course in calculus and provided a kind of handbook for change. A key point is that a decision to modernize the calculus sequence must, if it is to succeed, go well beyond a decision to change texts or introduce technology of some sort. This workshop sets the decision in a much larger context–setting goals–for the calculus sequence and for the courses that follow, anticipating student reaction, deciding on teaching methodologies, thinking about assessment, etc. It provides information about how to choose materials and methods that support departmental objectives. The workshop will begin with lunch on Thursday, August 8 and conclude Friday afternoon. Registration fees are $85/members or nonmembers, $45/students/emeritus/unemployed if registering before July 25, or $100/members or nonmembers, $55/students/emeritus/unemployed after that. Interested participants should mark the MathFest Advance Registration Form (found on page 14) and submit the appropriate fee. The registration fee includes lunch on Thursday, August 8.

In Celebration of the Centenary of the Prime Number Theorem: A Symposium on the Riemann Hypothesis

Sponsored by the American Institute of Mathematics (AIM), August 12–14

Organized by J. Brian Conrey, Oklahoma State University

One hundred years ago Hadamard and de la Vallee Poussin independently gave the final arguments in the Proof of the Prime Number Theorem. They followed a plan that had been mapped out by Riemann some thirty-six years earlier. However, Riemann's goals for understanding the prime numbers are still not realized, as the famous Riemann Hypothesis remains tantalizingly unsolved. Speakers at this conference will present many of the interesting developments that have arisen from Riemann's original work, with an eye toward understanding future research directions regarding the zeros of the Riemann zeta-function and related L-functions. The symposium will start with a special historical lecture on the Prime Number Theorem by Atle Selberg, on Monday, August 12 at 5:00 P.M. The following two days will feature talks by other experts in the field. At press time for this announcement, Roger Heath-Brown, Dorian Goldfeld, Dennis Hejhal, Henryk Iwaniec, Hugh Montgomery, Andrew Odlyzko, Samuel Patterson, and Peter Sarnak have tentatively accepted invitations to speak; for updates on the symposium on the World Wide Web, consult http://www.okstate.edu/~conrey/rh-conf.html. There is no registration fee for the symposium, however, space is limited. Those interested in participating should mark the appropriate box on the MathFest advance registration form (found on page 14).

Other Scientific Sessions

Other scientific sessions will include:

- Preparing for Careers
- A Tour through Applications to the Social Sciences
- Integrating Calculus and Physics Courses, Three Case Studies
- What Makes a Good Talk?
- Defending Your Graduate Program in Mathematics
- Women and Mathematics: Case Studies of Intervention Programs
- The Research Mathematician as an Educator: How Do We Use the Mathematics that We Create to Motivate Students?
- Mathematics as Performance Art
- e-MATH on the World Wide Web
- Promoting Interdisciplinary Activities–Mathematics Across the Curriculum
- Innovations in teaching introductory logic and proof
- Mathematics over the Internet
- Multivariable Calculus and Industrial Applications
- What's the Focus at DIMACS for 1996–97?
- Computations in Commutative Algebra

Other Events of Interest

Social Events

It is strongly recommended that tickets for events be purchased through advance registration, since only a very limited number of tickets will be available for sale on-site. If you must cancel your attendance at a ticketed event, you are eligible for a 50% refund provided you cancel by August 5. After that date no refunds can be made. Special meals are available upon request at some banquets, but this must be indicated on the Advance Registration and Housing (ARH) form. (Unfortunately, kosher meals are not available.) All prices include tax and gratuity where applicable.

Opening Banquet: The special feature of this banquet held in the ballroom of the Burlington Sheraton Hotel will be the awarding of AMS and MAA prizes. For AMS, recipients of three Leroy P. Steele Prizes will be announced. For MAA, the recipients of the Carl B. Allendoerfer, Lester R. Ford, and George Pólya Awards for outstanding journal articles, will be announced. Diners will have the opportunity to meet with the recipients on Friday, August 9, at 7:30 P.M. The banquet will be preceded by a cash bar reception at 6:30 P.M. The entree is roast prime rib of beef au jus; the vegetarian entree is vegetable lasagna. Tickets are $32.00 per person, including gratuity and taxes.

Luau: Aloha! All participants and their families are invited to attend this festive event on Saturday, August 10, 6:00 P.M. to 8:00 P.M. Bring your appetite and indulge in a bountiful buffet of delectable polynesian-style food. Entertainment will highlight the sights, sounds, and customs of the pan-Pacific peoples. Tickets are $32/adults and $18/children aged 6–11.

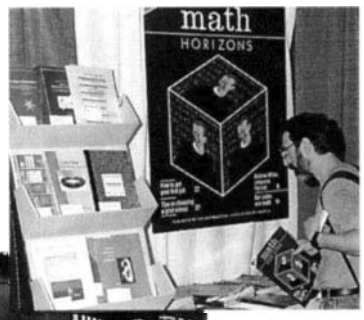
PME Banquet: This popular annual event will take place on Sunday, August 11, at 6:30 P.M. Tickets are $12 for PME members and their families, as well as for MAA Student Chapter members and students

giving talks in MAA Student Paper Sessions; and $21.50 for non-members.

MAA Twenty–Five-Year Member Banquet: The MAA is planning its nineteenth annual banquet on Monday for those individuals who have been members of the Association for twenty-five years or more. After a reception beginning at 6:00 P.M., dinner will be served at 6:45 P.M. The entree is a choice of braised salmon with ancho chilies, cumin, and chipotle hollandaise, or vegetarian lasagna with eggplant, sweet onions, zucchini, and ricotta cheese. Tickets are $33.

Tours

Because of its many attractions and marvelous climate, Seattle is a premier vacation destination. The following tours, offered by Seattle V.I.P Service, Inc., are recommended as typical of the area in the summer and are available exclusively to mathematicians and their families. Tickets should be purchased through advance registration, as seats are limited and many tours may sell out early. Please indicate preference for tour(s) on the Tour form, include applicable payments, and send the form directly to Seattle V.I.P. Service, Inc. by the deadlines indicated on the form.



Always a highlight, this year's exhibits will feature the MAA booksale and other mathematic displays.

NOTE: Should these tours not meet a minimum of 30, they will be canceled and full refunds issued. See the form for other cancellation fees and policies. All tours will take place as scheduled, rain or shine, and no refunds will be made because of weather. No food is included in the price of any tour. Pick up and drop off will be on Memorial Way located directly behind Kane Hall.

Seattle City Highlights: Our guide will give historical background on the area, point out interesting landmarks, and give insider tips on special sightseeing areas. Included in the tour are historic Pioneer Square, location of Seattle's top art galleries; the International District, heart of Seattle's Asian community; and the University of Washington campus. A drive over one of Seattle's two floating bridges will provide views of beautiful Lake Washington and its surrounding homes. A stop at the Hiram M. Chittenden Locks will show how the area's fresh and salt waters meet, and you will enjoy the underwater viewing at the adjoining salmon ladders. Last but not least, a short stop at Seattle's renowned Pike Place Market for an exciting array of color, aroma, and sounds! There will be time to shop and explore this fascinating area, and easy-to-read maps will be provided for those who wish to linger on their own; 9:00 A.M.–noon, Saturday, August 10, $22/person.

Cruise the Locks and Seattle Harbor: The Hiram Chittenden Locks, built early in the century, were as important for Seattle and Puget Sound as the Panama Canal was for the Western Hemisphere. They link Elliott Bay, a port for ships from around the world, with Lake Union and Lake Washington. These two lakes are frequented by work boats and pleasure boats of every description. As you pass through the locks, you will learn how they operate. Cruising in Elliott Bay, you will be fascinated by the maritime activity–chugging tugboats, smoothly gliding sailboats, mighty oceangoing tankers, and cargo ships–while you watch the architecturally exciting Seattle skyline unfold. For spectacular views look west to the Islands of Puget Sound and the snowcapped Olympic Mountains. This cruise is narrated to enhance your enjoyment; 10:00 A.M.–1:00 P.M., Sunday, August 11, $34/person; $24/child, 6–11 years, no charge for children under 6.

Whidbey Island: This day exploring one of the many beautiful islands near Seattle includes a scenic twenty-minute ride aboard a Washington State Ferry and a drive across the breathtaking 976-foot steel Deception Pass Bridge which links Whidbey and Fidalgo Islands. Our stops include Langley, a lovely village by the sea with an assortment of interesting shops, and picturesque Greenbank Farm, a historically recognized loganberry farm and current production site of the Washington liqueur "Whidbey's." The farm is also a Ste. Michelle Winery and you will enjoy sampling these delicious Washington wines. Along the coast is historic Fort Casey, a decomissioned fort featuring old gun mounts, the site of the first lighthouse in the area, a splendid beach, and commanding views from the bluffs. Lunch can be purchased in the quaint town of Coupeville; 8:30 A.M.–5:00 P.M., Monday, August 12, $48/person.

Mount Rainier: Considered sacred ground by the Indians, this landmark is now the symbol of natural grandeur for the Northwest. You will enjoy a drive through the countryside to Mount Rainier National Park (elevation 5400 feet) with its easy hiking trails that pass waterfalls, massive glaciers, and fields of wildflowers. An informative Visitor Center provides panoramic views and slide and movie presentations on the park and its history. You will find snack and gift shops at the Visitor Center and the beautiful Paradise Inn. Your guide will help you make the most of your time spent in this wonderful park. Jackets and sturdy walking shoes are advised; 8:00 A.M.–6:00 P.M., Tuesday, August 13, $48/person.

Victoria, British Columbia: For those wishing to visit this picturesque town on their own, passage aboard the Victoria Clipper can be arranged. This three-hundred passenger water-jet catamaran affords you a scenic three-hour cruise to the seat of British Columbia's provincial government, with its magnificent parliament buildings and the world-renowned Butchard Gardens. Reservations aboard the Clipper can be made for any day of the week, however, you are responsible for arranging your own transportation to and from Pier 69 in Seattle. You must check in at the dock forty-five minutes prior to departure to collect your boarding pass. Note: Proof of U.S. citizenship (passport or photo driver's license with certified copy of birth certificate) is required for all U.S. citizens (including minors) entering Canada.

Foreign nationals should check possible visa needs for entry into Canada and re-entry into the U.S.; 8:00 A.M. – 9:00 P.M., $91/person; $49.50/child, 1–11 years.

Book Sales and Exhibits

Open Saturday, Sunday, and Monday, 9:00 A.M. to 5:00 P.M. Books published by the AMS and MAA will be sold at discounted prices. VISA and MasterCard will be accepted.

Other commercial publishers will be represented, both in person and at the Joint Books and Journals exhibits. Your program will include a complete list of exhibitors known at press time.

Information Booths: All MathFest participants are invited to visit the AMS and MAA membership information booths open the same days and hours as the book sales. A representative will be available at each booth to answer questions about membership, publication, and other programs. Complimentary coffee will be available at the AMS booth.

How to Register in Advance

ORDINARY advance registration: Those who register by the ordinary deadline of July 9 may make housing reservations at the Meany Tower Hotel at special rates offered only through the MMSB. Changes to reservations made at the hotel may also be made by this deadline. Reservations and changes for residence hall housing at the University of Washington must be made by July 16 through the MMSB. Formal acknowledgments of all reservations and changes will be sent prior to the MathFest. In our continuing efforts to make the MathFest cost effective, badges, programs, and tickets will not be mailed out in advance.

Final Advance Registration: Those who register by the final deadline of August 5 may purchase tickets and register for the MAA CRAFTY Workshop. It should be noted that all those who plan to reserve their accommodations at the Meany Tower Hotel or the University of Washington residence halls through the MMSB must do so by the July deadlines mentioned above. Please note that the August 5 deadline is firm, and any forms received after that date will be returned!

It is essential that the ARH form (found in issue or on e-MATH) be completed fully and clearly. Each person must complete a separate copy of the ARH form, but all registrations from one family or group may be covered by one payment. Please print or type the information requested, and be sure to complete all sections. Absence of information (missing credit card numbers, incomplete addresses, etc.) will cause a delay in processing.

Guest: Defined as any family member or friend who is not a mathematician and who is accompanied by a participant of the MathFest, these official guests may attend all sessions and the exhibits. There is a $5 fee for the preparation of each guest badge.

All mathematicians who wish to attend sessions are expected to register and should be prepared to show their badge, if so requested. Badges are required to obtain discounts at the AMS and MAA Book Sales. If advance registrants arrive too late in the day to pick up their badges, the acknowledgment of registration received from the MMSB acts as proof of registration.

Advance registration forms accompanied by insufficient payment will be returned, therefore delaying the processing of any housing request, or a $5 charge will be assessed if an invoice must be prepared to collect the delinquent amount. Overpayments of less than $2 will not be refunded.

For each insufficient payment for registration or housing that results in an invalid check or credit card, a $5 charge will be assessed.

Electronic Advance Registration: This service is available for advance registration, and housing arrangements if desired, by requesting the forms via e-mail from meet@ams.org, or by calling up Web site http://www.ams.org/amsmtgs/2017_program.html and looking for Advance Registration and Housing Form. VISA, MasterCard, Discover, and American Express are the ONLY methods of payment which will be accepted for electronic advance registration, and charges to credit cards will be made in U.S. funds.

Travel Information

Travel: USAir has been selected as the official airline for the meeting for its generally convenient schedule to Seattle. Given the volatility in airfares we cannot guarantee that these are the lowest fares. For reservations call (or have your travel agent call) 800-334-8644 between 8:00 A.M. and 9:00 P.M. Eastern Daylight Time. Refer to Gold File Number 41380077.

Travel from the airport: A taxi from the Sea-Tac Airport to the campus costs approximately $30–$35. The Super Shuttle (206-622-1424) costs approximately $25 each way.

Automobile approaches to campus: Seattle is easily accessible via Interstate 5; exit at NE 45th St. and head east. For Terry-Lander Hall, turn right (south) onto Roosevelt Way NE, and proceed approximately four blocks. Turn left onto NE Campus Parkway (signs to NE Campus Parkway and UW Visitor Information). Terry-Lander Hall will be immediately to the right once you are on NE Campus Parkway.

By train: Please call AMTRAK directly for schedules and price information (800-872-7245). Taxi fare from the Seattle AMTRAK station to campus is approximately $15–20. The Super Shuttle (206-622-1424) costs approximately $41 each way.

Camping and RV Facilities: There are several campgrounds, most with RV facilities, in the general area. Interested participants should contact the MMSB at 401-455-4143 or meet@ams.org for a list.

Car Rental: Alamo Rent A Car, Inc. is offering special low car rental rates for the MathFest, effective August 3–19, 1996. To reserve a car at special rates, call 800-732-3232 and request group ID# 247733 and rate code GR.

Other Information

E-mail: Internet access for reading your e-mail may be available. Participants are advised to check with technicians at their own college or university to identify the numerical address of their machine, as well as its name, and bring this information with them, since not all locations can be contacted by name alone.

Employment Opportunities: There will be an opportunity for the posting of both applicant resume forms and announcements of open positions in a designated area on the meetings bulletin board. No provisions will be made for holding interviews; while interviews are encouraged, arrangements will be the responsibility of each employer and applicant. Messages may be left on the MathFest message board. Participants interested in securing a room for a short, informal interview should check with the logistics coordinator at the Registration Desk for availability.

Information Distribution: A table is set up in the exhibits area for dissemination of information of possible interest to participants but not promoting a product or program for sale. Those who wish to

display information promoting a product or program for sale may do so in the book sale area at the Joint Books, Journals, and Promotional Materials display for a fee of $50 per item.

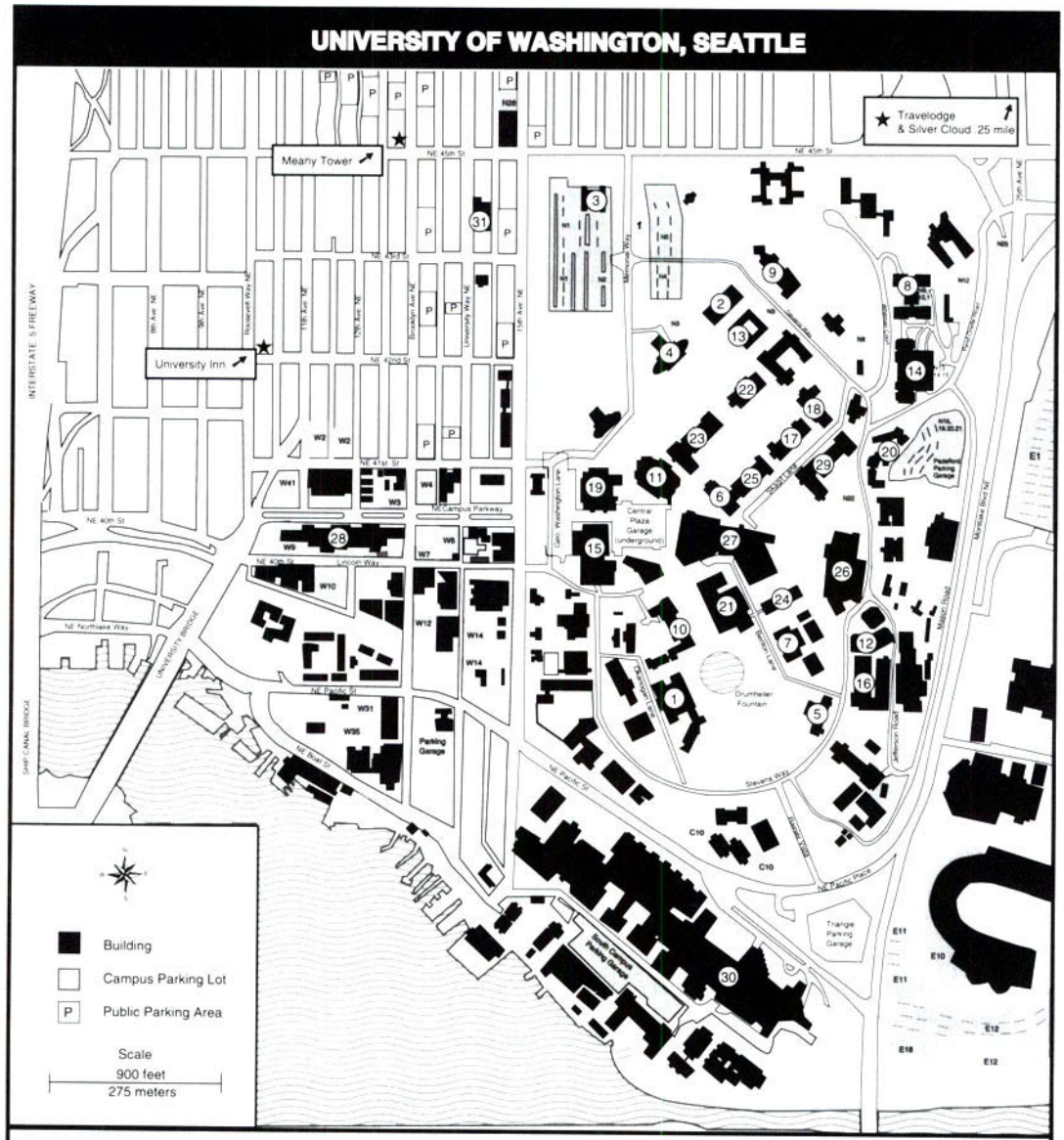
Those who would like to display material separate from the Joint Books table must reimburse the meeting for room rental and any extra furnishings requested (tables, chairs, easels, etc.). This latter display is also subject to space availability. The administration of these tables is in the hands of the exhibits coordinator under guidance from the Joint Meetings Committee. To request a contract or more information, please contact Exhibits Coordinator, MMSB, P.O. Box 6887, Providence, RI 02940; 401-455-4143; meet@ams.org.

Child Care: There is no formal or informal day care at the MathFest.

Parking: Participants staying in hotels or residence halls should refer to the housing page for parking instructions. Cost to park on campus is approximately $5/day with in/out privileges.

Registration Desk for the MathFest: HUB (Student Union), Room 209: noon to 4:00 P.M. on Friday, 8:00 A.M. to 4:00 P.M. on Saturday and Sunday, and 8:00 A.M. to noon on Tuesday. All participants must pick up their badges, programs, and social event tickets here.

Weather: Seattle weather is generally mild, with temperatures averaging 70° to 80°. Evenings can be cool, and there is occasional rain.



Key to University Buildings

1. Bagley Hall
2. Balmer Hall
3. Burke Memorial Museum
4. Denny Hall
5. Electrical Eng. Building
6. Gowen Hall
7. Guggenheim Hall
8. **Haggett Hall** *(Dormitory)*
9. Hutchinson Hall
10. Johnson Hall
11. Kane Hall
12. Loew
13. MacKenzie Hall
14. **McMahon Hall** *(Dormitory)*
15. Meany Hall
16. Mech. Engr. Building
17. Miller Hall
18. Music
19. Odegaard Undergraduate Library
20. Padelford Hall
21. Physics
22. Raitt Hall
23. Savery Hall
24. Sieg Hall
25. Smith Hall
26. Student Union (HUB)
27. Suzzallo/Allen Libraries
28. **Terry-Lander Hall** *(Dormitory)*
29. Thomson/Communications
30. University Medical Center
31. University Bookstore

Seattle MathFest
MAA Minicourses

Advance Registration Form
Seattle, Washington, August 9–12, 1996

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 Eighteenth Street, 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 a full refund. MAA Minicourses are open only to persons who register for the MathFest 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 #_____

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

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 _____
required

Credit card billing zipcode _____
required

Deadlines

MAA Minicourse Advance Registration	June 28, 1996
Cancellation in order to receive a 50% refund	August 1, 1996

Minicourse	Fee
1. Low cost visualization training for multivariate calculus drawing	$45
2. Computability and computational complexity: What is this all about?	$45
3. Technology, modeling, cooperative learning: Putting it all together	$45
4. How to test mathematics taught using graphing calculators	$45
5. Dynamic geometry lab with Sketchpad	$65
6. Projects for precalculus	$45

Registration

Personal Information

Name _____

Mailing Address _____

_____

Telephone _____ e-mail _____

Badge Information

Affiliation _____

(Please limit affiliation to 30 characters - one line only)

(Please note charge per guest registration below)

Name to appear on badge _____

Guest Badge _____

Guest Badge _____

Membership ✓ all that apply

AMS ☐

CMS ☐

MAA ☐

PME ☐

AWM ☐

NAM ☐

MR field of interest _____

AMS Cust. Code _____

Registration Fees

Mathfest	**by Aug 5**	**at meeting**
☐ Member AMS, CMS, MAA, PME	$127	$166
☐ Nonmember	$196	$262
☐ Graduate Student	$35	$45
☐ Undergraduate Student	$20	$26
☐ High School Student	$2	$5
☐ Unemployed	$35	$45
☐ Temporarily Employed	$95	$120
☐ Third World	$35	$45
☐ Emeritus Member of AMS or MAA	$35	$45
☐ High School Teacher	$35	$45
☐ Librarian	$35	$45
☐ One-day Member	—	$91
☐ One-day Nonmember	—	$144
☐ Exhibitor	$0	$0
☐ Guest	$5	$5

MAA CRAFTY Workshop	**by Aug 5**	**at meeting**
☐ Member, Nonmember	$85	$100
☐ Students, Unemployed, Emeritus	$45	$55

☐ I plan to attend the Riemann Hypothesis Symposium to be held 8/13–8/14.

☐ I am a mathematics department chair.

Event Tickets

Event	**Veg ✓**	**# Tix**	**Price**	**Total**
Opening Banquet				
Dinner	☐	____	$32.00	____
Luau				
Adult		____	$32.00	____
Children 6–11 yrs		____	$18.00	____
PME Banquet				
Member and Family		____	$12.00	____
MAA Student Chapter Member		____	$12.00	____
MAA Student Paper Presenter		____	$12.00	____
Nonmember		____	$21.50	____
MAA 25-year Banquet				
Salmon Dinner		____	$33.00	____
Vegetarian Lasagna Dinner		____	$33.00	____

TOTAL for Event Tickets **$** _____

Total Payment

Category	**Total**
Registration Fee(s)	_____
Event Tickets	_____
Dorm Payment	_____
Hotel Deposit (include only if paying by check)	_____
TOTAL Amount Due	**$** _____

Method of Payment

☐ Check. Make checks payable to the AMS. Canadian checks must be marked "U.S. Funds".

☐ Credit Card (VISA, MasterCard, American Express, Discover)

Card Number: _____

Card Type: _____ Expiration Date: _____

Signature: _____

Name on Card: _____

Zipcode of your credit card billing address: _____

(Please note that a $5 processing fee wil be applied for each returned check or invalid credit card.)

☐ Purchase order # _____(please enclose copy)

Please complete this form and return it to:

Mathematics Meetings Service Bureau (MMSB)
P. O. Box 6887
Providence, Rhode Island 02940
401-455-4143 or 1-800-321-4267 x 4143, FAX 401-455-4004

Deadlines

Advance Registration & Hotel Reservations	**July 9, 1996**
Advance Registration & Dorm Reservations	**July 16, 1996**
Final Advance Registration, Tickets, MAA Workshop (no housing)	**August 5, 1996**
50% Refund on Event Tickets	**August 5, 1996***
90% Refund on Dorm Cancellations	**July 26, 1996**
80% Refund on Dorm Cancellations	**August 7, 1996****
50% Refund on Registration Cancellation	**August 9, 1996***

*no refunds after this date **40% refund after this date

Tours: See separate tour form in this issue.

General Housing Information

Where applicable, please check of one of the following:

☐ I will be making my own reservations. Name of hotel or motel: _____

☐ I live in the area or will be staying privately with family or friends.

☐ I plan to share a room with _____, who is making our reservations.

☐ I request a reservation at the Meany Tower Hotel or the University of Washington. See reverse.

Housing Reservations

Seattle MathFest

University of Washington Reservations

Package Descriptions

Special packages have been created to provide campus housing and food services for registrants and exhibitors participating in the Mathfest. They include either:

4 nights of housing (August 9–12)
Breakfast (August 10–13)
Lunch (August 10–12), and
applicable sales tax

OR

3 nights of housing (August 10–12)
Breakfast (August 11–13)
Lunch (August 11–12), and
applicable sales tax

If you wish to arrange for one of these packages, please complete and return this form along with full payment **not later than July 16, 1996.** Upon receipt of your reservation and prepayment we will send you an acknowledgment including university housing information and policies. If you are attending only the CRAFTY Workshop, and not the Mathfest, a hotel room is advised.

Standard Package

Package Dates are as follows and may not be altered. Credit cannot be issued for fewer days or missed meals. **Package rates are per person.** Choose one.

	Aug 9–13	Aug 10-13		
Double occupancy:	$145	$107	x # of persons	$_____
Single occupancy:	$189	$140		$_____
Child under 9 in sleeping bag	$ 24	$17	x # of children (max. 2)	$_____

Please ✓ all that apply

Male ☐
Female ☐
Smoker ☐
Nonsmoker ☐

Extra nights: August 6, 7, 8, 13 & 14 ONLY. **No meals are included. These nights are available only to participants who purchase one of the packages above. Persons registered only for the MAA Crafty Workshop are encouraged to make alternate housing arrangements.**

Double occupancy:	$24	x # of nights x # of persons	$_____
Single occupancy:	$35	x # of nights	$_____
TOTAL ENCLOSED:			**$**_____

I prefer to be housed near:
_____,
(person or group).

Arrival date: _____ **Departure Date:** _____

Method of Payment:

☐ Check Card Number _____ Exp. Date _____

☐ Credit Card Signature _____

Roommate

If you select a double room, please indicate the name of your roommate, and mutual requests will be assigned. If you select a double room and do not designate a roommate, you will be charged the single rate.

Name _____ Arrival: _____ Departure: _____ Male ☐ Female ☐

Special Requests

Please describe any special needs you may have for housing or parking.

Meany Tower Hotel Reservations

Please indicate type of room:

☐ Single	$78
☐ Double	$88
☐ Triple	$98
☐ Rollaway	$10 per night

Special Requests:
_____
_____
_____

To guarantee a room, please include one night's deposit or provide a credit card number.

☐ Deposit enclosed ☐ Hold with my credit card Card Number _____ Exp. Date _____

Signature _____

Date and Time of Arrival: _____

Date and Time of Departure: _____

Names of Other Occupants: Arrival Date Departure Date

_____ _____ _____ (If child give age) _____

_____ _____ _____ (If child give age) _____

How to get a room at the Seattle Mathfest

General Information

Participants are required to register for the Mathfest in order to obtain residence hall and hotel accommodations through the Mathematics Meetings Service Bureau (MMSB). Reservations at discounted rates for the Meany Tower Hotel and the University of Washington housing can be obtained through the MMSB only. All reservation requests for the hotel must be received in writing by the MMSB by **July 9, 1996,** and for the university by **July 16, 1996.** Be sure to complete the housing section of the Advance Registration/Housing (ARH) Form (located at the end of this issue or on e-Math) to ensure accurate housing arrangements. All rates listed for the University of Washington and the Meany Tower Hotel include a $3 fee to offset the cost of the meeting.

University Housing

All rooms on campus are offered as a four-day or a three-day prepaid room/board package (breakfast and lunch) only; cost is included in the rates below. The **four-day** package includes four nights of housing (August 9, 10, 11, 12), breakfast on four mornings (August 10, 11, 12, 13), and lunch on three days (August 10, 11, 12). The **three-day** package includes three nights of housing (August 10, 11, 12), breakfast on three mornings (August 11, 12, 13), and lunch on two days (August 11, 12). Parents may add on **children** (limit of two per room) in sleeping bags and **under 9 years old** to their packages at no room charge and at a 50% board rate. Unfortunately, credit cannot be given for fewer days or missed meals. Rooms are available on August 7, 8, 13, and 14 with no meals included. All reservations and changes, other than cancellations, must be received by the MMSB by **July 16, 1996**. The University will accept changes after this date based only on availability. See the ARH Form for the refund deadlines for cancellations. **Rooms will not be available without an advance reservation.**

Residence Halls: McMahon and Haggett Halls will be used for participants staying through the Mathfest. The majority of Mathfest participants will be assigned to McMahon Hall. It is arranged in clusters of four to six sleeping rooms sharing a common lounge and bath. All bedrooms have one or two twin beds, a dresser, a lamp, a desk, and a closet. Beds will be made for arrival and clean towels can be exchanged daily. Couples will be assigned to Haggett Hall, which has bathrooms at the end of each hall. Each bathroom has two showers, two toilets, and three sinks. All halls offer a smoke-free environment but are not air-conditioned. Smoking is prohibited in all public areas and is discouraged in sleeping rooms. Token-operated washers and dryers, kitchenettes, pay telephones, vending machines, and television lounges are located in each hall. All kitchenettes have a sink and a microwave. Based on availability, refrigerators can be rented at the check-in desk for $12/week.

Package Rates:

4-Day **Single** - $189 per person, **Double** - $145 per person, **Child** - $24 per child

3-Day **Single** - $140 per person, **Double** - $107 per person, **Child** - $17 per child

Room Rates: (no meals) **Single** - $35 per person, **Double** - $24 per person **(8/6, 8/7, 8/8, 8/13, and 8/14 only)**

Meals: Meal cards will be issued at check-in. There will be unlimited seconds on meals. All meals offer a meatless selection. Sorry, other dietary restrictions cannot be accommodated. The Mathfest meal plan cannot be altered, meal substitutions cannot be made, and refunds cannot be issued for missed meals. The cost to replace a lost meal card is $5. A limited number of commuter meals will be available on a cash basis ($6.41— breakfast, $7.72— lunch, $9.40— dinner). **The availability of meals purchased by cash on-site will be extremely limited and we cannot guarantee that everyone will be accommodated.**

Dining Hall/Hours: Located in McMahon Hall. Hours of operation: breakfast —7:00 to 8:30 a.m., lunch—11:45 a.m. to 1:15 p.m., and dinner— 5:30 to 7:00 p.m.

Check-in and Check-out: A 24-hour desk will be located in McMahon Hall. Check-in is after 2:00 p.m. Anyone arriving after 10:00 p.m. and assigned to Haggett Hall may be directed to the 24-hour desk. Check-out is 11:00 a.m. Charge for losing or not returning room keys is $26 per key. Charge for losing outdoor entry or bathroom keys is $5 per key.

Parking: Overnight parking is available on a first-come, first-served basis. Current daily rate (includes in/out privileges) is $5.00 Monday through Friday, $2.50 on Saturday, and free on Sundays. **Rates are subject to change without notice**. You will be required to purchase a daily parking permit on entrance to the campus. Commuters will be directed to commuter lots. Long-term permits will be available at the residence hall check-in desk.

Hotel Accommodations

Participants are required to guarantee their reservations with either a first-night deposit by check or a major credit card. Requests for reservations without guarantees at the Meany Tower Hotel cannot be processed and will be returned. Reservations, changes, and cancellations for the Meany Tower Hotel will be accepted by the MMSB through **July 9, 1996**. **The Meany Tower Hotel will take changes directly after July 16, 1996. Reservations will be accepted at the Silver Cloud Inn prior to June 6, 1996, and at the other hotels/motels listed prior to July 7, 1996.** The MMSB cannot guarantee the availability of the convention rates listed below after these dates. Rates listed are subject to a 15.2% room tax. **Rooms are extremely limited at these hotels/motels.**

Meany Tower Hotel
(Headquarters - .54 miles from campus)
4507 Brooklyn Avenue N. E.
Seattle, WA 98105
(206) 634-2000, (800) 899-0251
reservations through MMSB only
$78 single/$88 double/$98 triple
additional $10 per rollaway
children under 14 years old free
restaurant, lounge, fitness room, free parking, dataports (have to unplug phones) in rooms, **not recommended for physically disabled**

University Silver Cloud Inn
(.9 miles from campus - steep hill)
5036 25th Avenue N. E.
Seattle, WA 98105
(206) 526-5200, (800) 551-7207
$74 single/$84 double/$94 suite
children under 12 years old free
free continental breakfast, no restaurant, dataports, refrigerators, and microwaves in all rooms, indoor pool, Jacuzzi, fitness room, free parking, **recommended for physically disabled with transportation**

University Inn (.4 miles from campus)
4140 Roosevelt Way N. E.
Seattle, WA 98105
(206) 632-5055, (800) 733-3855
e-mail: univinn@aol.com
$74 single/$84 double (standards w/balcony)
$84 single/$94 double (deluxes)
$94 single/$104 double (junior suites)
rollaways and all children free, free continental breakfast, restaurant, outdoor pool, free parking, fitness room, Jacuzzi, dataports, suites have refrigerators, micro-waves, and sofa sleepers, **recommended for physically disabled**

Seattle University Travelodge
(.9 miles from campus - steep hill)
4725 25th Avenue, N. E.
Seattle, WA 98105
(206) 525-4612, (800) 578-7878
$78 single/$88 double
children under 17 years old free
free coffee, no restaurant, outdoor pool, Jacuzzi, some rooms have a refrigerator and a microwave, no rollaways, free parking, **not recommended for physically disabled**

MATHFEST
Seattle, Washington ■ August 10-12, 1996

REGISTRATION FOR OPTIONAL TOURS

REGISTRATION DEADLINES: The Tour Registration Deadlines are July 15, 1996 for Victoria, and July 25, 1996 for all other tours. After those dates, tour registrations will be taken on a space available basis only. Any tickets available for sale on-site will include an additional $2.00 charge.

TOUR DEPARTURES: Tours will depart promptly from Memorial Way located directly behind Kane Hall. Please arrive 10 minutes prior to departure time.

CANCELLATIONS: Prepaid tour registrations are refundable only if cancelled by deadline dates. Tour refunds will be made less a $2.00 per ticket handling charge. There will be no refunds or exchanges after deadline dates. Note that should tour minimums not be met, all monies will be refunded.

PLEASE RETURN THE REGISTRATION FORM BELOW, ALONG WITH A CHECK OR MONEY ORDER IN U.S. FUNDS AND DRAWN ON A U.S. BANK, OR FAX FORM & CREDIT CARD NUMBER (VISA OR MASTERCARD ONLY) FOR THE AMOUNT DUE TO:

Seattle V.I.P. Services, 500 Union, Suite 640,
Seattle, WA 98101 or FAX (206)623-2540

MATHFEST
Seattle, Washington ■ August 10 - 12, 1996

REGISTRATION FORM FOR OPTIONAL TOURS

PARTICIPANT
NAME: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP: _____

PHONE: _____ FAX NUMBER: _____

CREDIT CARD NUMBER: _____ EXPIRATION DATE: _____
(VISA OR MASTERCARD)

HOUSING IN SEATTLE: _____ ARRIVAL DATE: _____

TOUR	PRICE	X	#TICKETS	=	TOTAL DUE
SATURDAY, AUGUST 10, 1996					
Seattle City Highlights Tour ■ 9:00am - 12:00pm	$ 22.00	X	_____	=	_____
SUNDAY, AUGUST 11, 1996					
Cruise the Locks/Harbor Tour ■ 10:00am - 1:00pm	$ 34.00	X	_____	=	_____
Children 6 years - 11 years (5 and under Free)	$ 24.00	X	_____	=	_____
MONDAY, AUGUST 12, 1996					
Whidbey Island Tour ■ 8:30am - 5:00pm	$ 48.00	X	_____	=	_____
TUESDAY, AUGUST 13, 1996					
Mount Rainier Tour ■ 8:00am - 6:00pm	$ 48.00	X	_____	=	_____
Unescorted Victoria Day Trip ■ 8:00am - 9:00pm	$ 91.00	X	_____	=	_____
Children 1 year - 11 years	$ 49.50	X	_____	=	_____
TOTAL AMOUNT ENCLOSED					_____

START AN MAA STUDENT CHAPTER NOW!!!

FACULTY help your STUDENTS become part of the world's largest professional organization devoted to the interests of college mathematics. Increase interest and excitement among your mathematics students. Encourage more students to consider careers in the mathematical sciences. MAA Student Chapters are devoted to increasing student involvement with mathematics, careers, and mathematicians at the national and local levels.

Student Chapter members:

- join the MAA at reduced rates
- receive travel support for paper presentations at the summer mathematics meetings
- receive notification of student activities at the national mathematics meetings which include a Student Lecture, a Student Workshop and the Student Hospitality Center
- receive career information
- automatically become members in one of the MAA's 29 regional Sections, which sponsor student workshops, student banquets, career conferences, environmental mathematics conferences and student paper sessions

What some CHAPTERS do:

- organize scavenger hunts for high school students
- publish newsletters distributed to math majors and alumni math majors
- write articles about mathematics for the school newspaper, and organize a puzzle contest
- present a campus-wide evening of mathematics for the non-technical major, and, of course
- arrange for speakers with topics from "Bernoulli Boys and the Calculus" to "Mathematics in Congress"

To receive more information on Student Chapters contact: Jane Heckler, MAA, 1529 18th Street, NW, Washington, DC 20036, e-mail: jheckler@maa.org or call 1-800-331-1MAA.

MAA President Ross Writes to the University of Rochester

At the announcement of the closing of the University of Rochester's Ph.D. program in mathematics (see FOCUS, *February 1996, page 1), Ken Ross, president of the MAA, sent the letter below to the president of the University of Rochester. The resolution mentioned in the letter's final paragraph was published in the August 1995* FOCUS, *page 39, and all subsequent issues in the "Employment Opportunities" sections.*

Thomas H. Jackson, President
University of Rochester
Rochester NY 14627

Dear Dr. Jackson,

I write on behalf of the Executive Committee of the Mathematical Association of America to express our grave concern about the recent events at the University of Rochester and about the university's plan to "service [the] need for calculus instruction [through] the hiring of non-research (adjunct) faculty and/or the redirection of other qualified faculty from other disciplines."

The Mathematical Association of America is the professional association concerned primarily with collegiate mathematics instruction. The Association and its 30,000 members are vitally concerned about undergraduate mathematics instruction and agree with your statement that "Effective teaching of calculus is an essential ingredient of a quality undergraduate educational experience at Rochester, particularly given the large proportion (over 70%) of first year students who enroll in the calculus sequences." We do not believe that these students are well served by part-time instructors or by faculty who do not have a strong education in mathematics.

Mathematics and mathematics instruction are constantly changing. Recent initiatives by the National Science Foundation have, for example, resulted in major changes in the way that calculus is taught. Advances in technology have affected not only mathematics pedagogy, but also the curriculum. To attract and retain the brightest undergraduates requires that those who are responsible for instruction be active mathematicians and be aware of the ways that both the subject and its instruction are changing.

In view of this, the Board of Governors of the Mathematical Association of America, at its annual meeting in January 1995, passed a resolution that makes it clear that it is a disservice to students and to the profession to relegate the teaching of mathematics to adjuncts and faculty from other disciplines. For the best mathematical education, university students need committed professors who are also committed to mathematics. I enclose a copy of this resolution and urge you to reconsider your proposed course of action.

Sincerely yours,

Ken Ross

Late breaking news...
Rochester Reinstates its Ph.D. Program

The University of Rochester, which announced the closure of its Ph.D. program in mathematics last fall (Focus, February 1996) has decided to reverse that decision. It has announced a comprehensive proposal developed jointly by the administration and key faculty in the mathematics department, with input from other departments.

The mathematics faculty has agreed to a sweeping review of the courses it offers to undergraduates not majoring in mathematics, and of the department's linkages with the research specialties of faculty in other departments. The department will also develop a new Ph.D. program in mathematics.

THE COMPLETE STORY WILL APPEAR IN THE JUNE FOCUS

Quantitative Literacy Programs Bear Fruit

A deacade of NSF-funded programs to improve quantitative literacy in the nation's high school population has been steadily producing results. Cathy Crocker reports.

A basic understanding of statistics, data analysis, and quantitative literacy must be in the mainstream of mathematics. No longer are these skills and concepts considered an enrichment topic for the few. The National Council of Supervisors of Mathematics in its publication *Basic Skills for the 21st Century* listed a knowledge of statistics as one of the necessary basic skills that each student must possess to function as a consumer, worker, and citizen. This view is also embraced by the National Council of Teachers of Mathematics (NCTM) in its *Standards* and by the Mathematical Sciences Education Board.

As one examines the findings of commissions and task forces, deliberates over the recommendations initiated by national organizations, and listens to the outcry of business and government officials, it is evident that there is a critical need for students to be able to intelligently analyze and interpret data in order to reach valid decisions. Because of the pervasiveness of the use and creation of data in our technological society, the skills of collecting, organizing, displaying, and analyzing data are fundamental to each individual. Yet these skills are among the lowest scored by most students.

The above two paragraphs were part of the "Need Section" of a grant submitted to and funded by the National Science Foundation (NSF). It was clear that work must be done to help teachers incorporate data analysis into their lessons. The American Statistical Association (ASA) in collaboration with NCTM has worked for over ten years developing Quantitative Literacy (QL) projects. Since 1984 NSF has funded a total of five QL projects to a total amount of more than $3 million.

The first of these projects, "A Program to Improve Quantitative Literacy in the Schools," started in April 1984 with Richard Scheaffer as principal investigator, and

James Landwehr and Albert Shulte as co-investigators. Carried out by members of the ASA/NCTM Joint Committee, this project improved the quality of statistical education by preparing teachers of mathematics and the natural and social sciences to teach statistical and probabilistic skills and concepts effectively, and by introducing the most important and up-to-date topics in statistics into the middle and high school curriculum. In addition to the creation of curriculum units for students and teachers, relevant training materials and guidelines were written for teachers. The project developed a model workshop for teacher inservice training, a QL curriculum series based on examples, including computer software, guidelines for the teaching of statistics within the K–12 mathematics curriculum, and a videotape designed to inform teachers and administrators about the QL philosophy and style.

The unique aspect of the workshops was providing a multiplier effect far beyond the original concept. A nucleus of two hundred teachers was trained directly under the initial funding. Most of these teachers replicated their training, and as a result nearly three thousand teachers were exposed to the QL project.

"Quantitative Literacy: Leadership Training for Master Teachers and Mainstream Educators" started in August 1987 with Gail Burrill as principal investigator and Richard Scheaffer and Ann Watkins as co-investigators. Focused primarily on in-service workshops to implement statistical concepts into the mainstream mathematics curriculum, this project began with a pilot program in 1988. The pilot program led to four workshops held across the United States, and a one-week workshop during the summer, followed by at least twelve hours of inservice during the academic year.

Each summer institute hosted approximately forty teachers from one geographic area and enlisted the cooperation and support of local supervisors, professors of mathematics education, and statisticians. The statisticians not only helped with the summer institute but were instrumental in hosting and leading the follow-up sessions during the year. A nucleus of about 250 teachers was reached directly.

Nearing completion is the program "A Data-Driven Curriculum Strand for High School Mathematics." Gail Burrill is the principal investigator and Miriam Clifford and Ken Sherrick are the co-investigators. This project is developing a series of nine modules to be used in grades 9–12 as replacement units for traditional sections of the mathematics curriculum, for different approaches to mathematical topics, or as extension units. The modules emphasize real-word applications in order to show students the everyday uses of mathematics and statistics. This project has been introduced to teachers at eight two-day workshops across the United States. It was enthusiastically received by teachers at the seventy-third annual NCTM meeting in April 1995. The team was asked to present a one-day 'Conference Within a Conference,' which drew a room-capacity crowd of one hundred educators.

Cyrilla Hergenhan and Richard Scheaffer are the co-principal investigators for "Quantitative Literacy in the Elementary Mathematics Curriculum," designed to produce a scope and sequence plan and model inservice workshops on data analysis. Modules have been developed and sample lessons and activities relating mathematics and data analysis are included along with references. Several professional organizations invited members of the project to make presentations at their meetings to very positive receptions. Week-long workshops have been received equally well. At NCTM's invitation, this project also was presented as a one-day 'Conference Within a Conference.'

"Science Education and Quantitative Literacy" is bringing statistical techniques and data analysis into the science curriculum for grades 6–12. Jeff Witmer serves as principal investigator, and Mike Kimmel and Art Christensen serve as co-investigators of this project which addresses the subjects of biology, chemistry, earth science, physics, and general science. The first four-week workshop was held at Johns Hopkins University during the summer of 1995. In a residential setting, teachers came together to conduct hands-on experiments and use technology to analyze their results. Two workshops will be held during the summer of 1996 and one during 1997.

All QL project materials were written by teams of classroom teachers, mathematics educators, and statisticians, and all were field-tested in classrooms. ASA's members, chapters, sections, and its board of directors actively support and participate in all ASA QL projects. Dale Seymour Publications has been the publisher of our materials. If you are interested in bringing QL to your teachers, contact ASA. Become a part of the QL Team!

Cathy Crocker is director of education for the American Statistical Association.

Polyhedron Wars

A new record has been set for giant polyhedra. Hot on the heels of the announcement in the December 1995 FOCUS that students at Longfellow Elementary School in Columbia, Maryland had constructed a sixty-two-face rhombicosidodecahedron, news came in that students in Oregon had already beaten them to it. In March 1995, eighty middle school students from rural Oregon came to Oregon State University in Corvallis for the annual SMILE Challenge Weekend. (SMILE stands for Science and Math Investigative Learning, an enrichment program for rural minority students.) While there, the students took time out to assemble their own rhombicosidodecahedron. In fact they assembled a total of twelve giant polyhedra—four rhombicuboctahedra, four truncated icosahedra, and four rhombicosidodeca-hedra. In performing this feat, the students were aided by volunteer undergraduates from OSU and supervised by OSU Professor Blake Peterson.

PRESIDENT'S COLUMN

Rochester! What Next?

The elimination of the mathematics Ph.D. program at the University of Rochester has been big news in academia for the past few months. For a brief overview, see the front page story in the February issue of FOCUS. Clearly this is a time for reflection and action. As the cliché goes, it's no longer "business as usual." In this column, I will focus on some problems that I perceive. I should admit right off that it's a lot easier to point out the problems than to make suggestions for changes. I hope, though, that we can learn from what has happened at Rochester.

The University of Rochester did not make its decision about its mathematics department lightly, and the administration has been forthright in explaining its actions. In particular, the vice provost and dean of the college gave reasons for the cuts in the mathematics department. FOCUS readers may be most interested in the following two quotes: "There are other ways to service our need for calculus instruction, including the hiring of non-research (adjunct) faculty and/or the redirection of other qualified faculty from other disciplines." "In our judgment, we can significantly decrease the faculty size in mathematics who are primarily devoted to delivering quality undergraduate education to math majors and other sophisticated science majors, while seeking other avenues (technology and non-research faculty) to deliver instruction in basic calculus (typically for non-majors)." A subsequent letter addressed to me from the president of the University of Rochester reaffirmed these statements: "In the future, we expect math-based courses generally used by students majoring in other disciplines to be taught by a mixture of mathematics faculty, faculty in other disciplines (generally holding Ph.D.s in applied mathematics), and full-time, but not tenure-track, instructors holding Ph.D.s in mathematics or applied mathematics."

Of course, some adjunct faculty and faculty from other disciplines are very effective mathematics instructors. But keeping abreast of recent developments in mathematics, and making the important changes in the way mathematics is taught, cannot be accomplished by overworked temporary and adjunct faculty. Nor can this be done by engineers and applied mathematicians in other departments whose primary missions are somewhat remote from mathematics and who view mathematics as just a tool to be used for their work. Serious thought about the curriculum, methods of teaching, and the appropriate inclusion of reform methods is needed. A copy of a letter that I wrote to the University of Rochester on December 8, 1995, appears in this issue of FOCUS.

AMS President Cathleen Morawetz appointed a three-member fact-finding committee that visited the Rochester campus on December 6, 1995. A week later, she forwarded the committee report to the president of the University of Rochester and offered the assistance of the AMS in "finding a way to preserve the integrity of the mathematics program consistent with the overall goals of the University." According to an AMS news release, dozens of scientists from a range of disciplines—including six Nobel laureates and a large number of members of the National Academy of Science—have written to the Rochester administration urging it to revise its decision on the mathematics department. At the Orlando meeting, the AMS Council passed a resolution condemning the University's actions.

I definitely do not want to pass judgment on the mathematics department at the University of Rochester, but I will pass on some perceptions. The perceptions are real whether they are correct or not, and I am sure that they exist at many institutions across the country. The AMS fact-finding committee's report includes the following about teaching and interactions with other departments: "The committee found a serious difference of opinions between the administration and the department in the area of teaching effectiveness. The administration believes that the department has not been doing a satisfactory job in teaching, particularly in the calculus and service courses.... The administration believes that the linkage of the mathematics research and graduate program to the rest of the university is very limited. The president noted that, for instance, algebraic topology (one of the areas of strength in the Mathematics Department) has no connections to the other disciplines at UR...there was no strong objection to the suspension of the mathematics graduate program from other departments."

There will be more cutbacks and closures in our universities. The main reason will be basic economics combined with perceptions of what is inessential. It is a big mistake to assume that the value of mathematics is self-evident to others, even though the beauty and importance of mathematics is clear to us. We know that mathematics plays a fundamental role in every scientific discipline, in engineering, and in research. But it's a big mistake to assume, or act as if we have assumed, that mathematics is entitled to public support. In fact, even many scientists view mathematics with disdain. They either do not realize that mathematical research is a healthy, ongoing activity, or they view it as irrelevant. Indeed, some of our most powerful "enemies" come from within the science community. We mathematicians must take into account our service component, for we cannot serve ourselves only. We must reach out to the rest of the scientific and academic community with real service and perhaps a little humility. This means working closely with and forging alliances with our client disciplines. This means teaching well our service courses in calculus, statistics, etc. This means working with the science departments to develop suitable undergraduate training in mathematics and science.

Mathematicians also need to reach out to another important community: the precollege teachers and students. Actually, a lot has been accomplished in the past ten years by a few people, but much more needs to be done. More generally, mathematicians and scientists need to work with the public at large. This won't be easy in the current climate of anti-science. But we are all at great risk if we continue to have a scientifically illiterate and suspicious public, while science and technology advance into more and more technical and remote areas.

The decision at Rochester is a wake-up call for the mathematics community. Certainly it remains important for us to advance mathematics research and to educate future scholars; however, this by itself is no longer sufficient. We must help our majors and graduate students think more broadly about their career paths, and we must educate all students to be knowledgeable users of mathematics.

I am concerned about the long-term implications of the cutbacks at the University of Rochester. Will other schools follow suit? Will mathematics departments be decimated or taken over by engineering and business schools? What has happened, good or bad, elsewhere? The MAA would like to assist departments that are facing such erosion. What can and should we in the MAA be doing? I would like to know what is happening out there, and I would welcome your input. Let me hear from you.

—Ken Ross

Ivars Peterson Joins MAA Online

***Science News* writer, Ivars Peterson is now writing a series of weekly on-line contributions highlighting links between math and everyday concerns for MAA Online.**

Check out each week's column Monday afternoons at http://www.maa.org.

Secretary's Report

At its meeting on January 9, 1996, the Board of Governors elected two governors-at-large to membership: Katherine Layton of Beverly Hills High School and Manuel Berriozábal of the University of Texas at San Antonio. In addition David A. Sanchez of Texas A&M University was elected to membership on the Finance Committee, to replace John Kenelly of Clemson University, retiring after eight years of devoted service. Fortunately John will remain active in the MAA with a number of activities, including chairing the new Task Force on Member Services.

The Board approved the selection of Professor Lászlo Bábai of the University of Chicago and the Eötvös University to be the next Pólya Lecturer. Professor Bábai joins a growing list of distinguished Pólya Lecturers: John Ewing, Patricia K. Rogers, Robert Osserman, Carl Pomerance, and Underwood Dudley.

At the Business Meeting on January 13, the Association presented to Ed Dubinsky a Certificate of Appreciation for his many contributions to undergraduate mathematics education, in particular for his founding and editing *UME Trends*.

G. L. Alexanderson

Research in Collegiate Mathematics Education

Central Michigan University September 5–8, 1996

With support from the Exxon Education Foundation, the Research in Undergraduate Mathematics Education Community, and the Department of Mathematics of Central Michigan University are sponsoring a forum for researchers in post-secondary mathematics education research.

Speakers will include: Lida Barrett, Jim Leitzel, Mary Lindquist, Ed Dubinsky, and many others.

For more information and on-line registration, see http://www.mth.cmich.edu/faculty/mathews/conference.html, or contact David Mathews at (517) 774-4469; or David.M.Mathews@cmich.edu.

1996 NSYMATYC Summer Institute

Dutchess Community College (Poughkeepsie, NY) will host the NSYMATYC Summer Institute on June 14 and 15, 1996. It will be organized around two themes:

- **Workshops on Teaching Calculus as a Lab Course** will be conducted by Wesley Ostertag (mathematics) and Tony Zito (physics). No experience other than a familarity with calculus will be asumed. It will focus on lab activities which could be used in a stand-alone calculus course; however, participants might want to invite physics-teaching colleagues to attend the institute with them.
- **Workshops on Implementing the AMAYTC Standards** will cover the full range of courses in the community college mathematics curriculum, from Elementary Algebra to Differential Equations. The main presenters of this theme will be Anne Landry and Johanna Halsey of Dutchess Community College. They will share information on, and provide specific examples of: writing assignments, portfolio models, metacognitive activities, and assessment tools.

For more information, contact:

Wesley Ostertag, Dutchess Community College
Pendell Road, Poughkeepsie, NY 12601
(914) 431-8546
e-mail: ostertag@sunydutchess.edu

Epsilon Sandwiches

Herbert S. Wilf

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.

Even though I've been teaching for n! years, every class is a fresh adventure.

An adventure. That word is a euphemism for the stark reality, which is that every class contains some totally shocking development that I have never seen before and haven't any idea how to cope with.

Just last year, for the first time in many years, I taught a section of the junior level mathematical analysis course. You know, the one where students meet proofs in analysis for the first time. The one where students and epsilons meet, eyeball to eyeball, and it isn't the epsilons that blink. The one where students decide that they really wanted to be doctors and lawyers after all.

This course is famous for being our rite of passage. Our hazing ceremony. If you want to join the club, then here is the hurdle that you have to jump over. Somehow we spend a lot of our time agonizing over calculus reform and very little time thinking about how to improve this pivotal course, which, perhaps more than any other single course, determines who our majors will be, and therefore who the mathematicians of the future will be.

When I was an undergraduate at MIT, I had smooth sailing through the first two years of calculus. In my junior year I took this very same analysis course, and my teacher was a young C.L.E. Moore Instructor named Walter Rudin.

Then, as now, he wasted few words. (The thought of Walter Rudin wasting words is a possible definition of science fiction.) He let his epsilon be greater than zero, he took his capital M to be 1/3 of the reciprocal of that, and on the bottom line it all came out right. It came out to 1 times epsilon. It wouldn't have had the nerve, it wouldn't have dared to come out as (M + 3) times epsilon. Despite the saying that "for every epsilon there is a delta," (which is really rather romantic, when you think about it) I often could not get my epsilons paired off with suitable deltas. I found that course to be rough going.

I started teaching the course last year by concentrating on the concepts, the mathematical concepts. There are plenty of them there, including the likes of convergence of series, uniform and otherwise, continuity, uniform continuity, differentiability, compactness, Heine-Borel theorems, and so forth. The students, despite being a bright and hardworking bunch, were falling farther and farther behind.

After a while I started to understand a little better what was going on. The thing is that that course has not one but two major novel features in it. One is that the subject is just plain difficult and the concepts are quite deep. The other is that, for perhaps the first time in the students' mathematical careers, manipulative skills and pushing formulas around just will not suffice. Instead what is at the highest premium is the ability of the students to wrap complete English sentences around their mathematical thoughts. Not just to use English, and not just to use epsilons, but to embed the mathematics in epsilon sandwiches so that a continuous mathematical thought flows from one end of a long sentence to the other end, sometimes skimming across carefully chosen English words, then running through a brief mathematical display, finishing perhaps with an English conclusion; all woven together; seamless; proving what is supposed to be proved; grammatically correct and unambiguous; with the "for all"s and the "there exists" in just the right places; having a subject, a predicate, punctuation, and all due appurtenances, accessories, and optional extras.

An epsilon sandwich, then, is a layer of mathematics between two slices of English; hold the mayo.

"If, on the other hand, x is not equal to 0, then we can find an M for which $|u-u_0|$ is less than delta except for a set of measure less than epsilon/2, and then we would have ..."

What I am speaking to you about today has a lot in common with some of the works on mathematical writing, by Don Knuth, Len Gillman, and others, that have appeared in recent years. But they were striving also for lively, clear, and well motivated exposition. In this junior analysis course, I don't care about "lively" and I don't care

about "motivated." "Clear" is important, but "complete and correct and readable" is really what it's all about. I am not speaking about writing style here. That is a luxury that comes after the basics of survival. The construction of a correct and complete mathematical sentence is what I am talking about.

But where are our students supposed to have learned this ability to craft such delicately poised sentences?

In science it is a well known principle that we should never change two important things at once. Instead we should first change one thing, then let the waters settle for a bit, and then change the other thing. I had been violating that rule. What I have learned is that in this course it is worth pausing for a while in the development of the mathematical concepts to have an intermission in which the students are doing nothing but learning how to create their very own epsilon sandwiches.

I wish I had a nickel for every student who has told me, "I understand it. I just can't really say it!" That's a very human feeling. The problem is that unless you can say *this* thing, you won't be able even to understand the *next* thing. In this junior analysis course, the line between understanding and saying becomes very much blurred, maybe for the first time in the student's career. Without the saying, in this course, understanding is probably not possible.

That means it is a good idea to give the students practice in writing out mathematical sentences and paragraphs, in full, in which the mathematics in those sentences will be very familiar to them. Do that before getting into the substantive new mathematics. So only one thing will change. What will change will be the requirement for expressing mathematical thoughts in writing, clearly, using good English and

good mathematics. Both wrapped around each other. But the mathematics should be familiar at first.

How can this be carried out?

Pick a few attractive, elementary theorems that your students have probably seen before, and go to work. Prove that the square root of 2 is irrational. That's a good one. Explain it thoroughly. Go over it a few times until everyone understands what is going on. End of stage 1.

Then call on a student and ask him to describe the beginning of the proof, without asking him to write anything down. While the student is talking about the steps, you might jab at the blackboard, writing down a sketch of the ideas, but without trying to make good sentences out of them. Then call on another student. Ask her to continue from where the first one left off. Continue until, with contributions from several students, you have jointly talked your way through the proof.

Now comes the fun part. Call on a student and ask her to come to the blackboard and write out the first few lines of the proof. Insist on complete sentences! Subjects, predicates, verbs, objects, all that good stuff. Even punctuation; commas after displayed equations. Show no mercy. Do not accept any spoken sentences. The focus is on what is being written on the blackboard. To underscore this point, you might ask for silence in the classroom while those sentences are being written on the board. After they have been written there, you and the class should criticize them constructively, polish them, and get them to be absolutely perfect. Not a semicolon out of place.

Then erase the board and ask another student to come forward and write out the same proof. Go over it all again, insisting on perfection in writing, accepting no oral input. Never mind style, liveliness, and that sort of thing. Just get the vital signs beeping.

Then go on to another example. Give them the proof that the sum of the interior angles of a triangle is 180°. Then ask someone to step forward and write it on the board. Constructively criticize, with the class, every word, phrase, sentence, and paragraph, until the proof positively glitters on the blackboard. (Do us all a favor and skip the numbering of the steps that many high schools insist on.) Then erase the blackboard and do it again with another student.

What are some other examples of good theorems to practice on, aside from the irrationality of the square root of 2 and the sum of the angles of a triangle? There is the fact that the sum of the first n integers is $n(n+1)/2$; that the sum of the first n odd numbers is n^2; that if we cut diagonally opposite corners out of a chessboard, then it can't be covered by dominoes; that a set of n elements has exactly 2^n subsets; that the number of disjoint ordered pairs of subsets of n things is 3^n; and so forth. The attributes of these examples are that they are elementary to state and easy to understand, that they have short proofs, and that it is still not quite a trivial job, in each case, to write out a complete formal correct proof, as opposed to vigorous waving of hands.

Assign homework problems of this same kind. For one thing, ask them to write out once again exactly the proofs that were done in class, emphasizing that you will want them to be perfect. Then find a few other examples of proofs that really are proofs but whose mathematical content is not so difficult in itself, so that the main problem will be the arrangement of thoughts into sentences.

With some preparation like this, for a few class hours before you really get into the compact sets, the uniform convergence, and so forth, the bumps can be smoothed out considerably, leaving a transition that, instead of being traumatic, has risen all the way up to being merely painful. A little investment of your time and of your students' time in the construction of finely tuned mathematical sentences at the beginning of this course can reap large rewards in sailing the rough seas of the junior course in real analysis.

I don't see how any textbook could be written that would help significantly with this job. It is a classic teacher-and-student, human-to-human interaction situation, and what it is about is the appreciation of the differences between "I understand it, but I can't say it," and "I can say it in my own words, but I can't write it out formally," and "I can do it all." A textbook can't do that job. A computer can't either. Neither can a CD or a videotape. Nor can a $10 million grant from a funding agency.

But you can do it. We can do it.

What I have said here is surely not in the category of a major revelation to be funded by a multi-million dollar NSF grant.

If you follow my suggestion, it won't help a lot. But it will help a little. And that's all a teacher can ever do.

Good luck. You'll need it. And thank you.

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Call for Papers

Research Conference in Collegiate Mathematics Education

September 5–8, 1996

Central Michigan University
Mt. Pleasant, Michigan

The Research in Undergraduate Mathematics Education Community (RUMEC) and the Department of Mathematics of Central Michigan University are proud to sponsor a forum for researchers in post-secondary mathematics education (PSMER). Plenary speakers will be:

Ed Dubinsky, Purdue University; M. Kathleen Heid, Pennsylvania State University; Richard Noss, University of London; Anna Sierpinska, Concordia University.

One-page proposals for papers describing results of current research, application to classroom practice, contemporary learning theory as it relates to collegiate mathematics, issues in the psychology of mathematics education, or technology issues should be submitted (preferably by e-mail) by May 1 to David Mathews, Department of Mathematics, CMU, Mt. Pleasant, MI 48859; (517) 774-4469; e-mail: david.m.mathews@cmich.edu. Conference registration information may also be obtained from the above address, or on the WorldWide Web at http://www.mth.cmich.edu/faculty/mathews/conference.html. Partial support for this conference is being provided by the EXXON Education Foundation.

MAW 1996: Mathematics and Decision Making

Mathematics Awareness Week is April 21–27. In this article, Paul Davis talks about this year's theme. Readers of FOCUS *are free to make use of this article in their own MAW activities.*

Decisions shape our lives. Mathematics rationalizes the sifting of information and the balancing of alternatives inherent in any decision. Mathematical models underlie computer programs that support decision making, while bringing order and understanding to the overwhelming flow of data computers produce. Mathematics serves to evaluate and improve the quality of information in the face of uncertainty, to present and clarify options, to model available alternatives and their consequences, and even to control the smaller decisions necessary to reach a larger goal.

Mathematical areas like statistics, optimization, probability, queuing theory, control, game theory, modeling and operations research—a field devoted entirely to the application of mathematics in decision making—are essential for making difficult choices in public policy, health, business, manufacturing, finance, law, and many other human endeavors. Mathematics is at the heart of a multitude of decisions, including those that generate electric power economically, make a profit in financial markets, approve effective new drugs, weigh legal evidence, fly aircraft safely, manage complex construction projects, and choose new business strategies.

Models of Complex Systems

The costs of the policy decisions surrounding global warming are high politically and financially. Policy makers must work through a chain of issues: Is global warming real? Is it caused by automotive and industrial emissions? If so, which ones? Which remedial strategies will be effective? What is their true cost? Individual manufacturers whose products are among the suspected pollutants face parallel decisions at the corporate level.

Specialized mathematical models link the effects of selected atmospheric pollutants to predictions of global temperature change. They are the basis for the growing scientific consensus that observed increases in the average temperature of the earth are unlikely to be the consequence of natural variation alone. Similar models can also be used to simulate and evaluate remedial strategies. The mathematical tools of modeling, simulation, and risk analysis validate the cause and effect relationship upon which policy decisions are based, and they permit the evaluation of the effects of alternate courses of action. In addition, chaos theory is providing new lenses through which to view the behavior of such complicated systems.

Complex decisions arise in more tangible settings as well, such as choosing among the interrelated options that govern the process of building a complex system like an office building or an aircraft. Which sequence of tasks chosen now will best advance completion of the project? Which are potential bottlenecks? Operations research uses critical path analysis to identify the vital tasks so that each subunit is in place at the right time at minimum cost: no battles are lost for want of the proverbial nail.

Complexity is aggravated by uncertainty. For example, decisions about dynamic control of traffic in telephone and computer networks are made more difficult by the uncertain patterns of demand. In a simpler form, a bank faces a similar dilemma in deciding how many tellers to hire: how should resources be allocated to maintain adequate service (shorter lines) when only the random characteristics of customer arrival times are known? Queuing theory provides guidance for these kinds of decisions.

Testing and Evaluation

How can physicians be sure they are prescribing drugs that help, not hurt? Statistical analysis of clinical trial data guides the Food and Drug Administration's approval of every prescription drug.

To ensure an impartial assessment of dose and response effects, drug trials are conducted using protocols dictated by the statistical methodology known as the design of experiments. Assertions about the efficacy of a particular course of treatment are then accompanied by well-defined confidence intervals, statements of the likelihood of treatments being effective in specified circumstances. For example, such analyses are the foundation of recent reports that estrogen therapy reduces female mortality from heart attack and stroke.

Expert witnesses in the courtroom use the language of probability to argue the value of DNA evidence purporting to match blood samples to unique individuals. Calculations made using the deep body of mathematical thinking known as probability theory can surprise casual intuition, giving probability a particularly important role in guiding decisions in the face of uncertainty. As a simple example, the probability of two individuals chosen at random having the same DNA is not 1 in 5.7 billion, the population of the earth, but about 1 in 75 billion, the number of possible DNA configurations.

Control and Optimization

The tools of control theory allow humans to delegate some forms of decision making, such as those of a tactical character that require assessment of data and action on a time scale too rapid for humans. For example, control systems in commercial aircraft make fine adjustments in aileron settings as the pilot changes course so that the aircraft remains stable. A key compo-

Third International Mathematics and Science Study (TIMSS)

The Third International Mathematics and Science Study is considered by many to be the most important international study of education in the 1990s. The study is sponsored by the International Association for the Evaluation of Educational Achievement (IEA) and is taking place in approximately fifty countries from all parts of the world. Never before has an international comparative survey of education been conducted on such a scale. Nine- and thirteen-year-olds, and students in their last year of secondary school, their teachers, and the administrators of their schools comprise the target populations.

TIMSS goes beyond the traditional survey of achievement to include a comprehensive analysis of textbooks and curriculum guides, and instructional practices, as well as curricular influences on student learning. TIMSS seeks to identify variables associated with high levels of achievement in mathematics and science, and will endeavor to explain factors that influence educational performance.

The study is of interest to a wide range of audiences including parents, academics, educators, policy-makers, researchers, and politicians. United States participation in TIMSS is sponsored by the NSF and the National Center for Education Statistics (NCES). The U.S. National Research Center is located at Michigan State University, but includes both the NCES and the NSF.

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nent of this kind of automated decision making is selecting a control action that is optimal in a precisely defined mathematical sense. Mathematics is also the language in which those control systems are designed, evaluated, and implemented.

The number of low-cost tickets an airline will sell for a journey on that same aircraft is decided by a mathematical model of anticipated customer traffic and acceptance of various price levels. The mathematical tools of operations research can define and analyze the trade-offs between the revenues lost to empty seats and the costs of overbooking, a choice that has made the difference between profit and loss for at least one major airline.

The electricity we use every day comes from generators whose level is set to meet projected electric demand at minimum cost. An amalgam of mathematical and computational tools solves and re-solves this complicated optimization problem throughout the day as the utility control center adjusts to changing demand patterns.

Future demand for airline tickets, electricity, and many other commodities is often predicted using time series, a statistical tool that extrapolates into the future from historical data. Those predictions are accompanied by measures of confidence that help planners provide appropriate contingencies for deviations of the realized future from the predicted.

Many of the decisions about the design of equipment of all sorts are left to sophisticated design algorithms that integrate mathematical models of the device with optimization algorithms in state-of-the-art computational environments. For example, one technique links disparate analysis tools, such as one for the strength of an airplane wing and another for its aerodynamic drag, with powerful optimization engines in order to achieve a product goal, an aircraft with maximum range, that balances competing requirements like strength, weight, lift and drag.

Financial and Economic Analysis

Mutual funds can include investments in derivatives such as currency repurchase options, financial instruments whose prices are tied to prices of other commodities in the market. Both the value and the hedging structure of many derivatives are decided by models of economic behavior. Stochastic differential equations are the language of those models because they express naturally the market's intrinsic uncertainty. They lead to valuation formulas that balance risk and expected return.

Game theory, a discipline that was given its modern form by the mathematician John von Neumann, models markets in which the actions of competing parties influence one another while each acts in its own self-interest. The 1994 Nobel Prize in economics was shared by John Harsanyi and the mathematicians John Nash and Reinhard Selten for their introduction of several different concepts of market equilibria, situations in which each player is in an optimum position relative to its competitors. These perspectives provide deeper insights into price structures than simple supply and demand, thereby guiding investment and capital expenditure decisions.

Analyzing a different competitive setting, a political scientist and a mathematician have recently extended the age-old technique for dividing a piece of cake between two individuals—one cuts, the other chooses—to fair division among many parties when economics and other complex forces are at work. Such disputes might center on dividing cities and natural resources at the close of a multi-nation war. The theoretical solution of the underlying mathematical problem, that of fair, envy-free division among many parties, might lead eventually to tools that heads of state could apply to deciding disputes like the division of territory in Bosnia.

Mathematics at the Core

Mathematics shows many faces as it works in these diverse settings. Statistics measures the quality of information. Optimization finds the best alternative. Probability quantifies and manages uncertainty. Control automates decision making. Modeling and computation build the mathematical abstraction of reality upon which these and many other powerful mathematical tools operate. Mathematics is indeed the foundation of modern decision making.

For full details, see the Mathematics Awareness Week heading at http://forum.swathmore.edu/maw/.

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Parts of the Study

- A curriculum analysis component conducted with hundreds of coders from around the world collecting detailed content analytic data from over 1600 mathematics and science textbooks and official curriculum guides. Results are anticipated for release in 1996. The curriculum analysis component is a study of the intended curriculum reflected in textbooks and curriculum guides. It is designed to uncover international trends in intentions for mathematics and science education. It is also designed to be linked to data on instructional practices and student achievement.
- A student survey component with three parts: student assessments, performance assessments, and questionnaires.
- A number of countries are also participating in performance assessment tasks. A subset of students in the national TIMSS sample participate in solving performance tasks in mathematics and science.
- Student assessments contain multiple choice, short answer, and extended response items. International scoring guidelines for short answer and extended response items define a number of correct and incorrect response categories. These allow varying degrees of correct responses to be evaluated. Additionally there is a categorization of response types permitting the identification of alternative solutions and different types of misconceptions.
- Individual teachers completed questionnaires about their background, education, instructional practices, and their views on mathematics and science both as disciplines and from the point of view of pedagogy.
- Teachers report on their content goals from the school year by indicating topics from the TIMSS curriculum frameworks that they have taught or intend to teach.
- School administrators completed a questionnaire collecting information on curriculum, staffing levels, availability of instructional resources including science laboratories.
- States within the U.S. that desired to compare the achievement of their students to all of the nations participating in TIMSS had an opportunity to participate in the TIMSS data collection with statewide samples making such comparisons possible: Minnesota, Illinois, and Colorado participated in this way.
- Year-long case studies were conducted in ministries, schools, and homes in three countries (Germany, Japan, and the U.S.). The information on education policy issues thus collected supplements the data from the main study data base by providing additional comparative information about four topics relating to students' opportunity to learn: teacher working conditions, the implementation of standards, how ability differences are dealt with in the classroom, and the role of schooling in adolescents' lives. The case study data were collected by researchers at the University of Michigan.

TIMSS in the U.S.

Data collection for the student, teacher, and school administrator surveys of the TIMSS study took place during spring 1995 in the U.S. About six hundred schools agreed to participate in TIMSS, and these schools provided a total sample of approximately forty thousand students for the three populations combined. At the conclusion of the data collection period, in late May 1995, data had been collected from 189 Population 1 schools, 185 Population 2 schools, and 211 Population 3 schools—with about 11,100 students responding in each of the three populations.

The U.S. National Research Center publishes a newsletter for TIMSS. If you would like to be placed on the mailing list, please contact the TIMSS U.S. National Research Center at 464 Erickson Hall, College of Education, Michigan State University, East Lansing, MI 48824-1034; (517) 353-7755; e-mail: jbabcock@msu.edu. Personnel at the center are also interested in presenting more detailed information on TIMSS in person. If you have an upcoming meeting or event and you would like to schedule a presentation on the Third International Mathematics and Science Study, please contact the center at the above address or e-mail valverde@msu.edu.

Teachers Doing Mathematics: A Lower Division Mathematics Colloquium

Richard B. Thompson

The Concept

Music teachers get together and perform music. English teachers read and discuss literature. To maintain their own enthusiasm for the subject and to be able to motivate students, all teachers of mathematics need to be actively involved in doing mathematics. I believe that people do mathematics when they either discover or learn mathematics that is new to them, and then they apply those ideas in some mathematical setting. Unfortunately it is quite possible and altogether too common to teach routine mathematics classes without actually doing any mathematics. My concern about this problem led to the establishment of a basic mathematics colloquium at the University of Arizona. During our first year of operation, we had adjunct faculty members, graduate students, and regular faculty members locating the roots of polynomials, discussing the mathematics of consumer theory, and demonstrating juggling and mathematics. This article contains an account of what we did and some comments on the effectiveness of our program.

In our department a considerable amount of the lower division instruction is provided by a group of over twenty adjunct faculty members. This group includes high school and community college teachers who participate in cooperative exchange programs with the university, as well as other people who hold temporary appointments. An adjunct faculty member teaches a full-time load of twelve units. Since new students usually begin their mathematical work with lower division courses, we refer to the group of people with adjunct appointments as our Entry Level Faculty. All community colleges and many universities and four-year colleges have instructors whose duties and mathematical needs are similar to those of our Entry Level Faculty.

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The good news was (and still is) that any teacher in an entry level program is in an excellent position to enjoy doing mathematics. Many beautiful and useful mathematical topics are relevant to, or arise from, the material in our lower level classes. Moreover these topics can be explored by any mathematician with the experience and background needed to teach freshman and sophomore courses successfully. The bad news was that this activity was not happening to any great extent. Our regular faculty members do mathematics as part of their jobs. Teaching Assistants are expected to be doing mathematics in their graduate courses. Unfortunately we were not providing any opportunities or incentives for our Entry Level Faculty members to join in the fun.

We have an ongoing Mathematics Instructional Colloquium that considers topics in the teaching of mathematics and the evaluation of our teaching efforts. As a strong research department, we also have a very active program of talks on various advanced mathematical topics. Neither of these provided a venue for Entry Level Faculty members to discuss mathematics that they had done, or to see presentations of topics that fit within their mathematical experiences. To provide a suitable mathematical forum, I promoted and managed an Entry Level Mathematics Colloquium.

My resolve to address the problem of mathematical inactivity was greatly strengthened by a conversation that I had with a colleague who teaches in a local community college. When I encouraged her to participate in the colloquium, she declined, saying, "I've been so busy teaching and serving on committees, that I haven't had a mathematical thought in fifteen years!" I believe that one of the best ways to encourage our students to experiment with mathematical ideas and to discover basic concepts is to practice these same skills ourselves. In the same vain as the old adage "Physician, heal thyself," my rallying cry became, "Learning facilitator, facilitate thyself!"

What We Did

In 1994–95 I found volunteers to present a series of nine programs, with presentations scheduled for 4:15 P.M. every third Tuesday. Four of the talks were given by members of our Entry Level Faculty, one by a Teaching Assistant, and four by regular faculty. All of the speakers distributed nicely processed handouts covering the content of their presentations. I advertised each program with a handbill that featured a brief description of the talk and some type of eye-catching and irreverent artwork.

What are suitable topics for such a colloquium? Our titles and some brief notes give a partial answer to that question.

Spheres: Applications, Limits, and Reality I illustrated several natural ways to approximate the surface area of a sphere with a finite sum and then take the limit of such sums. Analysis, computation, and computer graphics were used to compare

Charles Naffziger demonstrates mathematics in action.

the results and to connect them with reality. The graphics led to a simple geometric motivation for the usual definition of area as a surface integral.

Does That Always Work? A "Shortcut" for Solving $\log_a(x - b) + \log_a(x - c) = d$ Charles Naffziger had an Intermediate Algebra student who used a self-discovered method for solving examples of such equations that was totally incorrect, but always gave the right answer. Charlie showed that this was due to the simple examples that we normally create, and gave conditions under which the student's plan actually did work.

Getting to the Root of the Matter: Finding Complex Roots of Polynomials Ed Kingham compared the location of complex roots with the high and low points on graphs of polynomials.

The Mathematics of Coin Tossing William Faris considered the advisability of using the strategy "quit while you are ahead" in fair games of chance. His conclusion was that you should either have deep pockets or very good credit. The probability of getting ahead is 1, but the expected time for this to happen is infinite!

Simpson's Rule—On Trial Mary Sibayan discussed a simple, unbounded, real function that has one discontinuity on [0,1]. Specific Riemann Sums were given, showing that the function was not Riemann integrable, yet an application of Simpson's Rule produced an apparent approximation of the non-existent integral. Analysis and computation were used to show that Simpson's Rule actually approximated the value of the improper integral of the function.

Roots of Polynomials: Where Are They, Why Are They There, and How Can We Find Them? I used cardboard cutouts and computer graphics to show that the roots of polynomials are located at the intersections of the 0-contours of the real and imaginary parts of the polynomial function, extended to the complex plane. This led to an understanding of the geometry behind the use of Newton's Method for finding complex roots.

What Surface Area Isn't John Leonard presented an example showing that surface area is a very tricky concept. He demonstrated that it is possible for the sums of the areas of inscribed triangles to have an infinite limit.

Calculus and Consumers Bruce Hartman illustrated the use of mathematics in consumer theory, employing topics that ranged from calculus to very elementary topology.

Mathematical Juggling: An Introduction to Site-swaps Charles Naffziger used combinatorics, computer simulation, and live juggling to establish and illustrate the mathematical analysis of juggling patterns.

Throughout the year, I used my selection of speakers and my introductions to the talks to stress the underlying structure of mathematics, the manner of its discovery, and the means of its dissemination. My talk on the roots of polynomials extended the ideas that Ed Kingham had presented in his earlier talk. The presentation by John Leonard pointed out how lucky I had been in my rather casual use of numerical ap-

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Interest in Math Technology Grows in Asia

Zaven A. Karian

The First Asian Technology Conference in Mathematics, held at the National Institute of Education in Singapore, December 18–21, 1995, indicated a growing Asian interest in the use of technology in mathematics.

The conference drew an attendance of more than three hundred individuals from twenty-two countries (eighteen from the U.S.). It consisted of seven Plenary Lectures, four Special Lectures, and about ninety contributed papers. The Plenary Lectures dealt with state-of-the-art issues related to the use of technology in the practice and teaching of mathematics, and set the agenda for the conference. M. Conder (New Zealand) spoke on semi-automated theorem proving and the manner in which the meaning of proof has changed; D. Johnson (United Kingdom) discussed the impact of technology on school mathematics; I gave a lecture describing the use of symbolic computation in undergraduate mathematics, particularly in probability and statistics; K. Oh (Korea) showed how computer-aided tutorials can be used in teaching and in evaluation; T. Sasaki (Japan) advocated a more collaborative effort among users and developers of mathematical software; J. Uhl (U.S.) discussed the disparity of the mathematics we do and the mathematics that we teach; W. Wu (China) described the use of technology and the development of mathematics in China.

The four Special Lectures described the trends and philosophy behind the development of major mathematical software packages such as *Maple*, *Mathematica*, and *Scientific Workplace*.

The next Asian Technology Conference in Mathematics will be held in Penang, Malaysia, June 16–20, 1997. For information, contact Professor Wei-chi Yang; e-mail: wyang@runet.edu.

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Mathematician Wins Top Sun Prize

A mathematician has won the grand prize in Sun Microsystems' contest to promote its new software "Java." Robert Morey, graduate student at the University of British Columbia, created his own Web page as the contest entry late last year. An animated graphical proof of the Pythagorean Theorem, Morey's Web page can be found at the URL: http://www.math.ubc.ca/~morey/morey.html

Developed by Sun, Java is the first programming language to enable interactivity on the Internet that is both software- and hardware-independent. It provides the multimedia richness of a CD-ROM with the reach of the Internet, enabling real-time, secure access to applications across the network.

A follow-up contest was already announced by Sun Microsystems. The Java Cup International ended March 31. Sponsors include Sun, Netscape Communications Corporation, Oracle Corporation, and SunSoft, Inc. For complete information on the Java Cup International, see the URL: http://javacontest.sun.com

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proximation for surface areas. Our resident juggler, Charlie Naffziger, became interested in the mathematical aspects of his hobby when I told him about Ron Graham's presentation at the 1994 Minneapolis MathFest.

How Well Did It Work?

The colloquium had an average attendance of around thirty people, with a typical audience including members of the Entry Level Faculty, the regular faculty, and a few visitors from outside of our department. Following the talks, discussions of the presentations could be occasionally heard around the Mathematics Building. I was delighted to have people initiate mathematical conversations with me—people who had never done so in the past. Perhaps the most interesting comment that I heard was from one of our Entry Level Faculty members: "It has been years since I heard a mathematical talk that I could actually understand!"

By far the greatest benefits accrued to the speakers. Mary Sibayan discovered that "Giving a mathematics talk is like showing people snapshots from a trip—they only share in a small part of what you have seen and learned." Ed Kingham and Charlie Naffziger both had almost identical reactions to their talks: "At first I thought that it would be just another thing that I was supposed to do. But when I got started, I really enjoyed actually doing mathematics."

From conversations with Entry Level Faculty members and from a questionnaire that I circulated, one significant problem became apparent. People who teach twelve units, grade their own homework papers, and hold long office hours do not have the time to do mathematics and prepare colloquium talks. Many people are somewhat intimidated by the thought of discussing actual mathematics, as opposed to the teaching of mathematics, in front of their colleagues. (This incidentally is one of the very strong reasons for having the Entry Level Mathematics Colloquium.) I believe that quite a few of these people would enjoy participating in the program if they had the time to scrape off their mathematical rust and encounter some new ideas. If the mathematical community wants the teachers of its basic college courses to be mathematically active, then we must find a way to provide time for such activity.

Based upon our experience with the Entry Level Mathematics Colloquium, I would encourage other universities and colleges to experiment with similar programs. The only requirement is to have someone who wants to put in the time and energy that are necessary to manage the talks and to maintain appropriate standards. As you are reading this, we are underway with our second year. Our current theme is navigation, ranging from spherical trigonometry to the mathematics of the Global Positioning System. If you cannot get to our talks, set up your own colloquium and enjoy doing mathematics!

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UME TRENDS: Observing a Decade of Change and Preparing for the Future

Ed Dubinsky

I don't really know where *UME Trends* came from, originally. I just know that in 1987 I got a phone call from Bill Leveque, who was then executive director of the American Mathematical Society. Bill told me about an idea that was going around that there should be some kind of publication specifically focused on mathematics education and that the National Science Foundation had indicated a willingness to consider a proposal to fund such a project. Would I be interested, he wanted to know, in working on designing a publication and preparing an NSF proposal which would name me as the editor?

What happened during the subsequent nine years relative to mathematics education can be summarized in three words: the culture changed. You might think it is impossible to tell whether the existence of *UME Trends* was a result of that change, which surely had begun well before Leveque's phone call, or whether it has been a cause of that change. Actually it is easy to tell. *UME Trends* has been both a result of, and an agent for, change in the role of mathematics education within the mathematical community.

At the invitation of Keith Devlin, editor of FOCUS, I would like to present some personal reflections on this cultural change and say a few things about what I consider important for the future. I think it would be very good to write a history of this period in mathematical life, but I am not a historian. I am not even an especially good keeper of long-term records. So I will not try to make this little piece any kind of record of names, dates, places. I will just put down some of my memories about what it was like when Leveque called me, how *UME Trends* came into being, how it developed in relation to the rest of events regarding mathematics education, and, finally, some of the things I see ahead—rather, what I would like to see in the near future.

The Culture in 1987

The end of the 1980s was also an end, or completion if you like, of a number of changes in the mathematical culture. Mathematics had experienced a "boom" period of growth in the 1960s, brought on by the nation's reaction to Sputnik, and had gone through more than one cycle of expansion and, if not contraction, at least slow-down. But the overall condition was growth. The number of mathematics departments, Ph.D. programs, and professional mathematicians had increased by orders of magnitude. Statistics, applied mathematics, and computer science had joined theoretical mathematics to form what we now call the Mathematical Sciences. The AMS and MAA had become "democratized," at least to the point of holding contested elections, and the content of annual winter and summer meetings expanded beyond invited hour talks and contributed papers.

The change in the annual meetings is important because of what it tells us about the interests of mathematicians and the responses of our professional organizations to those interests. Up until this point, the overwhelming majority of talks were about new and recent mathematics, or expository presentations of established mathematical content. Although this kind of program was, and is, of major importance to the profession, there was some concern in the 1980s about whether it was all that should be on the program, in terms of the interests of attendees. What is undeniable is that many of the events were very poorly attended, in fact, the overall attendance at these meetings was not as high as desired.

Not everyone felt there was anything amiss in all of this. I remember a conversation I had with one major figure in mathematics in which I pointed out that a large part of the professional activity that took place in our community was of interest and/or benefit to only a very small percentage of, for example, the membership of the AMS. I noted, in that regard, that a recent study had shown that less than 5% of the people who get a Ph.D. in mathematics publish more than one paper. The response was to the effect that this was as it should be. There were people who were doing the really important mathematics—and they were very few in number—and everyone else provided the audience for this mathematics. In return for this service, the overwhelming majority of members of the AMS were granted the privilege of belonging to the prestigious AMS, a fact they could list on their vitas! Incredible as it may seem, I do not think that it has been very long since this view was conventional wisdom in certain mathematical circles.

When the arguments for paying more attention to education made things too uncomfortable, mathematicians generally pointed to the MAA as the organization that was taking care of educational matters. Unfortunately, at that time, the general view among mathematicians was that paying attention to education meant thinking about what courses should be in the curriculum, and what their content should be, together with elegant expositions of interesting mathematics.

Again, as with the emphasis on reports of current mathematics that was the province of the AMS, I want to insist on the importance of paying attention to curricular matters as well as the joy, and therefore importance, of beautiful mathematical expositions. My point is that at this time there was a growing body of opinion that, at least as far as education was concerned, content and exposition were not enough.

UME Trends Starts Out

There is no question that the major changes in our mathematical culture with respect to education were fueled by the calculus reform movement. Initiated as a response to Tony Ralston's challenge to calculus as the appropriate "first college course" for all students, brought forth by the Tulane conference, stimulated by funds from the NSF, and most importantly, carried on by a myriad of mathematicians who really wanted to do something to improve what is a disastrous educational operation, this movement has existed for a decade. It has branched out beyond calculus to other more and less advanced college mathematics courses and been a major agent for educational change. This is not the place to chronicle the calculus reform movement (see the January 1995 issue of *UME Trends* for an extensive treatment). The main relevance to this article is that the existence of *UME Trends* was seen by many, especially the NSF, as part of this movement.

After Leveque's phone call, I worked with Jim Voytuk, associate secretary of the AMS, to organize a small planning meeting which took place at the Chicago airport in October 1987. Some of the results of this meeting were a name for a newsletter, a design, and plans for a proposal to the NSF. In the next few months, the proposal was written and submitted; in summer 1988 the proposal was funded; in fall of that year a staff was gathered; and, in March 1989, volume 1, number 1 of *UME Trends* appeared.

In the course of producing the NSF proposal, it was decided to make this a joint project of the AMS, MAA, and the Society for Industrial and Applied Mathematics (SIAM). This meant that an organization was needed to be the "owner" of *UME Trends* and the only possibility was the Joint Policy Board for Mathematics (JPBM). This was not the best solution, since JPBM is not really set up to publish a newsletter. It has neither the staff nor the budget to play this role, and although the AMS, MAA ,and SIAM all did more than they had to for *UME Trends* in the ensuing years, the publication suffered from the lack of an organizational home.

What happened in practice was that, for the first four years, the AMS served as the actual publisher and the MAA took over for the following three years. Both organizations devoted huge amounts of time, energy, talent, and money. SIAM also made its contribution. What success *UME Trends* has had owes a great deal to efforts of these organizations.

But the most important role was played by the department editors and the editorial committee. It was decided early that *UME Trends* would have a combination of regular departments and single articles. The heads of these departments almost without exception stayed the full seven years and, although the editorial committee underwent the normal changes of the AMS, MAA, and SIAM committees, there was a considerable measure of continuity. I have always considered this group of about fifteen people to make up the *UME Trends* team and I have relied on them heavily throughout the years. I believe that the quality of the publication is entirely due to their efforts. From the start, we adopted a proactive role in obtaining articles. Such an approach is relatively unique in publications of the mathematical community and I think it was one major factor in the success of *UME Trends*.

The Demise Begins

In the first years of publication, support from the NSF permitted us to send *UME Trends* free to all members of the mathematical community (the first year) and those who requested it (the second year) and defrayed some of the other costs of publication for the first three years. The NSF gave additional support for the special issue on calculus reform (January 1995) which was also sent to "everyone." Other than that, the only source of income for *UME Trends* was subscription fees and an occasional, unsolicited contribution.

The number of paid subscriptions never reached the level (a little over four thousand) necessary to make *UME Trends* self-supporting and the members of JPBM paid the difference. It is certainly the case that low subscriptions and excessive costs were important factors in deciding to cease publication.

But there is another consideration. We can estimate that there are about 40,000 college teachers of mathematics in the U.S. What does it mean that less than 10% of them have subscribed to *UME Trends*? One possible answer is insufficient interest in the contents of *UME Trends*. But there is reason to believe that this may not be so. There are a lot of indications that the set of subscribers to *UME Trends* is only a small subset of the set of readers. There is a very large number of mathematics departments in which exactly one person subscribes. The newsletter is found in many department commons rooms. There are, I think, many reasons, in these complex, financially difficult times why individuals may not subscribe to a particular publication.

The Changing Culture

How has the mathematical culture changed in the past decade with respect to mathematics education? I think there have been two major changes. There has been an overall increase in interest and activity in mathematics education, and the emphasis has shifted from being entirely concerned with what college mathematics courses should be taught, in what order and with what content, to what pedagogical strategies might be used and how can we learn to use them.

An important part of this change has to do with technology. We have gone from almost total concern with what changes in topics does technology allow (require?) to at least some interest in the different kinds of pedagogy that can be used in incorporating technology.

I can offer two anecdotes about this change. First there was the NSF-sponsored conference in San Antonio in October 1990. It was held to determine what should be the content of the reformed calculus course. It was a turning point because, at the conference, much of the discussion was about pedagogy and no topics list came out of the meeting. On the personal side, I worked with a group at Purdue University to submit, in fall 1987, a proposal to the NSF for a large, multi-year calculus reform project. It was rejected and we even got a letter from the NSF saying explicitly that we were not encouraged to revise and resubmit because our project was too much concerned with pedagogy and research in learning. Nevertheless, we did resubmit, making mainly minor cosmetic changes and the following year, our proposal was funded, giving us almost all the money we asked for. The amount of money was, at that time, the largest amount awarded to a single university for calculus reform. The culture was changing.

I think that *UME Trends* was one of the agents for that change. Apart from contributing to the overall ambiance of interest in education, I believe that the article by Lida Barrett and Bill Browder (October 1989) was instrumental in convincing people that pedagogy was not being paid enough attention.

The increase in interest and activity is easy to see. All of the professional societies now have councils or committees on education. The AMS and MAA have a Joint Committee on Research in Undergraduate Mathematics Education which, amongst other activities, edits *Research in Collegiate Mathematics Education*, an annual volume of research papers. The MAA Committee on Professional Development is engaged in developing a number of courses on pedagogy, including a course on cooperative learning, a course on pedagogy for graduate students, and a course on how mathematics can be applied. These courses

are expected to make heavy use of distance learning techniques. The MAA also has Project CLUME, funded by the NSF, which conducts workshops on cooperative learning. One of the most exciting new activities is Project NExT, funded by the Exxon Educational Foundation, which is a program for young mathematicians, aimed at improving college teaching. Other encouraging developments include the Humanistic Mathematics Network and the MER Department Network.

These changes are reflected in the winter and summer meetings of the AMS and MAA. Today the meetings are full of contributed paper sessions (which now average upwards of eighty people in every audience), panels, and even invited hour talks on research in collegiate mathematics education. In 1994 Steve Monk, and in 1995, Joan Ferrini-Mundy spoke to packed houses about this topic.

Again to put a personal note on it, I have been involved since about 1990 in organizing or helping to organize at these meetings, a contributed session of papers on research in undergraduate mathematics education. Although the interest in these sessions is always high, and has been increasing, it has become more and more difficult to get this session on the program. In the beginning, the program committee welcomed, almost to the point of soliciting, our request to run this session. Now we have to wait our turn and we don't get as much time as we want. The reason is that there are now many other programs of equal interest and importance being proposed, and the appropriate committees have moved from trying to generate programs to deciding which of many excellent suggestions should be accepted!

Into the Future

So, having participated in these changes, and edited a publication that tried to report on all of them, I perhaps can take for myself the liberty of saying what I think are the most important changes for the future. It is not so much a prediction as a call. Or, if you prefer, I am simply laying out what will be my personal agenda for progress in the coming years.

The first thing is to continue reporting on education matters. Now that *UME Trends* is no longer part of the scene, the MAA is making a major effort to increase the number of education articles that appear in MAA publications. (See the article by Daniel and Tucker on page 1 of the February 1996 FOCUS.) Next, I think that college faculty must become more reflective about how their students learn and what pedagogical strategies will be most helpful to the process. Concurrently, departments need to allocate resources (including positions) to curriculum development and educational research so all faculty can see that it "counts" and none will be tempted to say, "Education is what you do when you can't do math."

One major step in developing our pedagogy is research in learning and teaching. Of course we must study how we teach and what are the effects of our teaching. But we also need to find out a great deal about the learning process. What, exactly, is going on in the minds of our students as they struggle to understand mathematical concepts, to solve problems? Just why is it that some students will have certain kinds of difficulties that others will avoid? Can we focus our teaching on the elimination of these difficulties? Can we get into the minds of our students and make big changes in how successful they are in mathematics? I think we can and I think that research in learning is a major key to doing that. I want to emphasize that I mean both research that will tell us what we might do very soon, and also basic research that may not tell us anything now but contributes to building a foundation for our understanding the nature of mathematical knowledge and how individuals do or do not develop it.

And finally, we must do a lot of work with the pedagogical approaches that have the potential to be helpful. There are major strategies such as cooperative learning, the use of computers and calculators, large projects, writing, and distance learning. We have to learn how to use these methods and how to disseminate that knowledge throughout the profession.

In addition to the major strategies, there is a myriad of ideas for specific pedagogical techniques. The regular column "Innovative Teaching Exchange," edited for seven years by Bonnie Gold in *UME Trends*, produced nearly one hundred short pieces on one or more such methods. We need an outlet to continue publishing these suggestions—and we need a way of getting people to try them out so that we can discuss their merits.

All in all, it is a wonderful time to be a mathematician interested in education. We have just gone through a decade of growth and all indications are that this is only the beginning. I look forward to more decades in which I will be able to observe and participate in a continued program of pedagogical improvement from the point of view of theory and practice. And the beneficiaries of all this exciting activity are our students, who, according to my experience, are capable of rising joyfully to challenges we set before them and which we convince them are worthy of their greatest efforts.

Ed Dubinsky, editor of the former UME Trends, *is a professor at Purdue University. His e-mail address is bbf@cc.purdue.edu.*

New from the MAA

A Practical Guide to Cooperative Learning in Collegiate Mathematics

Nancy L. Hagelgans, Barbara E. Reynolds, Keith E. Schwingendorf, Draga Vidakovic, Ed Dubinsky, Mazen Shahin, G. Joseph Wimbish, Jr.

This book will greatly help readers introduce cooperative learning in their own undergraduate mathematics classes. Instructors who have tried some group activities as well as those who have not been involved at all with cooperative learning will find here detailed, useful discussions on every aspect of cooperative learning. the book reflects the extensive experience of the authors as well as that of over forth colleagues who responded to a survey on cooperative learning. Throughout he book cooperative learning is related to educational research results, which are clearly explained in one chapter.

The authors' approach to cooperative learning involves students working in heterogeneous groups, usually assigned for the duration of the course. Students become responsible for each others' learning since the cooperative spirit permeates every facet of the course; homework, laboratory, assignments, classes, and even some tests.

The book includes directions for organizing students into groups as well as complete descriptions of what these groups do once they are formed. Examples of group problems and group test questions for various mathematics courses illustrate the work that can be expected of students in cooperative learning groups, the authors present methods for monitoring groups and dealing with problems that may arise in a cooperative learning environment. They also address the question of student assessment.

In addition to descriptions of their own methods, the authors include a chapter that summarizes forms of cooperative learning used by others. An extensive and annotated bibliography is also included. This book is a valuable resource for any instructor who uses cooperative learning groups in an undergraduate mathematics class.

Catalog Number: NTE-37/FOC

190 pp., Paperbound, 1995

ISBN 0-88385-096-6

List: $24.00 MAA Member: $18.00

Models that Work

Case Studies in Effective Mathematics Programs

Alan C. Tucker, Editor

A wonderful resource for anyone who wants to improve their undergraduate mathematics programs. Here are samples of programs that really do work!

This study focuses on key aspects of the undergraduate mathematics enterprise.

- effective instruction
- advising
- tailoring the curriculum to students' needs,
- interactions between students and mathematics faculty.

If you are a faculty member seeking to improve your undergraduate program, you will find useful information in this volume. It offers summaries of effective practices at a set of mathematics departments that are:

- attracting and training large numbers of mathematics majors;
- preparing students to pursue advanced study in mathematics;
- preparing future school mathematics teachers; or
- attracting and training underrepresented groups in mathematics.

The report describes general attitudes and strategies as well as particular activities that are effective. Based on the site visits, it suggest ways that you can create and sustain an environment that will foster such attitudes and activities at your own institution. The institutions profiled span the spectrum from two-year colleges to research universities.

The site visits reveal that there is no single key to a successful undergraduate program in mathematics. Almost any approach can be made to work in almost any institutional context if your mathematical faculty care deeply about undergraduate education, if they create an atmosphere where faculty and students view the study of mathematics as important and rewarding, and if they maintain close interactions with their students.

There is much to be learned from these "models that work," that we can apply at our own institutions.

Catalog Code: NTE-38/FOC

ISBN-0-88385

112 pp., 1995

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New from the MAA

Calculus The Dynamics of Change

A. Wayne Roberts, Editor Notes

A must for anyone who teaches calculus! Presents the current thinking about how calculus should be taught.

January of 1995 marked the tenth anniversary of the calculus reform effort initiated by the Sloan Foundation sponsored Tulane Conference on Calculus Instruction in 1986. The proceedings of that conference were published in *Toward a Lean and Lively Calculus*, and clarified in a second volume, *Calculus for a New Century*, published by the MAA in 1987. By 1990 foundation support had produced a number of projects that the MAA's Calculus Reform and First Two Years (CRAFTY) committee summarized in its publication of *Priming the Calculus Pump: Innovations and Resources.*

As the tenth anniversary of the movement approached, CRAFTY felt it was time to say something conclusive about the state of calculus teaching today. This present volume is the result of that effort.

The opening essay, "A Modern Course in Calculus", will show you the themes that the Committee believes should characterize a modern calculus course, both in terms of teaching and content. Although this statement is not intended to be a prescriptive guide, it will give you solid information to help you decide whether or not your department is in line with current thinking, or even if it wants to be. For instance:

• The notion that a course should get off to a fast start. Students have been told throughout the secondary curriculum that "You'll see the reason for this when you get to calculus." It's time to make good.

• Instructors should focus on applications that they understand and are enthusiastic about. The goal should not be to just to solve the problem at hand, but to understand the methods of calculus that need to be used, and to apply those methods to new problems.

• A calculus course cannot be modernized simply by finding a way to make use of graphing calculators or computers. Their proper role is as a tool for experimenting, discovering, illustrating, or substantiating. They should be used to develop intuition and insight, not as a tool to crank out answers to larger and more complicated exercises.

• Students should move comfortably between symbolic, verbal, numerical, and graphical representation of mathematical ideas.

• Students should be able to give clear explanations of why things work the way they do, what they mean, and when they are used.

• When we evaluate students we must take into account how they work on extended projects, their contribution to the group, their knowledge of the proper use of technology, their ability to write mathematics, and the initiative they take to do independent reading.

The four main sections of the book describe the vision of those who have developed materials, offer guidance to departments considering a change, discuss methods of assessment, and describe the effect of calculus reform on other courses in the mathematics curriculum. Taken altogether, this is intended as a handbook for change.

Catalog Code: NTE-39/FOC

ISBN-0-88385-098-2; 172 pp., 1995

List: $34.95 MAA Member: $29.00

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New from the MAA

From Erdös to Kiev

Problems of Olympiad Caliber

Ross Honsberger

Ross Honsberger sums up his reason for writing his latest book this way,

"A proof can be a wonderful thing, and it is my hope that the reader will be thrilled by a leisurely presentation of some of the things that have fascinated me. Writing to give pleasure is far different from writing to instruct, and I hope this is evident in the style of of presentation. It does wonders for readers' attitudes if they believe that your only interest is to show them something beautiful; such a conviction is strong encouragement for them to commit to the level of concentration necessary for the appreciation of these gems."

Ross Honsberger's love of mathematics comes through very clearly **in From Erdös to Kiev**. He presents intriguing, stimulating problems that can be solved with elementary mathematical techniques. It will give pleasure to motivated students and their teachers, but it will also appeal to anyone who enjoys a mathematical challenge.

Most of the problems in the collection have appeared on national or international Olympiads or other contest. Thus, they are quite challenging (with solutions that are all the more rewarding). The solutions use straightforward arguments from elementary mathematics (often not very technical arguments) with only the occasional foray into sophisticated or advanced ideas. Anyone with a facility with high school mathematics is capable of appreciating a large part of the book.

The problems included in this collection are taken from geometry, number theory, probability, and combinatorics. Solutions to the problems are included.

Catalog Code: DOL-17/FOC

250 pp., Paper, 1995

ISBN-0-88385-324-8

List: $31.00 MAA Member: $23.50

From Martin Gardner—

Mathematical jokes, mathematical magic, and a dose of fun

New Mathematical Diversions

Martin Gardner

A revised version of a book previously published by University of Chicago Press.

Instructive reading for students, teachers, mathematicians at all levels, as well as interested laypersons.

Offered here are twenty reprints from Martin Gardner's monthly corner in *Scientific American.* Gardner tells us that his book is a book of "mathematical jokes," if "joke" is taken in a sense broad enough to include any kind of mathematics that is mixed with a strong element of fun. Readers of this book will be treated to a heavy dose of fun, and they will learn alot about mathematics along the way.

Martin Gardner instructs us about mathematics as he entertains us with wit and sense of the absurd. He stimulates, challenges and delights his readers. Martin Hollis (in *New Scientist*) says it best when he says of Gardner's work, "Should you ever need to explain subatomic particles to a Stone-age man, send for Martin Gardner...He leaves open questions open, conveys the thrill of the chase and deals flawlessly with hard and simple ideas alike."

Some of the problems you will find here are:

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- Polyominoes and Fault-Free Rectangles
- Euler's Spoilers: The Discovery of an Order-10 Graeco-Latin Square
- The 24 Color Squares and the 30 Color Cubes
- Bridg-it and Other Games

Answers are provided for these problems, as well as references for further reading and a bibliography. Martin Gardner's Postscript section provides updates to the problems.

Catalog Code: DIVER/FOC

272 pp., Paperbound, 1995

ISBN 0-88385-517-8

List: $19.95 MAA Member: $16.50

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or use order form on page 35

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It is our belief that the repeated hiring of temporary faculty not only impedes the career development of the young mathematicians holding these positions, but also increases the work load of permanent faculty. An individual in a one-year position must begin searching for a new job every October. He or she does not have the time and energy, and, indeed, can hardly be expected, to contribute to the life of the department and of the institution.

It is our hope that those departments that have been forced to hire temporary faculty on a regular basis will be able to work with their administrators in order to reduce or eliminate this practice.

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Mathematics Department

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Standard teaching load is three courses per semester. Muhlenberg College is an independent, undergraduate coeducation institution, affiliated with the Evangelical Lutheran Church in America. The College is within easy driving distance of both Philadelphia and New York City. To apply, send resume, statement detailing teaching experience and research, and three letters of recommendation. Please indicate for which of the positions (or both) you wish to be considered. All application materials should be sent to Dr. John Meyer, Head, Mathematical Sciences De-

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

partment, Muhlenberg College, Allentown, PA 18104-5586. Application review begins in March and will continue until the positions are filled.

Muhlenberg College is an equal opportunity employer.

Western Washington University
Applied Mathematics

Tenure-track Assistant Professor, starting Fall 1996. Mathematical modeling (particularly biological sciences) or optimization preferred. Other highly qualified candidates will be considered. Ph.D. and evidence of effective teaching required. Faculty are expected to be productive scholars and excellent teachers. Commitment to innovative undergraduate instruction essential. Teaching assignments (two courses per quarter) will include large lower-division classes. Scholarly collaboration with colleagues and development of grant-funded research projects is expected. WWU is an EEO/AA employer. Submit a letter of application, AMS cover sheet, vita, complete transcripts, evidence of teaching accomplishments, and three letters of recommendation addressing both teaching and research qualifications, by April 5, 1996, to: T.J. Ypma, Chair, Mathematics, Western Washington University, Bellingham, WA 98225-9063, U.S.A. Fax: (360) 650-7788. E-mail: mathdept@cc.wwu.edu.

Louisiana College
Division of Natural Sciences & Mathematics

Assistant/Associate Professor (tenure track). Ph.D. required. Teach full range of undergraduate courses. Must be able to demonstrate excellence in the classroom and must be able to enhance the academic program from a Christian perspective. Salary and rank dependent upon qualifications and experience. Church-related (Baptist) liberal arts college. Send letter of application and resume to Dr. Dennis Watson, Chairperson, Division of Natural Sciences and Mathematics, Box 602, College Station, Louisiana College, Pineville, LA 71359. AA/EOE

Hendrix College Mathematics

The Department of Mathematics invites applications for a one-year assistant professor position in mathematics anticipated to begin in August 1996. [An additional year's renewal is possible.] A Ph.D. in mathematics, promise of excellence in teaching, and a commitment to continued scholarship are essential. Preference will be given to applicants with expertise in analysis or statistics. Responsibilities of the position include teaching seven courses over three terms (fall, winter, spring) with emphasis on the continuing development of reform calculus courses and undergraduate research.

Hendrix College is a private, selective, United Methodist related, liberal arts college of about 1000 students in Arkansas about 30 miles north of Little Rock in the foothills of the Ozark mountains. The Department of Mathematics, with five full-time faculty, has a vigorous undergraduate research program and currently offers a major in mathematics and minors in mathematics and computer science.

Send a letter of application, curriculum vitae, statement of teaching interests and scholarship goals in a liberal arts environment, graduate and undergraduate transcripts and letters from three references (at least one of whom is qualified to address teaching effectiveness) in hard copy to: David C. Sutherland, Chair, Department of Mathematics, Hendrix College, Conway, AR 72032 (sutherlandd@ hendrix.edu).

Evaluation of applications will begin May 1, 1996, and continue until the position is filled. Hendrix College is an Equal Opportunity/Affirmative Action employer. Women and minority candidates are especially encouraged to apply.

The University of Oklahoma
Department of Mathematics

Applications are invited for a tenure-track or tenured faculty position in Mathematics Education starting in Fall 1996. Rank and salary will be commensurate with qualifications and experience. Candidates are required to have a Ph.D. in Mathematics or in Education with a Mathematics specialization, and demonstrated commitment to research in Mathematics Education. A strong background in Mathematics beyond the Master's level is also required. Preference will be given to those whose primary research involves collegiate Mathematics Education, or secondary school teacher training.

The faculty member is expected to carry a teaching load of two courses per semester. Candidates should be capable of directing doctoral students and contributing leadership to the department's active graduate program in Mathematics Education. Responsibilities will include involvement with undergraduate Mathematics courses, and with both undergraduate and graduate courses in Mathematics Education.

The Mathematics Department at the University of Oklahoma offers a Doctoral Degree in Research in Undergraduate Curriculum and Pedagogy. Faculty interests include research in quantitative literacy, undergraduate curriculum and pedagogy, and international comparative Mathematics Education. The Mathematics Department faculty cooperate with the University's College of Education which has an M.Ed. Program in Mathematics Education and a Ph.D. program focusing on research in K-12 Mathematics Education. As a University service the Department is also responsible for advising and preparation of some undergraduate secondary Mathematics Education majors, and for providing courses for both elementary and secondary preservice teachers (about 250 and 20 per year, respectively).

Applicants should send a vita, a statement of professional goals, and three letters of recommendation to:

Math Education Search Committee
Department of Mathematics
University of Oklahoma
601 Elm Avenue, Phsc 423
Norman, OK 73019-0315

Initial screening will begin on January 31, 1996 and continue until the position is filled.

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

Women and minorities are encouraged to apply.

The University of Oklahoma has a policy of being responsive to the needs of dual career couples.

Calendar

National MAA Meetings

August 10–12, 1996 Annual Joint Summer Meetings, University of Washington–Seattle, Seattle, WA. Board of Governors Meeting August 9, 1996

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

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

Sectional MAA Meetings

ALLEGHENY MOUNTAIN - April 12-13, 1996, Indiana Univ. of Pennsylvania,Indiana, PA

EASTERN PA & DELAWARE - April 13, 1996, Millersville University, Millersville, PA

- November 1996, Delaware State College, Dover, DE

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

- Spring 1997 Franklin College, Franklin, IN

INTERMOUNTAIN - April 19-20, 1996, Mesa State College, Grand Junction, CO

(joint meeting w/ Rocky Mountain Section)

IOWA - April 26-27, 1996, Cornell College, Mt. Vernon, IA

KANSAS - April 19-20, 1996, McPherson College, McPherson, KS

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

MD-DC-VA - April 12-13, 1996, Randolph-Macon College, Ashland, VA

METRO. NEW YORK - May 5, 1996, C.W. Post College, Greenvale, NY

- May 3, 1997 Mercy College, Dobbs Ferry, NY

MICHIGAN - May 10-11, 1996, Siena Heights College, Adrian, MI

MISSOURI - April 12-13, 1996, Southeast Missouri State Univ., Cape Girardeau, MO

- Spring 1997 Missouri Western State College, St. Joseph, MO

- Spring 1998 Southwest Missouri State University, Springfield, MO

NORTH CENTRAL - April 12-13, 1996, Hamline University, St. Paul, MN

- October, 1996, University of Minnesota, Duluth

NORTHEASTERN - June 7-8, 1996, Hampshire College, Amherst, MA

- November 22-23, 1996, Univ. of Massachusetts-Boston, Boston, MA

OHIO - April 12-13, 1996, University of Akron, Akron, OH

- October 25-26, 1996, Denison University, Granville, OH

ROCKY MOUNTAIN - April 19-20, 1996, Mesa State College, Grand Junction, CO

(joint meeting w/ Intermountain Section)

SEAWAY - April 12-13, 1996, Elmira College, Elmira, NY

- November 8-9, 1996, SUNY College at Geneseo, Geneseo, NY

SOUTH DAKOTA - April 19-20, 1996, Univ. of Nebraska-Kearney, Kearney, NE

SOUTHEASTERN - April 12-13, 1996, Univ. of Alabama-Huntsville, Huntsville, AL

SOUTHWESTERN - April 12-13, 1996, Northern Arizona University, Flagstaff, AZ

- Spring 1997 Texas Lutheran College, Seguin, TX

- Spring 1998 Southern Methodist University, Dallas, TX

TEXAS - Spring 1997 Texas Lutheran College, Sequin, TX

WISCONSIN - April 12-13, 1996, University of Wisconsin-Platteville, Platteville, WI

- Spring 1997 University of Wisconsin-River Falls, River Falls, WI

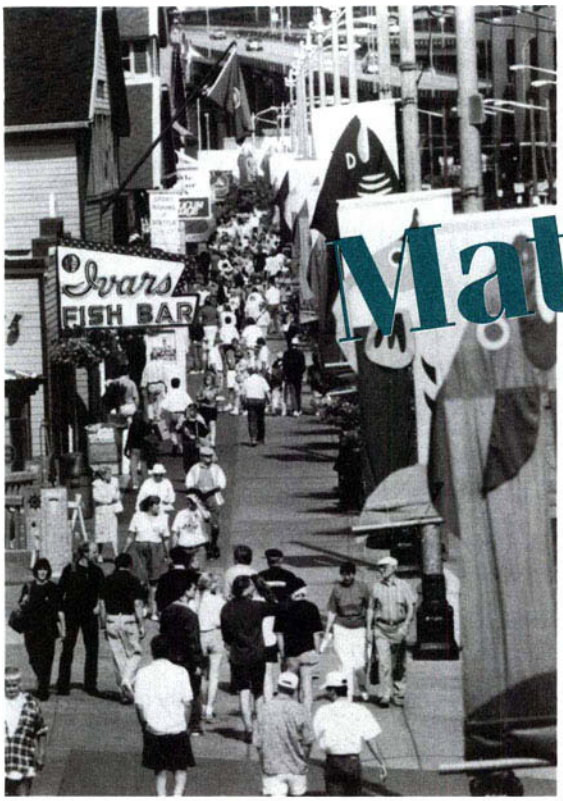
Other Meetings

June 3–7, 1996 CAS–CAL Course, calculus enhanced with computer symbolic algebra using the TI-92 and CBL, LaSalle University, Philadelphia, PA. Contact Charles Hofmann; (215) 951-1136; fax: (215) 951-1805; e-mail: hofmann@lasalle.edu.

June 22–26,1996 Art and Mathematics Conference (AM96), SUNY–Albany, NY. Speakers include John Horton Conway, Martin Golubitsky, and Benoit Mandelbrot. For information, contact Nat Friedman, Dept. of Math and Statistics,SUNY, Albany, NY 12222; (518) 442-4621; fax: (518) 442-4731; e-mail: artmath@math.albany.edu.

July 29–August 2, 1996 PCALC Course, precalculus and calculus topics using the TI-82 and CBL with an introducation to the TI-92, LaSalle University, Philadelphia, PA. Contact Charles Hofmann; (215) 951-1136; fax: (215) 951-1805; e-mail: hofmann@lasalle.edu.

August 5–9, 1996 CAS–CAL Course, calculus enhanced with computer symbolic algebra using the TI-92 and CBL, Montgomery County Community College, Blue Bell, PA. Contact Roseanne Hofmann; (215) 641-6405; e-mail: rhofman@admin.mc3.edu.



MathFest 1996 Seattle

Seattle
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University of Washington
August 9–12, 1996

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