FOCUS

Volume 12, Number 3 THE NEWSLETTER OF THE MATHEMATICAL ASSOCIATION OF AMERICA June 1992

Finding Errors in Long Proofs

How do you set about checking the accuracy of a long proof, one that might stretch into hundreds of pages? Do you have to check it line by line? The question is not only of relevance to overstretched referees of mathematical papers; long proofs also arise in the form of long computations in business applications and in hardware and software testing.

If the proof to be checked is completely formalized (which is the case in computer computations), a remarkable solution is suggested by recent joint work of László Babai, Lance Fortnow, Carsten Lund, and Mario Szegedy of the University of Chicago and Leonid A. Levin of Boston University. In essence, their idea is this: You first transform the long, formal proof into what the authors call a "transparent form." This transparent form can then, in turn, be verified by randomly sampling a tiny fraction of its length.

This work leads to surprising implications regarding the inherent difficulty of finding approximate solutions to a class of discrete optimization problems. Recent exciting developments in this direction were reported in an article written by Gina Kolata in the "Science Section" of *The New York Times* on 7 April 1992. Sensing that there was more to this story than was conveyed by the *Times,* FOCUS went straight to the source and asked László Babai, a member of the original University of Chicago team, to provide the inside story. What follows is the first of two articles from Babai. In it, he describes the earlier work on proof checkers. In the September 1992 issue of FOCUS, he will explain the connection to the solution of optimization problems.

Keith Devlin

Transparent Proofs

László Babai

Proofs Are Fragile One of the most remarkable gifts human civilization has inherited from ancient Greece is the notion of a mathematical proof. The basic scheme of Euclid's *Elements* (c. 300 BC) has proved astoundingly durable over the millennia and, in spite of numerous revolutionary innovations in mathematics, it still guides the patterns of mathematical communication. This scheme was formalized around the turn of the century and, ever since the creation of the *Principia Mathematica* by Whitehead and Russell (1910), mathematicians have rested assured that all their ingenious proofs could, in principle, be transformed into a dull string of symbols which could then be verified mechanically.

One of the basic features of this paradigm is that proofs are fragile: a single, minute mistake (e. g. an incorrectly copied sign) invalidates the entire proof. If a journal editor receives a manuscript running hundreds of pages (as is not uncommon these days in some areas of mathematics), she has little hope of being able to skip a page while assessing the validity of the result.

Almost Sure Proofs? Another fundamental aspect of the classical notion of mathematical proofs is that a proof is either right or wrong; there is no such thing as a theorem proven "beyond reasonable doubt."

This view received a blow in 1977 when R. M. Solovay of the University of California at Berkeley and V. Strassen of the University of Konstanz published an algorithm that achieves just that. It is capable of certifying beyond even utterly unreasonable doubt that a given, large (say 300-digit) number is prime; yet the algorithm will produce no formal proof of primality, and there is a lingering, tiny chance of error.

Let me illustrate this phenomenon with another simple example. Imagine an $n \times n$ determinant D with entries of the type $3x - 15y + \ldots + 4w$, where $x, y, \ldots, w$ are variables. How could we verify the assertion that D (a polynomial of degree n of these variables) is identically zero? It is simple; just expand the determinant. It is identically zero precisely if all terms cancel. The difficulty is that the intermediate stages may require listing an exponentially large number, say more than 2^n, expansion terms. Even for n as small as 300, 2^n exceeds the number of atoms in the known universe, so, with due respect to Cray Corporation, it seems safe to predict that this approach will remain beyond the capacity of computers of the twenty-first century.

But, suppose that, instead, we perform the following experiment. Draw numbers at random from $\{1, 2, \ldots, 2n\}$ and substitute such a number for x, another one (drawn independently) for y, etc. Our determinant is now fairly easily evaluated using Gaussian elimination. (We need high precision arithmetic; for $n = 300$, this task can be implemented on a moderately sized contemporary computer.[1]) Now, there are two possibilities. If $D = 0$, then we get zero regardless of the choice of our random numbers. However, if $D \neq 0$, then, according to a simple lemma of Jacob Schwarz (1980), we have at least a 50 percent chance of catching a "witness," a substitution which results in a nonzero numerical value.

Repeat this say 300 times and the probability of not catching a witness (accepting the false statement $D = 0$ on the evidence obtained by 300 random substitutions all giving the numerical value zero) will be less than 2^{-300}, or less than the reciprocal of the numbers of atoms in the universe.[2]

*(**Transparent Proofs** continues on page two.)*

"... a goldplated Macintosh monitoring the operation of a herd of Crays."

*(**Transparent Proofs** continued from cover page.)*
The philosophical cost of this efficient method is that we lose the absolute certainty of a Euclidean proof. You may have doubts, even after 300 experiments all resulting in 0, that D is identically zero. We certainly don't have a formal proof. But if you do have doubts, will you bet with me?

MAKING PROOFS TRANSPARENT For absolute certainty, a formal proof has to be checked in full detail. The good news is, however, that if we are satisfied with "near certainty" as just outlined, the cost to the verifier can be greatly reduced. The new result says that *all formal proofs* can be transformed into robust, *transparent* forms which, in turn, can be checked by randomly sampling a small number of places in the proof. If the proof is a string of N symbols, its "transparent version" will have length about $N^{1.5}$ and is computable from the formal proof using a simple-minded program. (Most of the work of the *transforming program* consists of hardly more than listing millions of terms in an arithmetic progression. This simple but tedious work will be the *job of the prover,* who desperately wants us to accept his result.) Now the *checker,* a small machine with a prewired program, will sample about $(\log N)^4$ bits of the proof using clever randomized selection. (All that the checker requires as input is the number N.) Failing to discover some indication of error in the sample, it will declare the proof "correct with at least 50 percent probability." We may then repeat the checking procedure 300 times to gain the "ultimate" assurance.

Roughly speaking, one can say that the transformation which turns a proof into transparent form magnifies any error so it will be visible nearly everywhere. On the other hand, if the prover makes a (possibly deliberate) error in the transformation itself, this fact is also likely to be detected if it significantly distorts the tightly knit fabric of the transparent proof. If the distortion is small, however, then a correct version can be uniquely recovered and, like a gentle grader, the checker will accept the (otherwise correct) proof.

COST OF RELIABILITY REDUCED Verification of computer programs in general faces formidable obstacles; even the simplest questions about the behavior of programs is algorithmically undecidable. As an alternative, M. Blum of the University of California at Berkeley championed the idea of "instance checking," verifying that a particular computation produces what it is supposed to produce. Together with M. Luby of the International Computer Science Institute (ICSI) and Berkeley students S. Kannan and R. Rubinfeld, Blum demonstrated the surprising fact that, in many cases, the programs themselves can be used to check their own validity.

While our approach is partly motivated by this concept, we cannot use the original computation to check itself.

So, what is the deal, you may ask. It is a lot of extra work to produce the transparent form, certainly more than going through the entire original computation.

True, but, as in Blum's case, we do not need to invoke *faith in the reliability* of large machines with their powerful but untested hardware and software. To certify reliability of large systems is all but impossible and businesses may even have to worry about an adversary trying to forge their accounts.

Instead, we shift the burden of certifying reliability to a small machine which will run a single program in a comparatively tiny amount of time—*a goldplated Macintosh monitoring the operation of a herd of Crays.*

HOW DOES IT WORK? By turning logical operations (such as "and") into arithmetic operations (such as "times"), and by appropriately encoding the steps of a classical (step-by-step) verification process, one can reduce the validity of a proof to a statement of the following form: given an explicit expression for a polynomial $f(x, y, \ldots, w)$ of about $n = \log N$ variables and degree 6 in each variable, verify that the sum of all f-values over the 2^n possible substitutions of 0 and 1 for the variables is zero.

This problem bears some resemblance to the determinant evaluation problem discussed earlier. To catch the error, we have to allow random substitutions for the variables from a domain of size about n^2. A process of gradual elimination of the variables, called the "LFKN protocol" for its inventors C. Lund, L. Fortnow, and H. Karloff, all of the University of Chicago, and N. Nisan of MIT and Hebrew University, is used in the way a police inspector cross-examines a suspect, forcing him to make his tale more and more specific until he is caught contradicting an easily verified fact (misstatement of a value of f). This process requires the prover to list the values of n auxiliary functions f_k, $1 \le k \le n$. The function f_k is obtained from f by evaluating the first k variables of f for values 0 and 1 in all possible ways and adding up the resulting 2^k functions. The "transparent proof" will consist of the arrays listing the values of each f_k.

A key part of the procedure is to check "the fabric": the tight structure commanded by the requirement that the arrays represent polynomials of low degree. For simplicity, imagine that the degree in each variable is 1: the polynomial is *multilinear* (e. g. $3xyz - 7xzw$). To check multilinearity, we randomly fix the values of all but one of the variables and verify that as the remaining variable varies through $0, 1, \ldots, n^2$, the function traverses an arithmetic progression.

It can be shown that by making a small number of tests of this type, one can gain large confidence that the array represents a function that is very nearly multilinear (errs in a small fraction of the entries only). Curiously, the proof of the latter fact depends on an isoperimetric inequality for the n-dimensional grid.

Finally, let me note that, at the moment, the main obstacle to practical applicability of our checker is in the length of the transparent proof. It is an open problem to reduce this length to nearly linear (something like $N \log N$) while retaining the efficiency of the checker.

The technical details of the "transparent proofs" theorem are described in the following two papers:

L. Babai, L. Fortnow, and C. Lund. "Nondeterministic Exponential Time Has Two-prover Interactive Protocols," *Computational Complexity,* **1** (1991): 3–40.

L. Babai, L. Fortnow, L. A. Levin, and M. Szegedy. "Checking Computations in Polylogarithmic Time," *Proceedings of the Association of Computing Machinery's (ACM) Twenty-Third Symposium on Theory of Computing* (1991): 21–31.

NOTES

1. According to J. I. Northrup of Colby College, using *Mathematica* on a MacIIcx, a 300 x 300 integer determinant will take around two hours to compute.

2. Better yet, we may choose our random numbers from the range $\{1, 2, \ldots, 1000n\}$. Then in a single round, the chance of error will beat most 1/1000; in two rounds, one in a million, and thirty rounds suffice to get below one over the universe.

László Babai is Professor of Computer Science at the University of Chicago and Professor of Mathematics at Eötvös University in Budapest, Hungary.

New Mersenne Prime Discovered

Cray Research recently announced the discovery of a new Mersenne prime. After a nineteen-hour computation using a fast primality testing method called the *Lucas-Lehmer Test,* a Cray-2 supercomputer in England pronounced the 227,832 digit number

$$2^{756839} - 1$$

a prime number.

Mersenne numbers are integers of the form $2^N - 1$ and are named after a seventeenth-century French monk who first investigated the primality of such numbers. The new discovery is the thirty-second Mersenne prime to have been identified. The previous record holder was

$$2^{216091} - 1$$

which was identified as a Mersenne prime back in 1985. It is not known if there are any other Mersenne prime numbers between these two. The exponent range from 216,091 to 365,000 has been checked completely and no Mersenne primes were found. A partial check has been made up to exponent 430,000. The range 430,000 to 520,000 has been completely checked. The range between 520,000 and 750,000 has been only sparsely checked. Moreover, the exponent range from 170,000 to 216,091 has not been completely investigated.

Since an even number is perfect if and only if it is of the form

$$2^{N-1}(2^N - 1)$$

where $2^N - 1$ is prime, the new discovery has resulted in the identification of a thirty-second perfect number. The new perfect number has 455,663 decimal digits.

It should be noted that the nineteen-hour computation was required just to run the Lucas-Lehmer Test on that one Mersenne number. A great many exponents were examined prior to the one that gave a positive answer. Although it is known that only prime exponents can produce Mersenne primes, the scale of such a search is still enormous, which puts this game well beyond the reach of all but the supercomputer companies, who run such programs as a means of testing hardware and software.

Attracting Minorities into Teaching

The MAA's Strengthening Underrepresented Minority Mathematics Achievement (SUMMA) program recently received one-year funding from the National Science Foundation (NSF) for its project on *Attracting Minorities into Teaching Mathematics* (AMIT). This project will study the characteristics of undergraduate programs that successfully attract minority students into teaching mathematics at the secondary level. While the SUMMA staff knows of several exemplary programs, other, lesser-known programs at both minority and majority institutions may exist. Please send information about any such programs to:

Dr. William A. Hawkins, Jr.
Director of the SUMMA Program
The Mathematical Association of America
1529 Eighteenth Street Northwest
Washington, DC 20036-1385
telephone:(202) 387-5200
email: maa@athena.umd.edu
fax: (202) 265-2384.

Letters to the Editor

I was much interested in and appreciative of your editorial in the April 1992 issue of FOCUS [page fifteen] about the influence of "popularizations" of mathematics. However, I believe that your statement that Courant and Robbins' *What Is Mathematics* was the first of its kind fails to do justice to Tobias Dantzig's *Number: The Language of Science,* which, published in 1930, preceded Courant and Robbins by twelve years.

My copy of the fourth edition of Dr. Dantzig's books contains this quotation from Albert Einstein:

> This is beyond doubt the most interesting book on the evolution of mathematics which has ever fallen into my hands. If people know how to treasure the truly good, this book will attain a lasting place in the literature of the world. The evolution of mathematical thought from the earliest times to the latest constructions is presented here with admirable consistency and originality and in a wonderfully lively style.

To the best of my faltering recollection, Dr. Dantzig's book was for some years on the nonfiction best sellers list—at that time, and perhaps still, a unique tribute to a treatise on mathematics.

As one who had the great privilege of studying and teaching under Dr. Dantzig (at the University of Maryland from 1935 to 1941), I am particularly concerned that his remarkable achievement should not be overlooked or forgotten.

Walter R. Volckhausen
Hampton, Virginia

The following letter was sent to FOCUS in response to Richard A. Askey's article on QUANTUM which appeared in the February 1992 issue of FOCUS.

A couple of years ago, I donated a subscription to *Quantum* to a local high school library where a friend of mine is a librarian. Perhaps, in addition to subscribing themselves, as suggested by Richard Askey in his recent FOCUS article, MAA and AMS members could be encouraged to donate (tax-deductible!) subscriptions to schools of their choice. There are several possibilities: the school your children attend, a school in the neighborhood, or even your alma mater.

Of course, it would be nice if the schools could buy these subscriptions themselves. On the other hand, most schools (both public and private) these days depend on contributions for part of their budget, so if you wish to contribute at all, this may be an effective way to do it.

A word of warning—when renewal time comes up, you will be asked to contribute again. At this point, you might want to speak to the librarian to find out what the students' reactions to the magazine have been.

Alan Weinstein
Department of Mathematics
University of California at Berkeley

Please address all correspondence concerning FOCUS to: Keith Devlin, Editor of FOCUS, Carter Professor of Mathematics, Department of Mathematics and Computer Science, Colby College, Watervile, Maine 04901; telephone and fax: (207) 872-3257; email: kjdevlin@COLBY.EDU.

Changing Your Calculus Course?

California State University at Long Beach will hold a workshop on "Changing Your Calculus Course? How? Why?", from 19 July 1992 through 24 July 1992. The workshop will offer participants:

- an overview of calculus reform projects as they have developed around the country;
- indepth exposure to resources developed as aids to anyone wishing to revise a course or just to add some new components to an existing course; and
- a chance to develop new materials for their own course.

This is an intensive week that utilizes time after dinner as well as throughout the day. We expect that, except in cases where extenuating circumstances make it impossible, participants will stay on campus from their arrival on Sunday evening dinner through the closing of the workshop with Friday lunch. The National Science Foundation (NSF) will pay for all expenses except travel.

For additional information and application forms, contact: James Stein, Department of Mathematics, California State University at Long Beach, 1250 Bellflower Boulevard, Long Beach, California 90840; telephone: (310) 985-5397. Participant selection begins on 15 May 1992 and will continue until available slots are filled.

FOCUS

ISSN: 0731-2040

FOCUS is published by The Mathematical Association of America, 1529 Eighteenth Street Northwest, Washington, DC 20036-1385, six times a year: February, April, June, September, October, and December.

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The annual FOCUS subscription price to individual members of the Association is $6.00, included in the annual dues. (Annual dues for regular members, exclusive of annual subscription prices for MAA journals, are $68.00. Student and unemployed members receive a 66 percent discount; emeritus members receive a 50 percent discount; new members receive a 40 percent discount for the first two membership years.)

Second-class postage paid at Washington, DC and additional mailing offices. Postmaster: Address changes to FOCUS, Membership and Subscriptions Department, The Mathematical Association of America, 1529 Eighteenth Street Northwest, Washington, DC 20036-1385.

Printed in the United States of America.

Calculus Reform Study Group Formed

At the1992 Annual Meeting in Baltimore, 8–11 January 1992, a new group, interested in the improvement of calculus instruction, took shape. The Calculus Reform Study Group, chaired by Marcelle Bessman of Frostburg State University, is a network of persons working on calculus reform projects, with or without outside funding. The Study Group seeks to provide a forum for ongoing reports, dialogue, and debate about all aspects of calculus teaching.

In furtherance of that goal, the Study Group is sponsoring the following activities at the 1993 Annual Meeting in San Antonio, Texas, 13–16 January 1993:

- A panel discussion on "Calculus Reform and the AP-Calculus Program," organized by Howard Lewis Penn of the United States Naval Academy and George M. Rosenstein, Jr. of Franklin and Marshall College. Additional information on this panel will appear in future issues of FOCUS.
- A poster session for calculus reform projects, cosponsored by the American Mathematical Society (AMS) and the MAA's Committee on Calculus Reform and the First Two Years (CRAFTY). This session is being organized by James F. Hurley of the University of Connecticut and Paul Zorn of Saint Olaf College. For additional details, see below.
- An informal open forum for those involved in calculus reform or interested in becoming involved. Organized by Marcelle Bessman, this forum will provide an opportunity for discussion of any and all issues related to calculus reform and its improvement. Watch for more information in future issues of FOCUS.

The poster session will feature displays of information about and materials from current calculus reform projects of all types. It will also furnish a point of contact for those interested in becoming involved in calculus reform with project directors who have already gone through the start-up process. Those interested in displaying materials at the session should contact: James F. Hurley, Department of Mathematics, University of Connecticut, U-9, 196 Auditorium Road, Room 111, Storrs, Connecticut 06269-3009; telephone: (203) 486-2404; email: hurley@uconnvm.uconn.edu; or Paul Zorn, Department of Mathematics, Saint Olaf College, Northfield, Minnesota 55057; telephoneL (507) 663-3414; email: Zorn@stolaf.edu as early as possible. A brief abstract (150–300 words) about the project should indicate how long it has been under way, the nature of the activity, and how many students will be participating during 1992–1993.

Forty-Fourth Meeting of the ICSIMT

The Department of Mathematics, Statistics, and Computer Science at the University of Illinois at Chicago will host the Forty-Fourth Meeting of the International Commission for the Study and Improvement of Mathematics Teaching (ICSIMT). The Commission, established in 1950 through the impetus of Caleb Gattegno by C. Gattegno, J. Piaget, E. W. Beth, J. Diudonné, A. Lichnerowicz, and G. Choquet, organizes annual conferences on subjects of interest to mathematics educators. A unique feature of these meetings is that they are small (about 250–300 participants) and usually involve teachers, teacher educators, and researchers. The conference's main activity is conducted in working groups discussing a central theme; this year's theme is "The Student Confronted by Mathematics." 1992 represents the first time the Commission will hold its meeting in the United States. For additional information, contact: ICSIMT44, c/o Dr. A. I. Weinzweig, Department of Mathematics, Statistics, and Computer Science, m/c 249, University of Illinois at Chicago, Box 4348, Chicago, Illinois 60680; telephone: (312) 996-8612 or (312) 996-2439; email: U14818@UICVM; fax: (312) 996-1491.

New Committee on Advising

The Mathematical Association of America has established an ad hoc Committee on Advising whose charge is to consider all aspects of advising undergraduate mathematics students, freshmen to seniors. The committee will collect information about successful advising practices and will give particular attention to ways of advising students about careers in the mathematical sciences. The committee may prepare a booklet to help mathematics faculty in their advising role. The committee's activities will be overseen by the MAA Council on Education, chaired by Alan C. Tucker of the State University of New York at Stony Brook.

The committee asks the mathematical community for advice on advising. If your department or institution has what you view as an especially effective or innovative advising system, the committee would be pleased to receive a report on that effort. If you know of materials that deal with careers in the mathematical sciences, please send references or, better yet, copies of that material to the committee chair. The committee would also appreciate hearing your concerns about special advising problems that should be addressed.

Members of the committee are Vasily C. Cateforis of the State University of New York at Potsdam; Roger Contreras of Texas Southmost College; Donald W. Crowe of the University of Wisconsin at Madison; Kendall O. Griggs of Hutchinson Community College; Diane L. Herrmann of the University of Chicago; Charles H. Jepsen of Grinnell College, David J. Lutzer of the College of William and Mary; and Juan C. Meza of Sandia National Laboratories.

For additional information, contact: David J. Lutzer, Chair, MAA ad hoc Committee on Advising, Dean of Arts and Sciences, College of William and Mary, Williamsburg, Virginia 23187; telephone: (804) 221-2470; email: djlutz@wmvm1.bitnet.

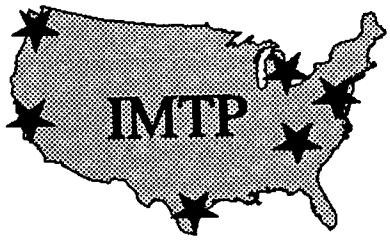
Conference on Technology

San Jacinto College will present a third Conference on Technology, focusing on the use of graphing and symbolic calculators in mathematics and addressing the needs and interests of mathematics and science teachers from college and secondary schools. The conference will be held at the Hotel Sofitel in Houston, Texas on Friday, 24 July 1992 and Saturday, 25 July 1992.

Nationally known speakers who have been invited include Charlene E. Beckmann of Grand Valley State University; Franklin D. Demana of Ohio State University; Thomas P. Dick of Oregon State University; Gloria S. Dion of Pennsylvania State University at Ogontz; Iris B. Fetta of Clemson University; Gregory D. Foley of Sam Houston State University; Joan E. Girard of Edison Community College; Matthew J. Hassett of Arizona State University; Yves Nievergelt of Eastern Washington University; Alan R. Osborne of Ohio State University; Charles B. Vonder Embse of Central Michigan University; and Bert K. Waits of Ohio State University.

The conference will feature hands-on workshops using the latest models of graphing calculators by Hewlett-Packard, Texas Instruments, Casio, and Sharp. Individual sessions will include presentations on how calculators can be used effectively in classrooms and discussions on how such use will affect testing, teaching styles, and the curriculum itself. Also, there will be demonstrations on integrating technology into lessons, as well as sessions that deal with writing activities and with student attitudes. Friday evening will feature a buffet dinner where the participants will discuss calculator projects from across the country. This informative session will provide an opportunity to share ideas about the many ways in which calculators are now being used in the learning process as well as the different kinds of programs available to help teachers learn to use them most effectively. For registration information, contact: Department of Mathematics, San Jacinto College Central, PO Box 2007, 8060 Spencer Highway, Pasadena, Texas 77501-2207; telephone: (713) 476-1884.

Interactive Mathematics Text Workshops



The MAA's Interactive Mathematics Text Project (IMTP) has as its goal the improvement of student learning of mathematics through the use of computer-based interactive texts. An interactive mathematics text is a computer-based text from which numeric, symbolic, and graphical commands can be executed with the result appearing in the document. The text may be a single lesson or it may be an entire course.

The IMTP has selected six regional sites at which it will run week-long workshops during the summers of 1992 and 1993. These sites include: Los Angeles Pierce College in Woodland Hills, California; Morehouse College in Atlanta, Georgia; Seattle Central Community College in Seattle, Washington; Towson State University in Towson, Maryland; the University of Houston-Downtown in Houston, Texas; and the University of Michigan at Dearborn in Dearborn, Michigan. At these workshops, participants will be given an overview of interactive texts and their use in instruction, will spend time using a text, will receive instructions on how to author a text, and will work closely with the workshop staff and each other on the creation of a short text on a topic of their choice.

Texts will be developed to run under *Microsoft Windows* on an IBM PS/2 using *Mathcad for Windows, Maple for Windows*, or *Mathematica for Windows*. Up to twelve workshop participants will be chosen each summer to receive the loan of an IBM PS/2 to enable them to continue development of their text.

The workshops begin on a Monday morning and run six days. They are supported by a grant to the MAA from IBM. The charge to participants includes room and board (seven nights, single occupancy) and a copy of the authoring software. This charge varies depending upon the site and the software. (Individuals who already have access to the authoring software will not be required to purchase an additional copy.)

Anyone interested in attending an IMTP workshop should immediately contact: Gerald J. Porter, Codirector, Interactive Mathematics Text Project (IMTP), Department of Mathematics, University of Pennsylvania, 209 South Thirty-third Street, Philadelphia, Pennsylvania 19104-6395; telephone: (215) 898-8467; email: gjporter@pennsas.upenn.edu.

Special Summer Student Meeting

Pi Mu Epsilon and the MAA's Student Chapters will hold a special summer meeting for students, 6–8 August 1992, on the campus of Miami University, Oxford, Ohio. The program will provide opportunities for student contributed paper sessions, various workshops on mathematical topics of interest to undergraduate students, and informal recreational activities, including an evening at nearby King's Island theme park. Underwood Dudley of DePauw University will deliver the Pi Mu Epsilon *J. Sutherland Frame Lecture*. Other special lectures will be under the auspices of the MAA. Dormitory housing and food service will be available. In addition, there are nearby motels and camping sites. The organizers distributed registration materials and conference information to all Pi Mu Epsilon and MAA Student Chapter advisors in May 1992. For additional information on local arrangements, contact: Robert S. Smith, Department of Mathematics and Statistics, Miami University, Oxford, Ohio 45056-1604; telephone: (513) 529-3556; email: rssmith @miavx1.bitnet.

Beefing-Up Graduate Education

In order to promote serious discussion of the issues of graduate education and to move the mathematical sciences community to action, the Conference Board of the Mathematical Sciences (CBMS) organized a three-day conference on *Graduate Education in Transition* in Washington, DC, 4–6 May 1991. Support for the conference was obtained from the Exxon Education Foundation. Twenty-four individuals participated in the conference, among them seven current presidents and six former presidents of CBMS member societies. They were asked two key questions: what are the nation's needs and how can the community best respond?

The report they produced, *Graduate Education in Transition,* just published, is based on the written summaries of the working groups and on the discussions which took place at the plenary sessions. It is organized into two main sections: "Discussion of the Issues" and "Recommendations."

Highlights from the report are reproduced below. For copies of the complete document, free of charge, contact: the Conference Board of the Mathematical Sciences (CBMS), 1529 Eighteenth Street Northwest, Washington DC 20036-1385; telephone: (202) 293-1170.

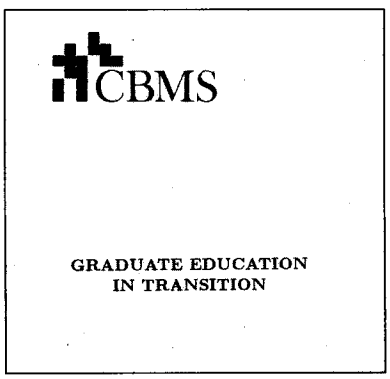
HIGHLIGHTS FROM THE DISCUSSION The report of the Federal Coordinating Council for Science, Education, and Technology (FCCSET) accompanying the President's 1992 budget both deplores the present state of science and mathematics education and proposes objectives and priorities to guide future federal activities. Recommended budget increases run 28 percent at the precollege level and 14 percent at the undergraduate level, but only 2 percent at the graduate level.

Unlike the postsputnik reform, which was driven by military needs, the present effort is driven by economic concerns. The government sees leadership in science and mathematics as a critical element to regain American competitiveness in the international arena.

Short-term intervention programs in the schools will yield some temporary benefits but the attitudes and skills of school teachers are, in the long run, molded in colleges and universities where these teachers are instructed by the products of our graduate schools. One does not have to subscribe to a domino theory to see that all parts of our education system are interdependent.

Although our graduate programs have brought US mathematics to world leadership in research, they have been less successful in preparing students for college teaching and for positions in industry. Indeed, the report emphasizes that *"without reform in graduate education no lasting change in school or undergraduate education is likely."* [their italics]

The importance of all the roles of faculty—research and graduate education, undergraduate education, service to a broad set of client disciplines, community outreach, and service to the department, the university, the local community, and the profession—must be recognized and some preparation for these roles should begin in graduate school.



One unfortunate consequence of the parochialism in graduate mathematics education is that much of industry and business still regards mathematicians with some suspicion. Few industries have career paths for mathematicians; contributions of a mathematical nature are often not recognized as such because they are made by physicists, engineers, and computer scientists. To remedy this situation, the report "endorse[s] the key principles of the Mathematical Association of America's Committee on Preparation for College Teaching, namely that doctoral programs should prepare students to meet a wide range of professional responsibilities and should not be limited to specialization in narrow areas, and should give systematic attention to promoting excellence in the teaching of mathematics." (See "How Should Mathematicians Prepare for College Teaching," *Notices of the American Mathematical Society,* **36** (December 1989): 1344–1346.)

The continued technological and economic health of the US depends on maintaining at least the present supply of graduate-level mathematical scientists.

American women and minorities, who will be a large fraction of new entrants in the work force by the year 2000, have traditionally not been attracted in sufficient numbers to careers in the mathematical sciences.

We must convey to students (and to the public at large) that mathematics is a lively, dynamic, and varied profession that has attracted inquisitive minds since the birth of civilization. It is important that both principal aspects of mathematics be appreciated; its useful, indispensable role in science and technology and its continuing intellectual fascination over the ages.

SOME OF THE RECOMMENDATIONS Among the nineteen specific recommendations proposed by the committee are the following:

- *Mathematical sciences departments should:*

  Expose graduate students to some collaborative projects with oral presentations and prepare all students to become effective teachers or communicators of mathematics.

- *Universities should:*

  Establish a climate in which a broad spectrum of contributions by the faculty is recognized and valued. Consider adopting guidelines such as those described in Boyer's *Scholarship Reconsidered.*

- *Professional societies should:*

  Develop and publicize a list of mathematical contributions to industry and government. Promote the industrial use of mathematics, mathematical models, and computational mathematics. Develop an industrial liaison group to help industry find appropriate specialists for particular problems.

- *Government should:*

  Provide stable funding for PhD students by balancing teaching, fellowship, and research support.

- *Industry should:*

  Cooperate with professional societies and universities to communicate the mathematical needs of the workplace and to develop suitable programs in industrial mathematics.

"... without reform in graduate education no lasting change in school or undergraduate education is likely."

Characteristics of Successful Graduate Programs in the Mathematical Sciences

Educating Mathematical Scientists: Doctoral Study and the Postdoctoral Experience in the United States, from the National Research Council (NRC), reports to the mathematical community several characteristics of successful graduate programs. The report from the Committee on Doctoral and Postdoctoral Study in the United States, chaired by Ronald G. Douglas of the State University of New York at Stony Brook, characterizes, as was its charge, components of "certain programs that are successful in producing large numbers of domestic PhDs, including women and underrepresented minorities, with sufficient professional experience and versatility to meet the research, teaching, and industrial needs of our technology-based society." The report will begin a dialogue within the mathematical community that extends the call for revitalizing undergraduate mathematics in the NRC's report, *Moving Beyond Myths,* to consideration of change in graduate and postdoctoral experiences.

The report notes that, in addition to the imperative of having a quality faculty, there are three additional characteristics of successful graduate programs: a focused, realistic mission, a positive learning environment, and relevant professional development.

The work of the committee was supported by the Alfred P. Sloan Foundation and conducted under the auspices of the Board on Mathematical Sciences (BMS) and the Commission on Physical Sciences, Mathematics, and Applications of the NRC.

To prepare its report, the Committee selected and visited a set of diverse programs in ten universities—diverse in emphasis as well as geography, and including both large and small, and public and private institutions. While concluding that there is more than one model for successful programs, the report highlights one particular common characteristic. A supportive learning environment is important for the success of all students, but especially critical for women and members of groups traditionally underrepresented in the mathematical sciences. Rhonda J. Hughes of Bryn Mawr College, a member of the committee, observed that there are many undergraduate students who are interested in pursuing careers in the mathematical sciences, so there is no shortage of potential graduate students. The need is to broaden our view of the types of students that can be successful in our graduate programs. Changing faculty attitudes and building a supportive environment are not expensive. When a student is accepted into a graduate program, that admission should carry the expectation of successful completion of the program.

The report also recommends that departments and the mathematical community seriously consider developing "professional" master's degree programs. Such programs would confer a degree "perceived as having intrinsic value itself and not as being a second choice" to the doctorate degree. Furthermore, a professional master's degree program, particularly if designed according to specialized models, would complement existing doctoral program offerings. In this respect, as in others, the report agrees with the recommendations of the recently released report, *Graduate Education in Transition,* from the Conference Board of the Mathematical Sciences (CBMS).

To aid students in their selection of graduate programs, the report urges better advising by faculty and includes in its Appendix B suggested questions for potential students to address before making a final decision on an institution. The report also includes a series of questions for departments to use to assess their current functioning and to determine directions for change.

Copies of the report are available for $19.00 each from the National Academy Press, 2101 Constitution Avenue Northwest, Washington, DC 20418. Quantity purchases qualify for the following discounts: 5–24 copies at 15 percent off; 25–499 copies at 25 percent off.

New Pólya Lecturer Selected

The Association has chosen its second Pólya Lecturer, Patricia K. Rogers of York University. This lectureship, established in 1990 to honor the late George Pólya, gives Sections an opportunity, on a rotating basis, to enhance their Section meeting programs with another national speaker without cost to the Section. The first Lecturer in the series was John H. Ewing of Indiana University. Each Pólya Lecturer visits six Sections of the Association over a two-year period.

Professor Rogers received her education at Oxford and Toronto Universities and the University of London, where she wrote her dissertation on the model theory of abelian and nilpotent groups. She has taught at a number of universities, but principally at York University, Ontario, Canada, where she is academic director of the Centre for the Support of Teaching and a member of the graduate faculties of both mathematics and education.

She has written papers in group theory and on various aspects of education and has twice won the silver medal from the American Council for the Advancement and Support of Education. Rogers also serves on the National Organizing Committee for the Seventh International Congress on Mathematical Education (ICME-7) in Québec City, Québec, Canada in 1992.

"Of course, I was absolutely thrilled and very surprised—it did come out of the blue," said Rogers on hearing the news of her appointment. "It feels like an enormous honor. Almost my first thought was how pleased my students would be. I use the Pólya movie *Let's Teach Guessing* in a math course I have designed for teacher candidates who are terrified of math. After we've spent many weeks doing open-ended investigations and reflecting on what it means to do mathematics (really do it, rather than do little exercises with straightforward answers), I show them the movie. It takes us about three hours to go through it, stopping along the way to work things out ourselves and talking about how he is structuring his proof and what he is saying about the nature of mathematical reasoning. So, Pólya means something to them.

"Also, as you can see, I am a fan, so the Lectureship will really mean a lot to me. These things always go to more people than the one who is named. I've been very lucky to have some very special mentors who have always looked out for me—they know who they are because they are sharing my joy over this."

The MAA Committee on Sections schedules the Pólya Lecturers; Sections eligible for a Pólya Lecturer will be notified by the Chair of that Committee.

CBMS 1990–1991 Survey

Statistical Abstract of Undergraduate

The MAA has just published the 1990–1991 Survey of the Conference Board of the Mathematical Sciences entitled *Statistical Abstract of Undergraduate Programs in the Mathematical Sciences and Computer Science in the United States.* The Survey's report contains data for fall 1990 on undergraduate programs in mathematics, statistics, and computer science at two- and four-year colleges and universities. This data includes detailed course enrollments, number of baccalaureate degrees awarded in 1989–1990, a faculty profile that examines information on part-time faculty, and departmental major requirements. The report also features a compendium of departmental figures, including institutional expenditures on travel and the ratio between faculty and support staff. In addition, the report describes the average section size and mode of instruction for beginning courses (including Calculus I and II) in each of the three disciplines; data on mathematical sciences libraries; and a detailed report on two-year college mathematics programs.

The report groups departments according to the highest mathematics degree the institution offers. For example, the report contains data on course enrollments for all departments offering only a baccalaureate degree in mathematics. This configuration is new to the 1990 Survey. In addition, the report appears in a "reader-friendly" format. The Survey organizes material on four-year colleges and universities according to individual tables; both figures highlighting aspects of the table and some explanatory text accompany each table. The authors have newly designed the tables; furthermore, to facilitate longitudinal analysis, tables in the summary chapter contain historical data from previous CBMS survey reports.

The report includes ninety-two tables; forty-three of these appear in the seven chapters on four-year colleges and universities and forty-three appear in the two two-year college chapters.

The Survey obtained data from a statistically designed sample. This sample produced 418 responses (the highest response total of any CBMS survey), well distributed across population and sufficient to insure reliable estimates.

Each chapter opens with a summary that lists tables in the chapter specific to mathematics, statistics, computer science, and two-year college programs.

Several tables and accompanying text from the report appear below (slightly edited for this article). Both the tables and text illustrate the report's format and present data of general interest. Figures that accompany tables in the full report do not appear in this article.

In all the Survey's tables, "full-time faculty" represents actual faculty count and not full-time equivalent. The report discusses the number of part-time faculty separately.An "–" indicates data not available.

TABLE A Enrollment (thousands) by level in mathematics, statistics and computer science courses in four-year college and university departments of mathematics, statistics and computer science and in two-year college mathematics programs: Fall 1970, 1980, 1985, 1990. (Unavailable historical data is indicated by a "-".)

	Fall enrollment (thousands)											
	Four-year colleges and universities								Two-year colleges			
	Math depts				Stat depts		CS depts		Math programs			
Course level	1970	1980	1985	1990	1970	1990	1970	1990	1970	1980	1985	1990
Math courses												
Remedial	101	242	251	261	0	0	0	0	191	441	482	724
Precalculus	538	602	593	593	0	0	0	0	134	180	188	245
Calculus	414	590	637	647	0	1	0	0	59	86	97	128
Advanced	135	91	138	120	0	1	0	1	0	0	0	0
Other (2-year)									171	218	133	144
TOTAL MATH	**1188**	**1525**	**1619**	**1621**	**0**	**2**	**0**	**1**	**555**	**925**	**900**	**1241**
Stat courses												
Elementary	-	-	-	87	-	29	0	3	16	28	36	54
Advanced	-	-	-	38	-	14	0	2	0	0	0	0
TOTAL STAT	**60**	**-**	**-**	**125**	**32**	**43**	**0**	**5**	**16**	**28**	**36**	**54**
CS courses												
Lower	-	-	-	134	0	0	-	204	13	95	98	98
Middle	-	-	-	12	0	0	-	25	0	0	0	0
Upper	-	-	-	34	0	0	-	82	0	0	0	0
TOTAL CS	**60**	**-**	**-**	**180**	**0**	**0**	**46**	**311**	**13**	**95**	**98**	**98**
GRAND TOTAL	**1308**	**-**	**-**	**1926**	**32**	**45**	**46**	**317**	**584**	**1048**	**1034**	**1393**

Programs in the Mathematical Sciences and Computer Science in the United States

TABLE B Enrollment (thousands) for Mathematics, Statistics and Computer Science courses in four-year college and university Departments of Mathematics, Statistics and Computer Science by level of course and by type of school. Also full-time faculty: Fall 1990.

Fall 1990 enrollment (thousands)

	Math Depts			Stat Depts			CS Depts			
	Univ (PhD)	Univ (MA)	Coll (BA)	Univ (PhD)	Univ (MA)	Coll (BA)	Univ (PhD)	Univ (MA)	Coll (BA)	TOTAL
Number of full-time faculty	6427	5058	7926	668	53	14	2746	1408	1164	**25464**
Math courses										
Remedial	68	93	100							**261**
Precalculus	206	202	185							**593**
Calculus	337	122	188	1						**648**
Adv math	58	29	33	1					1	**122**
TOTAL MATH	**669**	**446**	**506**	**2**					**1**	**1624**
Stat courses										
Elem stat	14	27	46	25	4				3	**119**
Adv stat	18	12	8	14					2	**54**
TOTAL STAT	**32**	**39**	**54**	**39**	**4**				**5**	**173**
CS courses										
Lower CS	9	42	83				100	60	44	**338**
Middle CS	1	4	7				11	8	6	**37**
Upper CS	6	12	16				47	19	16	**116**
TOTAL CS	**16**	**58**	**106**				**158**	**87**	**66**	**491**
GRAND TOTAL	**717**	**543**	**666**	**41**	**4**		**158**	**87**	**72**	**2288**

The first two tables—Tables A and B (on this and the opposite page)—present enrollment data by level of course. Table A appears in the report's summary chapter that presents both historical data and data for fall 1990. Table B appears in the chapter on enrollment and amplifies Table A by presenting enrollment by department type. Further elaboration of two-year college enrollments appears in the chapters on two-year college programs. Over the last five years the two-year college mathematics program faculty increased by 15 percent, while Table A shows that, during this period, enrollment increased by 35 percent. The 1990 edition of the Digest of Educational Statistics (from the government) reported that the 1987 total of full-time and part-time higher education faculty with a rank of instructor or above was 793,000. The comparable total from this Survey for the mathematical sciences and computer science was 54,679, including 21,933 part-time faculty.

TABLE A (Opposite page) While remedial course enrollment has increased substantially over the last twenty years, so has enrollment in nonremedial mathematics courses. For example, in four-year institutions, calculus and advanced-level enrollment has remained at about 47 percent of the total mathematics enrollment during this period. In fall 1990, a total of 777,000 enrolled in two- and four-year calculus level courses. In four-year college and university mathematics departments, enrollment in courses above the precalculus level (including advanced statistics and middle- and upper-level computer science courses) was 44 percent of the total mathematics department enrollment; for statistics departments, the comparable figure was 36 percent; for computer science departments, it was 35 percent.

TABLE B This table (above) reports on enrollment by type of departments. An analysis of the statistics and computer sciences departments responding indicates that the table's division into PhD, MA, and BA according to the highest mathematics degree awarded by the institution closely fits with the highest degree these departments actually award. The BA mathematics department taught a noteworthy myriad of courses: 31 percent of all mathematics enrollment; 31 percent of all statistics enrollment; and 22 percent of all computer science enrollment. PhD mathematics departments showed a ratio of enrollment to total, full-time faculty of 112; MA departments showed a ration of 107; and BA departments showed a ration of 84. Statistics and computer science departments showed a nearly identical ration of 60.

*(**CBMS 1990–1991 Survey** continues on page ten.)*

CBMS 1990–1991 Survey

TABLE C Number of full-time faculty in four-year college and university departments of mathematics, statistics and computer science and in two-year college mathematics programs: Fall 1970, 1980, 1985, 1990.

	Number of full-time faculty			
	1970	1980	1985	1990
Four-year colleges and universities				
Math Depts	15655	16022	17849	19411
Stat Depts	700	610	740	735
CS Depts	688	1672	3605	5318
TOTAL	**17043**	**18304**	**22194**	**25464**
Two-year colleges				
Math Programs	4879	5623	6277	7222
GRAND TOTAL	**21922**	**23927**	**28471**	**32686**

*(**CBMS 1990–1991 Survey** continued from page nine.)*

The second pair of tables, Tables C and D, contain data on the number of departmental faculty. Table C presents faculty totals over time; Table D further details faculty in mathematics departments. Other tables present similar data for statistics and computer science departments and for two-year college mathematics programs.

TABLE C In four-year institutions, as compared to 1985, the number of full-time mathematics faculty increased by almost 9 percent; the number of statistics faculty remained level; and the number of computer science faculty increased by 48 percent. Using Table A, the enrollment per full-time mathematics faculty member in four-year institutions was just under 100; in statistics departments, the ratio was 61; and in computer science departments, the ratio was 60. The corresponding 1970 ratios were 84, 46, and 67 respectively. The 1990 two-year college enrollment per full-time faculty member was 193; in 1970 it was 119. Again, using Table A, in four-year colleges and universities, that ratio of calculus and above enrollments (including statistics and computer science) per full-time faculty member was 44 in mathematics departments, and 21 in both statistics and computer science departments.

TABLE D Number of full-time faculty in four-year college and university departments of mathematics by highest degree and in 1990 by teaching responsibility: Fall 1970, 1980, 1985, 1990.

					1990 totals broken down by teaching responsibility		
	1970	1980	1985	1990	Math/ Stat	CS	Math/Stat and CS
Doctoral degree	9744 (62%)	12497 (78%)	13208 (74%)	14963 (77%)	12824	816	1323
Other degree	5911 (38%)	3525 (22%)	4641 (26%)	4448 (23%)	3266	676	506
TOTAL	**15655**	**16022**	**17849**	**19411**	**16090**	**1492**	**1829**

TABLE D For the first time, the Survey reports mathematics department faculty according to teaching responsibilities. The number of faculty teaching only mathematics courses in fall 1990 did not increase significantly since 1970, when, presumably, almost all of the teaching was in mathematics and statistics only.

TABLE E Percent women among full-time faculty in four-year college and university departments of mathematics, statistics and computer science and two-year college mathematics programs: Fall 1975, 1980, 1985, 1990; percent women among faculty aged less than 35: Fall 1990.

	Math depts	Stat depts	CS depts	Math programs
Women among full-time faculty 1975	10%	-	-	21%
Women among full-time faculty 1980	14%	-	-	25%
Women among full-time faculty 1985	15%	10%	13%	31%
Women among full-time faculty 1990	20%	14%	16%	34%
Women among faculty aged less than 35 1990	25%	24%	12%	51%
TOTAL FACULTY 1990	**19411**	**735**	**5318**	**7222**

Lastly, Table E presents information on the percentage of women among the faculty. Later tables, where data on other minority groups appear, refine these numbers even further.

TABLE E Over the last ten years, the percent increase of women faculty members in mathematics departments averaged 1 percent per year in mathematics. For the first time, this CBMS Survey also reports the percent of women among those faculty age 34 or less. Only in computer science departments was this percent less than the overall percent.

Trends in Federal Support for the Mathematical Sciences

Lisa A. Thompson

For the last five years or so, federal support for the mathematical sciences has been growing at an annual rate of just two or three percent above inflation. Budget crunches in both the domestic and defense sectors and shifts in federal research and development priorities—which increasingly emphasize large science projects and targeted research programs—have conspired to bring to a close the expansion of federal mathematical sciences programs during the early and mid-1980s.

The most notable feature of recent federal funding for the mathematical sciences is the increasing degree to which it is influenced by the Presidential Research Initiatives and other multidisciplinary activities. These initiatives provide the field with new opportunities and resources in the context of important national science and technology goals. However, slower growth in overall funding for the mathematical sciences combined with expansion of cross-disciplinary activities raises questions about the adequacy of support for research in core mathematics.

It should be noted that the increasingly quantitative nature of research in general hinders the complete accounting of federal support for mathematical scientists. For instance, beginning in fiscal year (FY) 1992, a new National Science Foundation (NSF) activity will make awards to High-Performance Computing and Communications (HPCC) Grand Challenges Applications—multidisciplinary teams seeking to apply high performance computing techniques and resources to fundamental problems in science and engineering with broad economic and scientific impact. The involvement of the mathematical sciences in such an activity would not necessarily be reflected in the spending figures discussed here.

Federal Support for the Mathematical Sciences in FY 1993 In FY 1993, combined spending by the seven mathematical sciences programs is projected to grow by little more than three percent above the FY 1992 level. As this is the expected rate of inflation, it appears that federal support for the mathematical sciences will experience no real growth in FY 1993.This result arises from the combined effects of proposed spending increases by the NSF and the Office of Naval Research and from relatively flat spending or projected decreases by the other programs at the Department of Defense, including a sharp drop in funding from the Defense Advanced Research Projects Agency.

The National Science Foundation (NSF) The NSF Division of Mathematical Sciences (DMS) provides almost half of all federal support for the mathematical sciences, covering the broadest range of mathematical fields with support for individual investigators and small groups, research institutes, shared computing equipment, postdoctoral fellowships, research conferences, and undergraduate programs.

The Division budget, which will grow in FY 1992 by 7.4 percent to $78.58 million, has been reorganized into three categories: disciplinary research in mathematics, cross-disciplinary and computational research in mathematics, and special projects. DMS has requested a budget of $84.95 million for FY 1993, a proposed increase of $6.37 million or 8.1 percent over FY 1992 spending. Funds for disciplinary research in FY 1993 would remain at the FY 1992 level, $48.23 million; support for cross-disciplinary and computational research would expand from $15.55 million to $20.48 million; and funds for special projects would increase by $1.44 million to $16.24 million.

This budget proposal reflects the overall priorities of the Foundation and federal research and development effort. More than three-quarters of the proposed DMS budget increase would be used to enhance the participation of the mathematical sciences in the Federal Coordinating Council for Science, Education, and Technology (FCCSET) and NSF research initiatives—high performance computing and communications, advanced materials and processing, biotechnology, advanced manufacturing, and environmental science. Researchers currently supported in disciplinary programs will be able to take advantage of the new opportunities in the cross-disciplinary and computational research category. The remainder of the increment would be used to expand support for postdoctoral fellowships and for undergraduate curriculum development.

Lisa A. Thompson is the Assistant for Governmental Affairs in the Washington, DC offices of the Joint Policy Board for Mathematics (JPBM).

JPBM Committee on Professional Recognition and Rewards

The Joint Policy Board for Mathematics (JPBM) Committee on Professional Recognition and Rewards, chaired by Calvin C. Moore of the University of California, was appointed in response to growing awareness that the rewards structure is one of the key factors supporting and inhibiting renewal of the profession, the revitalization of precollege, undergraduate, and graduate education, and the promotion of interdisciplinary work and efforts by the mathematics community to reach out to other disciplines and to industry. The problems faced by the community and the role of the rewards system are documented in a number of recent reports, particularly the National Research Council report, *Renewing US Mathematics: A Plan for the 1990s,* the Carnegie Foundation for the Advancement of Teaching report by Ernest Boyer, *Scholarship Reconsidered: Priorities of the Professoriate,* and the National Science Foundation (NSF) report, *America's Academic Future: A Report of the Presidential Young Investigator's Colloquium on US Engineering, Mathematics, and Science Education for the Year 2010 and Beyond.*

The Committee has accepted the following seven-point charge: initiate a dialogue on these issues within the mathematical sciences community; identify contributions that should be recognized and rewarded; determine how those involved (faculty members, department chairs, deans, mathematicians, and managers employed in industry) value the various contributions and determine how the rewards system works in practice; study methods of evaluation of types of contributions that are identified as being important; articulate the ways contributions are, and can be, rewarded; make recommendations on the contributions that should be recognized and rewarded and on methods to evaluate these contributions; and produce a plan to lead the community toward implementing the recommendations.

Creating a dialogue within the mathematical sciences community is viewed as one of the most important charges to the committee. This dialogue will begin with five site visits planned for April and May 1992. Fifteen to twenty additional site visits will be made during the 1992–1993 academic year, mathematical sciences departments will be surveyed, and panel discussion will be organized at national and regional meetings of the three organizations that comprise JPBM; the American Mathematical Society (AMS); the MAA; and the Society for Industrial and Applied Mathematics (SIAM). Comments and suggestions from individuals are welcome; contact: William Adams, Project Director, Department of Mathematics, University of Maryland, College Park, Maryland 20742; email: wwa@math.umd.edu.

Contributed Papers Solicited

Seventy-sixth Annual Meeting

The Mathematical Association of America (MAA) and the American Mathematical Society (AMS) will hold their Annual Joint Meetings from Wednesday, 6 January 1993 through Saturday, 9 January 1993 in San Antonio, Texas. The complete meetings program will appear in the October 1992 issues of both FOCUS and the Notices of the American Mathematical Society. This preliminary announcement is designed to provide lead-time for participation in the MAA's contributed papers sessions. Please note that the days scheduled for these sessions remain tentative. The organizers listed below solicit contributed papers pertinent to their sessions' interests and concerns; you should forward proposals directly to the organizer whose name is followed by an asterisk (*). For additional instructions, see the *Revised Submission Procedures* Box accompanying this announcement on page twelve.

Sessions generally must limit presentations to ten minutes each, but selected participants may extend their contributions up to twenty minutes. Each session room contains an overhead projector and screen; blackboards are normally not available. Persons needing additional equipment should contact, as soon as possible, but prior to 9 November 1992: Kenneth A. Ross, Department of Mathematics, University of Oregon, Eugene, Oregon 97403-1222; email: ross@math.uoregon.edu. You may request one additional overhead projector, a 35mm slide projector, or a 1/2 inch of 3/4 inch VHS VCR with one color monitor.

Assessment Programs for the Undergraduate Major

Friday morning, 8 January 1993, and
Saturday afternoon, 9 January 1993

Charles F. Peltier (*)
Department of Mathematics
Saint Mary's College
Notre Dame, Indiana 46556-5001
telephone:(219) 284-4498
email: cpeltier@bach.helios.nd.edu
fax:(219) 284-4492

James Wilson Stepp
University of Houston

This session, sponsored by the Subcommittee on Assessment of the MAA Committee on the Undergraduate Program in Mathematics (CUPM), seeks papers on the use of assessment of student achievement in the evaluation of undergraduate mathematics programs. Contributors may address program evaluation (as related to assessment of student achievement), methods of assessment of individual student achievement, development of assessment goals and criteria, or the effects of assessment on program development. The organizers particularly encourage contributions that explore assessment methods or describe experiences with assessment programs.

"Capstone" Courses for Senior Mathematics Majors

Wednesday and Thursday mornings, 6 and 7 January 1993

Pamela Crawford (*) and Christopher Eugene Bara
Department of Mathematics
Randolph-Macon College
Ashland, Virginia 23005-0619
telephone: (804) 752-7372
email: rmcashlpam@uunet.uu.net

In recent years, the number and variety of "capstone" courses has increased dramatically. Such courses not only provide senior mathematics majors with a "summation" of their undergraduate experiences, but also sharpen such fundamental skills as reading and writing mathematics, problem-solving, and research techniques. This session welcomes papers that either describe "capstone" courses or discuss how to develop such courses. Topics may include the selection of a "capstone" theme, course organization, innovative student assignments, evaluation of student performance, and the integration of "capstone" courses into existing major sequences.

Empowering the Mathematical Community

Wednesday morning, 6 January 1993, and
Thursday afternoon, 7 January 1993

Gloria Gilmer (*)
Math-Tech, Incorporated
9155 North Seventieth Street
Milwaukee, Wisconsin 53223-2155
telephone: (414) 933-2322
fax: (414) 355-9175

Marilyn Frankenstein
University of Massachusetts at Boston

Patricia Clark Kenschaft
Montclair State College

Alvin M. White
Harvey Mudd College

The Joint AMS-MAA-AAAS Committee on Opportunities in Mathematics for Underrepresented Minorities (COMUM), in cooperation with the MAA's Committee on the Participation of Women, the Critical Mathematics Network, and the Humanistic Mathematics Network, has organized this session.

Student empowerment refers to an internal state in which students see themselves as responsible for, in control of, or the source of their own learning. When students control few elements in their learning environment, their empowerment plummets; when they control many elements, it deepens and expands. Mathematically powerful students draw on mathematical ideas and employ mathematical tools and techniques to think and communicate. Mathematically powerful work is purposeful.

Thus, the organizers seek papers which respond to the following questions: What are we doing to empower students? What must the profession do to empower others at all educational levels and interests? Why are some instructional models more empowering for students than others?

Impact of Nontraditional Instructional Methods on Testing and Evaluation

Wednesday and Thursday afternoons, 6 and 7 January 1993

Linda H. Boyd (*)
Department of Mathematics
DeKalb College
555 North Indian Creek Drive
Clarkston, Georgia 30021-2396
telephone: (404) 299-4167

Elizabeth J. Teles
Montgomery College

This session, organized by the MAA Committee on Two-Year Colleges, invites papers describing the impact of nontraditional methods of instruction on testing and evaluation. These methods include but are not limited to laboratory exercises or experiments, group projects, and student presentations.

6–9 January 1993 San Antonio, Texas

INTERACTIVE LEARNING ENVIRONMENTS

Wednesday and Thursday mornings, 6 and 7 January 1993

Katherine L. Pedersen (*)
National Science Foundation (NSF) Statewide Systemic Initiative
435 South Chapelle
Pierre, South Dakota 57501

Sandra Z. Keith
Saint Cloud State University

In the last few years, interest in interactive learning environments in undergraduate mathematics has grown substantially. Interactive modes of teaching include not only collaborative and cooperative learning, but also teaching-learning strategies that enable students to interact with each other, their instructors, and materials and technology. Typically, the instructor designs student interactions to maximize student benefit. Technology often plays a role because group study and assignments naturally flourish in environments that use computers and calculators. This session, sponsored by the MAA Committee on Computers in Mathematics Education (CCIME), will not limit papers, however, only to those employing technology; the organizers particularly seek papers describing, with appropriate data, personal experiences in promoting interactive and especially collaborative and cooperative, learning environments.

LINEAR ALGEBRA

Wednesday afternoon, 6 January 1993, Thursday evening, 7 January 1993, and Friday afternoon, 8 January 1993

Donald R. LaTorre (*)
Department of Mathematical Sciences
Clemson University
Clemson, South Carolina 29631-5310
telephone: (803) 656-3434
email: Latorrd@clemson.bitnet
fax: (803) 656-5230

Steven J. Leon
University of Massachusetts at Dartmouth

A. Duane Porter (for the LACSG)
University of Wyoming

This session invites papers on innovations in teaching linear algebra, including: (1) the use of computer algebra systems, supercalculators, or computer software; (2) experiences with materials from the ATLAST summer workshops; (3) experiences with the Core Curriculum recommended by the Linear Algebra Curriculum Study Group (LACSG); (4) "gems" of linear algebra exposition; and (5) other innovative teaching or curriculum initiatives in linear algebra.

MATHEMATICS AND THE ARTS

Thursday afternoon, 7 January 1993, and Saturday morning, 9 January 1993

JoAnne S. Growney (*)
Department of Mathematics and Computer Science
Bloomsburg University of Pennsylvania
Bloomsburg, Pennsylvania 17815-1758
telephone: (717) 389-4503
fax: (717) 389-3700

This session invites submissions on the following themes: (1) application of mathematical methods of thought and design to another art form; (2) examination of art works and art forms whose construction or content includes mathematics; and (3) strategies for and examples of teaching and learning mathematics through exploration of its links to other arts.

RECREATIONAL MATHEMAGICAL COMPUTING

Friday morning, 8 January 1993, and Saturday afternoon, 9 January 1993

Dr. Michael W. Ecker
Editor and Publisher
Recreational and Educational Computing
909 Violet Terrace
Clarks Summit, Pennsylvania 18411
telephone: (717) 586-2784

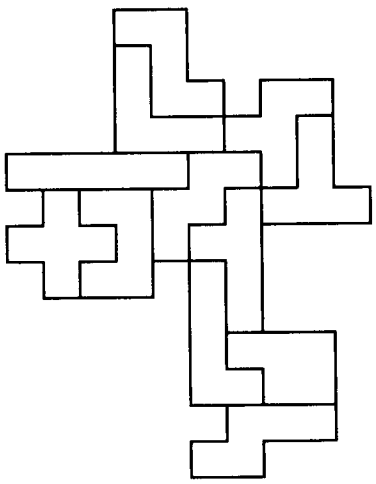
This session will present diverse recreations in which computer programming plays a supplementary but essential role. Computer languages and topics are open; for maximum accessibility, however, the organizer will give preference to recreations and recreational problem-solving with the widest appeal. Consequently, the session invites papers at the elementary or intermediate level, perhaps using BASIC, QuickBasic, or Pascal; the session especially welcomes papers investigating recreations off the beaten path or that unify seemingly diverse themes. Utility software for aiding such investigations will be welcome, but more so to the extent that it is connected to particular problems. Since it is impossible to anticipate the range of topics and papers of interest, all proposals and suggestions are encouraged and will be given serious consideration.

RECRUITMENT AND RETENTION OF WOMEN IN MATHEMATICS REVISITED

Saturday morning and afternoon, 9 January 1993

Marcelle Bessman (*)
328 Braddock, #212
Frostberg, Maryland 21532
telephone: (301) 689-4453
email: R2NKBES@FRE.TOWSON.EDU
fax: (813) 872-934
(From 10 May 1992 through 20 August 1992, forward proposals to 644 Geneva Place, Tampa, Florida 33606)

This session, sponsored by the MAA Committee on the Participation of Women in Mathematics, is a sequel to the 1987 contributed paper session on "Recruitment and Retention of Women in Mathematics," which focused on factors affecting the participation of women in mathematics. Since then, the MAA Committee on the Participation of Women in Mathematics was formed to assess this concern and develop or encourage projects designed to improve recruitment and retention of women. Winning Women Into Mathematics, a recent publication form the Committee, exemplifies such a project. This session will detail projects undertaken at educational institutions and agencies that employ mathematicians to encourage participation of women in mathematics. The organizer particularly seeks presentations that describe such projects, the obstacles encountered, proposed or accomplished solutions, and projections for the future.



***(Contributed Papers** continues on page fourteen.)*

*(**Contributed Papers** continued from page thirteen.)*

TEACHING MATHEMATICS TO MULTICULTURAL AND MULTILINGUAL STUDENTS
Friday morning and afternoon, 8 January 1993

Richard C. O'Lander (*)
Division of Computer Science, Mathematics, and Science
Saint Vincent's College of Saint John's University
Bent Hall, Room 113
Jamaica, New York 11439-0001
telephone: (718) 990-6471
fax: (718) 380-3803

Demographic changes require that educators now teach mathematics to students from a variety of multicultural and multilingual backgrounds. This session welcomes papers which describe research on student learning, as well as methods of teaching mathematics to these students. Course descriptions should address how these students learn mathematics, teaching methods used, and the effectiveness of these methods.

USE OF VISUALIZATION IN THE TEACHING OF MATHEMATICS
Friday morning, 8 January 1993, and
Saturday afternoon, 9 January 1993

Howard Lewis Penn (*)
Department of Mathematics
United States Naval Academy
572 Holloway Road
Annapolis, Maryland 21402-5002
telephone: (410) 267-3892
email: hlp@math2.sma.usna.navy.mil
fax: (410) 267-4883

James R. King
University of Washington

This session, organized by the MAA Committee on Computers in Mathematics Education (CCIME), invites presentations that illustrate the use of visualization in mathematics teaching. Proposal summaries should detail how the presentation will use visualization. In particular, if the presenters contemplate use of computers or other technology, they should include a precise description of equipment necessary. (Both a Macintosh and an MS-DOS PC with overhead projection panels will likely be available for use during this contributed paper session.)

USING DATA AND COMPUTERS IN TEACHING STATISTICS
Wednesday morning, 6 January 1993, and
Thursday afternoon, 7 January 1993

Mary R. Parker (*)
Department of Mathematics
Austin Community College
Box 140707
11928 Stonehollow Drive
Austin, Texas 78714-0707
telephone: (512) 483-7000
fax:(512) 495-7115

George W. Cobb
Mount Holyoke College

The Joint Committee on Undergraduate Statistics of the MAA and the American Statistical Association (ASA) have organized this session to explore the use of data and computers in undergraduate statistics courses. The organizers specifically invite discussions on the use of data and computer simulations to strengthen the teaching of important concepts, emphasize statistical thinking, and foster active learning. The session welcomes papers on both elementary and upper division mathematical statistics courses.

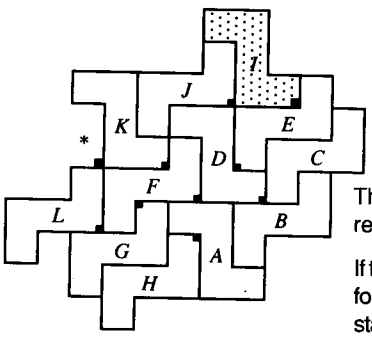
Revised Submission Procedures for Contributed Paper Proposals

After you have selected a session to which you wish to contribute a paper, forward directly to the designated organizer (indicated with an asterisk on the accompanying list):

- the name(s) and address(es) of the author(s); and
- a one-page summary of your paper.

The summary should enable the organizer(s) to evaluate the appropriateness of your paper for the selected session. Consequently, you should include as much detailed information as possible within the one-page length limitation.

Your summary must reach the designated organizer by **Thursday, 10 September 1992.**



DO NOT FORWARD PROPOSALS TO MAA HEADQUARTERS IN WASHINGTON, DC.

The organizer will acknowledge receipt of all paper summaries.

If the organizer accepts your paper for presentation, you will receive a standardized abstract form.

Use this standardized abstract form to prepare, as instructed, a brief abstract. Please return the completed abstract form to the designated organizer by **24 September 1992.** Abstracts received after the deadline will not be published in the 1993 Joint Annual Meetings *Abstracts Journal.*

You may obtain a copy of this *Abstracts Journal* in the meetings registration area during the conference in San Antonio, Texas.

DO NOT FORWARD COMPLETED ABSTRACTS TO MAA HEADQUARTERS IN WASHINGTON, DC OR THE AMERICAN MATHEMATICAL SOCIETY (AMS) IN PROVIDENCE, RHODE ISLAND

DO NOT SUBMIT COMPLETED ABSTRACTS ELECTRONICALLY TO *ANYONE*, INCLUDING THE DESIGNATED ORGANIZER.

If you wish to obtain an abstract form in advance and then submit it to the designated organizer along with your summary, contact:

Mary McLean Bancroft
The Mathematical Association of America
1529 Eighteenth Street Northwest
Washington, DC 20036-1385
telephone: (202) 387-5200
email: maa@athena.umd.edu
fax: (202) 265-2384.

From the IMO to the Putnam Competition

As you might expect, United States team members for the International Mathematical Olympiad (IMO) regularly figure prominently among top scorers in the Putnam Competition. But it must surely be a "first" for the entire winning team in the Putnam Competition to be a subset of an IMO team, which is what happened with the most recent Putnam Competition: all three members of the Harvard University team that won the Fifty-second Putnam represented the US in the 1988 IMO.

The accompanying photograph of the IMO team for that year was taken on 7 July 1988 at Dulles International Airport, Virginia, just before the team's departure for the Twenty-ninth Annual Olympiad in Canberra, Australia. (Jonas H. Ellenberg, father of team member Jordan S. Ellenberg and, at that time, president of the Biometric Society, took the photograph.) As it happens, the IMO team members are arranged in such a way that, by shrinking the photograph's frame to a smaller rectangle, it will enclose a photograph of the current winning Putnam team.

Left to right in the photograph: IMO Assistant Coach Gregg Patruno of The First Boston Corporation, then the three winning Putnam team members from Harvard University: Eric K. Wepsic of Boston, Massachusetts, Jordan S. Ellenberg of Potomac, Maryland, and Samuel Kutin of Old Westbury, New York; followed by John Woo of Pepper Pike, Ohio; Tal N. Kubo of Brookline, Massachusetts, and Hubert L. Bray of Houston, Texas. IMO Coach Gerald A. Heuer of Concordia College appears at the far right. Bray earned a bronze medal at the 1988 IMO; the other team members each won a silver medal. Woo and Kubo are currently Harvard University students; Bray is a student at Rice University.

1992 Wolf Prize Laureates

Professors Lennart A. E. Carleson of Sweden's Uppsala University and John G. Thompson of Cambridge University, England, will share the 1992 Wolf Prize in Mathematics.

Carleson, who is also a professor at the University of California at Los Angeles, was cited for his "fundamental contributions to Fourier analysis, complex analysis, quasi-conformal mappings, and dynamical systems, which have established his position as one of the greatest analysts of the twentieth century."

Born in Stockholm in 1928, Carleson received his BA and PhD at Uppsala University and completed postgraduate studies at Harvard University. A member of the Swedish Academy of Sciences, he has taught at the University of Stockholm and was a visiting professor at the Massachusetts Institute of Technology and Stanford University. He served as president of the International Mathematical Union (IMU) from 1978 through 1982 and, from 1968 until 1984, as Director of the Mittag-Leffler Institute in Stockholm.

Professor John G. Thompson, 59, is being honored "for his profound contributions to all aspects of finite group theory and connections with other branches of mathematics." Born in Kansas, Thompson received his BA from Yale University and his PhD from the University of Chicago, where he taught until joining the faculty of Cambridge University in 1968. He is a member of the National Academy of Sciences and a Fellow of the Royal Society, London.

Professors Carleson and Thompson received the Wolf Prize in Mathematics from the President of Israel on 17 May 1992 in Jerusalem. Annual awards of $100,000 each are made by this Israel-based foundation for outstanding achievements in the fields of medicine, chemistry, physics, agriculture, and the arts, as well as in mathematics.

The Wolf Foundation was established in 1975 by the late Dr. Ricardo Wolf "to promote science and art for the benefit of mankind." A German-born chemist and philanthropist, Dr. Wolf emigrated to Cuba before World War I and served as its Ambassador to Israel, where he died in 1981. The Foundation also grants annual stipends to university students and researchers in Israel.

1992 Bergman Trust Prize Awarded

Charles Fefferman of Princeton University has been selected as the 1992 awardee of the Stefan Bergman Trust. The trust, established in 1988, recognizes mathematical accomplishments in the areas of research in which Stefan Bergman worked. The award consists of $20,000 per year for two years.

The committee awarding the prize to Professor Fefferman consisted of Frederick J. Gehring of the University of Michigan at Ann Arbor, Joseph J. Kohn (committee chair) of Princeton University, and Halsey L. Royden of Stanford University. The committee's citation for the prize says, "Charles Fefferman has made enormously important contributions to the study of the Bergman kernel and has initiated much of the activity in the topic."

In response to receiving the award, Professor Fefferman said, "I'm grateful to the selection committee for awarding me the Bergman Prize. Bergman's ideas have been a major influence in my work. They continue to provide deep, important problems for analysis."

Charles Fefferman was born on 18 April 1949 in Washington, DC. He received his BS in mathematics and physics from the University of Maryland in 1966 and his PhD in mathematics from Princeton University in 1969. He was a lecturer at Princeton (1969–1970) before moving to the University of Chicago, where he advanced to the rank of professor in 1971. In 1973, he returned to Princeton, where he was appointed to his current position as Herbert Jones University Professor in 1984.

The Bergman Prize honors the memory of Stefan Bergman, best known for his research in several complex variables and for the Bergman projection and Bergman kernel function which both bear his name. A native of Poland, he taught at Stanford University for many years and died in 1977 at the age of seventy-eight. When his wife died, the terms of her will stipulated that funds should go toward a special prize in her husband's honor.

The Bergman Prize was awarded for the first time in 1990 to David Catlin of Purdue University. Steven R. Bell of Purdue University and Ewa Ligocka of the Polish Academy of Sciences shared the prize in 1991.

The Mills Women

The ways to encourage women in mathematics are the ways to approach people in general; it's the natural thing to do.

—a student participant in the Mills Summer Research Program

Susan L. Forman

For me, one of the most exciting parts of the 1992 Annual Meeting in Baltimore, Maryland was a presentation by a group of young women at the workshop of the Association of Women in Mathematics (AWM) on the day before the meetings officially started. They were talking about their experiences at the Mills Summer Research program, a National Science Foundation (NSF) funded summer mathematics program for women. Those of us sitting in the audience, who had never had an opportunity to participate in anything like it, were both delighted with what the students had to say and envious of their experiences. I recorded some of the comments made by the women, both in their presentations and in a brief discussion that followed. (See elsewhere on this and the opposite page.)

At the beginning of the summer, more than half the participants said they were not planning to go to graduate school right away. By the end, the ratio had changed, in part because of the shift from not feeling like part of the mathematical community to feeling as though they were on their way to becoming part of it.

As of this writing, one of the women has been accepted at the University of Chicago and Princeton University and is first on the waiting list at Harvard University for physics; another was accepted at the Universities of Chicago, Michigan at Ann Arbor, Wisconsin at Madison, and Texas at Austin; another has gotten into the Universities of Chicago and Wisconsin at Madison; and one other has been accepted at the University of Wisconsin at Madison.

Some Comments from the Mills Women

- "I think one thing professors can do is not to have the only issue they discuss with women who are in math be women and math. For example, one professor in our department was asking me about the summer program and what sort of math we did. I started listing the professors who were in the program because he was hoping he might know some of them and after I had mentioned three women's names, he stopped me and said, 'Oh, wait, this is a women's program?' I said that it was, and began to talk more about the math in response to his earlier questions. He interrupted and said, 'Oh, I understand, it was a sisterhood kind of thing,' and ended the conversation without listening to what I had to say or asking me any more questions."
- "Another thing that needs to be changed is the attitude that, when women get together to do their work, it is a sign of weakness or dependence. The time I've spent working with other women has been great and the atmosphere really positive. But even the participants remember that, at the beginning, we were embarrassed to tell people that we were part of a women's program. Instead, we would say that we were doing math at Berkeley. By the end of the summer, our attitudes were completely different."
- "There's something I want to say to the math community, and this is something I discussed at my school with the Dean and someone at the Women's Center. We often don't realize that we might be lacking confidence in our ability in mathematics because we're women. We don't think of it that way. And it's important to realize the impact it has because, once you do, you can go out and do something about it rather than think, 'Oh, I'm not smart enough to do math,' or say something like, 'I think this course is too hard.' And a lot of these things are subconscious. So, if professors have female students coming to them saying that they are confused and showing a lack of confidence, I think it is important for them to realize that there is this subconscious that's telling women that mathematics is too hard and they shouldn't go into it. But these ideas are a result of the gender issue and not a reflection of our real abilities or interests."
- Women show this tendency to discount their abilities in a variety of ways. For example, when we started the seminars, every time one of us went to the board, the first sentence would be, 'This is probably not right . . .' or 'This is very stupid . . .' and it was all great. So, after about a week, we said, 'No more. You can't say anything like that any more.'"
- ". . . this summer was the first time I ever realized that math is fun. I was a physics major and took calculus and got through it, but I didn't realize that there were really fun things to do with math because I wasn't one of these math team people or honor students. I would want to try to communicate that feeling to people who weren't lucky enough to have mathematicians as parents or didn't go to math camp, by bringing in a little of the fun aspect. Even in calculus classes, we can tell people that this is really a great field and even though you've got to learn all of these skills and do all these exercises, there's something worthwhile at the end."

For Additional Information . . .

For additional information on the Mills Summer Research Program, contact:

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1947 Center Street
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telephone: (510) 643-9153
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fax: (510) 643-7684.

During the Association's 1992 Annual Meeting in Baltimore, Maryland, participants in the Mills Summer Research Program reassembled during a workshop of the Association for Women in Mathematics (AWM). From left to right: Nancy Cunningham, Rebecca Field, Cheryl Grood, Jessica Wolpaw, Min Kang, Maria Basterra, Sunita Vatuk, Professor Lenore Blum, Kendra Hershey, and Julie Kerr.

"Probably the most wonderful thing in this program for me was that no one thought I was weird for getting excited about math. Normally, when you get all excited about a math problem, people step back as though you have cooties or something. But at Mills, it was wonderful because, when you got excited about a problem, people didn't do that."

Rebecca Field, a sophomore at Bowdoin College

"I think a big benefit of the program was that it helped increase our confidence. A lot of times during my first two years of classes, I felt like I didn't know anything or was just really stupid compared to everyone else. I'd often feel that people were talking over my head or trying to show off. Yet, when I came into the Mills program and was working with this community of women, it was easy and natural to talk to them. Since the summer, we've kept in contact with one another and we talk about mathematics. Back at school, math seems more of an isolated thing, which it shouldn't be."

Kendra Hershey, a junior at Princeton University

"Before I went to Mills this summer, most of the conversations I'd had with women my own age about mathematics centered around how much they hated it. People would tell me how they hated their calculus class or how they'd thought about being a math major and then decided not to. The worst, or the most discouraging at least, were other math majors who told me how much they wished they had majored in something else. There weren't very many other women in most of my classes and I hadn't ever worked closely with those that were there, so it was hard for me to come up with counterexamples when people put forward the hypothesis that women aren't really very good at mathematics. Well, when I went to Mills, I met twenty-three counterexamples. Although we spent some time talking about the position of being women doing mathematics, mostly we did math. So now, when people ask, 'Why is it that women aren't better at mathematics?' I say, 'Let me introduce you to some of my friends.'

"One of the most important things for me was going back to school and deciding to create a place for women to go where they are allowed to be excited about math. A physics major and I started a program called Math-Science Sibs, where juniors and seniors adopt first- and second-year students and go out for ice cream with them or present papers to them. The focus of the program is not just to get together to gripe about how hard it is to be a math or science major, but to tell people how excited we are about the things we do and why we do them. And its seems to be effective."

Nancy Cunningham, a senior at Yale University

"Although there is not a single female professor in the applied math department [at Brown University], it was not until I came to the Mills program that I realized there was a problem of underrepresentation of women in this field. The situation is so taken for granted at Brown that I never really thought about it, so the program has been valuable to me because it has opened my eyes in this way. Next semester, they will be launching a women in science program at Brown and I think I'll get involved with it. I'm not sure I would have done that if not for the Mills program."

Min Kang, a junior at Brown University

"I think that, for most of us, one of the most exciting things is the feeling of community, of having friends that sit around and talk not only about their lives and their parents, but also about math. It's like, 'I'm working on this problem and got stuck at such-and-such a point. Do you have any ideas about it?' I know it's probably more common for guys to do that kind of thing but, for a lot of us, it's the first time we've had that kind of opportunity. We're emailing problems to each other and it makes us feel like we're part of a community.

. . . when I went back to Berkeley, I actually felt like a mathematician and that made me feel closer to the men I knew—both the men that I have classes with and my teachers."

Sunita Vatuk, a senior at the University of California at Berkeley

The National Science Foundation (NSF) awarded Mills College a grant for this program, and students are paid a stipend for participating. The Mills program runs for six weeks, from mid-June to late July. The courses offered this past summer were harmonic analysis, symmetries and geometries, combinatorics, and algebraic logic. The topics were picked by professors selected to teach at the Institute, who were asked to choose subjects not necessarily offered as part of the standard curriculum at undergraduate institutions. Students met in two-hour seminars on Monday, Tuesday, Thursday, and Friday mornings. On Wednesday morning and afternoon, there were TA sessions with a graduate student. On Tuesday and Thursday afternoons, Mills students would join participants in the Professional Development Program (PDP) for minorities at the University of California at Berkeley for colloquia given by mathematicians from all over the country. The rest of the time was unstructured. Students had problems to solve and projects to work on. They also presented seminars to one another. There were no grades; the only pressure was from the participants themselves to understand

FOCUS EDITORIAL

The article on the Mills College Summer Program by Susan L. Forman (see pages sixteen and seventeen in this issue of FOCUS), presents a positive side to the way the mathematics community is trying to overcome the huge social pressures that, from an early age, conspire to keep women from becoming mathematicians.

But what happens to the women that emerge from such a program, or indeed to any woman who ventures into the largely male-dominated world of professional mathematics? How do we greet them?

Not well at all, according to *Science* magazine, which lambasted the mathematical profession in a special feature article published in the 13 March 1992 (Volume 255, Number 5050) issue, parts of which are reprinted on the facing page.

"In mathematics . . . sexist ideas are pervasive, and women often feel isolated and embattled," wrote John Benditt in his introduction to the special section on "Women in Science," which he edited.

The fine print appeared a few pages later, in the profile on mathematics written by Paul Selvin, a postdoctorate in biophysics at the University of California at Berkeley: "The kind of up-front sexism encountered [by a female mathematician at Princeton University] is on its way out in most areas of science. Yet it survives in mathematics, along with less overt—but pervasive—forms of discrimination." Later on in his two-page article, Selvin makes the same point again: "The persistence of rampant sexism seems almost unique to mathematics among scientific disciplines today."

My first reaction on reading the article was "Is it true? Is mathematics far worse than other sciences when it comes to sexism?" I did not think so. And my view was echoed by Carol S. Wood, a well-known mathematician at Wesleyan University and current president of the Association for Women in Mathematics (AWM), whom I called after reading the *Science* piece. Though many of the specific instances of sexism cited by Selvin in his article are indeed true, Wood acknowledges, you can find similar examples just as easily in other areas of science.

Wood's view is also supported by Jill P. Mesirov of Thinking Machines Corporation, a past-president of the AWM: "Things are difficult in math but certainly not worse than physics or chemistry. Also there is a concerted effort on the part of a number of good departments and on a number of organizations to work to correct some of the inequities. Look at the opportunities that have accrued to our Schaefer prize winner for example."

In fact, Mesirov, together with Wood and Rhonda J. Hughes of Bryn Mawr College, also a past-president of the AWM, took such great exception to the *Science* piece, and, in particular, to the way a quotation from Hughes was juxtaposed with allegations of sexual impropriety and innuendo, that they lodged a formal complaint with the magazine.

In response to the complaint, Benditt published the following retraction in the 24 April 1992 issue of *Science* (page 428):

"In the 'Women in Science' special section, Rhonda Hughes, chair of mathematics at Bryn Mawr College, was quoted—correctly—in the article "Profile of a Field: Mathematics. Heroism Is Still the Norm" as saying that graduate school in math constitutes a 'minefield' for women. The next sentence said that some of the 'landmines concealed under the surface' include a 'lack of encouragement from faculty members, sexual advances of mentors, and a suspicion on the part of male colleagues that women can succeed only by sleeping with male mathematicians.' Those specifics came from interviews with a number of female mathematicians—not from Hughes—and the sentence should have said so."

Quite a retraction, and one that had to be made. But of course, as always in such cases, the damage had already been done.

And yet damage done by the article to the reputation of mathematics in the wider community ought not to be our main concern. The main problem with the *Science* piece, as I see it, is that the controversy raised by the unfortunate and badly misleading editorial slant taken by the author, may obscure the fact that all of the actual cases quoted—and there are many of them—are indeed true. And it is they, not the silly conclusions the writer drew, that deserve our attention.

Referring to the *Science* article, Hughes said: "The mathematics community has a bad reputation for overlooking and undervaluing the work of women and deservedly so. But it doesn't deserve THIS. Selvin seriously misused my interview with him to make his case."

There are three sentences here. Hughes' third point was acknowledged by the *Science* retraction. Her second sentence reflects the fact that mathematics is Hughes' own community, one she identifies with and cares about. But it is her first sentence that should worry us most.

Keith Devlin

The views expressed above represent the opinions of the Editor of FOCUS and do not necessarily reflect the views of the MAA.

Interview with Carol Wood

During the course of my research into the *Science* article, I had a brief, electronic-mail dialogue with Carol S. Wood, President of the Association for Women in Mathematics (AWM). With Wood's permission, our discussion is reprinted below.

Keith Devlin

Devlin Do you think the Selvin article advances the cause of women in mathematics?

Wood No, but of course that was not the purpose. I thought the purpose was to describe the current situation. Selvin told me it was to be a discussion of the situation for women in the top universities, in fact.

Devlin Can you elaborate?

Wood Despite some good will and many efforts, barriers remain to the full acceptance of women, especially at so-called elite institutions with their overly narrow definition of "first-rate" mathematician. Stressing sexual conduct or citing outrageous remarks trivializes a highly complex situation, however, as if to suggest that the major problems facing women mathematicians were the speculations of neanderthals about our personal lives. The serious obstacles are much more subtle.

. . . out of SCIENCE

Below are some of the assertions made by SCIENCE magazine in their 13 March 1992 (Volume 255, Number 5050) feature "Profile of a Field: Mathematics. Heroism Is Still the Norm," written by Paul Selvin. The full article appeared on pages 1382 and 1383 of that issue, as part of a much larger collection of articles entitled "Women in Science."

- Lynne Butler, a thirty-two-year-old assistant professor of math, is leaving Princeton University—one of math's elite bastions—for Haverford College. "There's a perception in the math community that I'm taking an enormous step down for no good reason," she says. But, in fact, there are good reasons why Lynne Butler is leaving Princeton. Indeed, her time there seems to have been something of a nightmare—because she's a woman. "While in the hall, one junior faculty came up to me and said, 'I feel bad about it, but I really do feel women are genetically inferior in math' . . . . Other junior faculty would say similarly upsetting things . . . . I'd thank them for sharing their personal prejudices with me." Eventually, Butler says, "I just locked myself in my office and didn't come out for four years."

- In mathematics, young women PhDs run into a well-reinforced glass ceiling that keeps them from reaching the pinnacle of academic success: tenured professorships at top universities. At the top ten math departments in the United States, there are three hundred tenured men—and only two women. And the situation at the entry level isn't much better. In the 1990–1991 academic year, the top ten departments had approximately fifty men with tenure-track assistant professorships—and three women. The situation is only a bit better in the next rank of success—the top forty schools—where women make up 4.5 percent of the tenured faculty. And many of them are concentrated at just a few universities, including Rutgers University, the University of Illinois at Chicago Circle, the State University of New York (SUNY) at Stony Brook, and the University of Texas at Austin.

- The lack of encouragement in the general culture—the sense that mathematics is somehow "unfeminine"—only intensifies on entry to the academic world. Graduate school, in particular, is a "minefield" for female mathematicians, says Rhonda Hughes, chairperson of math at Bryn Mawr College and a past-president of the Association for Women in Mathematics (AWM). *Other women mathematicians* say that the landmines concealed under the surface include a lack of encouragement from faculty members, sexual advances of mentors—and a suspicion on the part of male colleagues that women can succeed only by sleeping with male mathematicians.

- The treatment Joan Birman received is an example of what happens to women mathematicians later in their careers, after they've achieved senior status by solving major problems in mathematics. Birman, a tenured professor at Barnard College, says that when she was hired, she was promised a position in the affiliated Columbia University department, where she also teaches. That was eighteen years ago—and the promise is yet to be fulfilled. Birman, who is internationally known for her work in knot theory, notes that the two men who preceded her as chairs of the Barnard department were given appointments at Columbia.

  "There is a subtle and underlying prejudice against women at Columbia," says Birman. When hiring decisions are made, she adds, "women are put aside, not with anybody saying, 'We don't want a woman,' but by someone saying at a crucial moment that their math is not the greatest—and that's a sure way to kill anybody." Birman says she can't say for sure whether that kind of treatment is due to honest judgments or to sexism, but she argues that Columbia's overall record (it has no women math faculty) speaks strongly for the latter. Although she is treated well on a daily basis in the Columbia department, she says, the appointment is a matter of pride and principle. "The thing that bothers me is that I'm a second-class citizen in the Columbia department. That's a terrible message to send to young women: No matter what they achieve, they will be held down."

- Some universities—including the University of California at Berkeley—give untenured professors who want to have a family an extra year to get tenure. Another alternative is to change the reward structure to give teaching positions tenure or the equivalent (as Harvard University did in 1982 with Deborah Hughes Hallett, who is instrumental in undergraduate teaching). Since many female mathematicians are in teaching positions that are currently non-tenure-track, such a change could dramatically increase the number of tenured women.

  Some universities are also trying affirmative action in mathematics. At the instructor and junior faculty level, Princeton has an affirmative action program that brought five women into the department in the past two years. "We're absolutely not bending standards," says Robert Gunning, dean of the faculty at Princeton and professor of math. "The program does not function that way." Instead, he says, the university gives "free slots" to departments that may be "searching in one field, but an opportunity comes along in another field." These positions, however, offer little hope of tenure, since Princeton rarely promotes assistant professors.

DEVLIN But isn't it good to have all those specific instances of sexist behavior out there on the table? And I assume all of the actual instances mentioned in the article are true—no one is, I gather, claiming that Selvin manufactured any of the details or the quotations.

WOOD One of Selvin's quotes, while not manufactured by him, was highly disingenuous on the part of the speaker and should not have been included. And he can't count mathematicians in the National Academy of Sciences (NAS), as Cathleen Morawetz, NAS member and mathematician, points out. Of course I do not oppose airing instances of sexism; I do it all the time! But I am disappointed at the overwhelmingly negative tenor of the article, depicting the world I inhabit in a way I could barely recognize.

The conclusion that mathematicians are worse than other scientists rings particularly false to me, although I have no more proof than did Selvin. We may be different, due to our own mix of arrogance and elitism; I see us as socially naive and intellectually savvy, relative to our counterparts in the sciences. But worse? Maybe I'm just too loyal to mathematics and mathematicians to imagine that.

President's Message

Deborah Tepper Haimo

As we are well aware, the increasingly diverse membership of the Mathematical Association of America has grown dramatically in recent years. Thus, when I assumed the Presidency a little over a year ago, the time seemed right to follow the advice of our energetic Executive Director, Marcia P. Sward, to step back, to review our activities, and to update the long-range plan we had developed five years earlier. To this end, for many months now we have been working on a strategic plan, examining our mission and goals, and identifying initiatives that reflect these directions. Other organizations, in particular, the American Mathematical Society (AMS), have completed a similar venture, whereas the Society for Industrial and Applied Mathematics (SIAM) and the American Mathematical Association of Two-Year Colleges (AMATYC), are currently in the initial stages of such exercises.

From the beginning, we have sought to involve our membership as fully as possible in the project. Our Board of Governors has actively participated all along, and its members have introduced many recommendations for the plan. By including the All-Member Strategic Planning Survey in the February 1992 issue of FOCUS, we provided our entire membership with the opportunity to offer suggestions during the plan's evolution. Drafts are being written, modified, and revised, and it is our expectation that we will present a final version to the Board for its approval at the 1993 Annual Meeting, 13–16 January, in San Antonio, Texas.

Our introspection and analysis of the situation lead us to set the stage for the future. In doing so, we must never lose sight of the fact that we are, first and foremost, a mathematics professional organization. What has drawn us together is our deep appreciation of the inherent beauty and elegance of mathematics, and our recognition of its great power for broad application. Our unquestionable commitment is to share our love of mathematics with those with the ability and inclination to become leaders in the field, as well as with many others. We also want to expand awareness and increase understanding of the nature of mathematics as widely as possible. Our challenge is to initiate and to advance those activities that reflect our primary interests and, as we head into the twenty-first century, to set the direction in which we can provide effective leadership.

One of the new developments in the MAA that gives me the greatest satisfaction is the implementation, this year, of the Award for Distinguished College or University Teaching of Mathematics (ADCUTM). By happenstance, I was invited to speak at the Northern California Section—the first to meet this spring. This afforded me the added personal joy of presenting the MAA's first Section award to Gulbank Donald Chakerian of the University of California at Davis.

ADCUTM Committee Chair Henry L. Alder of the University of California at Davis and his supportive committee expertly resolved the seemingly insurmountable problems inherent in introducing a new program under serious time constraints. They effectively created a climate of inclusiveness by generating a sense of immediacy and by providing a forum for full-Section participation and expression of individual concerns. As a result,even at this initial stage, twenty-five Sections have designated a Section honoree, and we expect all twenty-nine to participate hereafter. I look forward with great anticipation to recognizing the MAA's first national awardees for Distinguished College or University Teaching of Mathematics at our 1993 Annual Meeting in San Antonio.

As if launching a strategic plan and program of awards for distinguished teaching were not sufficient cause for celebration, we were reminded by MAA Associate Executive Director Donald J. Albers and MAA Secretary Gerald L. Alexanderson of yet another great milestone to observe in San Antonio. In 1993, the American Mathematical Monthly will mark its centennial. As history reveals, the debate over its adoption as an AMS publication resulted in the creation of the MAA where it secured a permanent home. The Monthly, considered by some to be the world leader in expository mathematical writing, continues for many as the primary inducement for membership in the Association. As the Monthly ends its first hundred years and enters a new era under the editorship of John H. Ewing of Indiana University, we applaud its roster of distinguished former editors and celebrate its continuation as a major mathematics periodical.

As we look forward expectantly to the 1993 Annual Meeting in San Antonio, we should also reflect with pride on our 1991 Summer Meeting in Orono, Maine. That event unequivocally reversed the worrisome trend of declining attendance at summer meetings. A well-coordinated program of professional activities and a day reserved for nonoverlapping sessions generated a remarkably high registration. Further, in conjunction with the AMS, we hosted an historic awards dinner, and thus, extended to each organization's meritorious honorees the greater recognition and acclaim of a broader audience.

At our 1992 Annual Meeting in Baltimore, Maryland, the varied and appealing program achieved the solid attendance predicted for such a site. Happily, the location provided an opportunity for Marcia Sward to invite each staff member of our Washington, DC headquarters to spend at least a day observing the Association in action. The evening before the Board of Governors meeting, we held a much-welcomed reception in response to the expressed eagerness of the governors for more opportunity to communicate with their peers. In addition, at the suggestion of our new First Vice President, Susan L. Forman of Bronx Community College of The City University of New York, and in cooperation with the AMS, we sponsored a social for first-time national meeting attendees. The large crowd, including many students, strained the limits of the expansive reception area and simple refreshments, attesting undeniably to the great success of this event.

On the homefront, we have been equally active in many directions. With the election of Donald L. Kreider of Dartmouth College as our next president, we needed to select a successor to fill the resulting vacancy for Treasurer. Following recent procedures, we advertised the position in FOCUS and were delighted to discover within the Association much impressive talent, even in so specialized an area. We identified six outstanding nominees and evaluated their individual strengths. When the Board of Governors approved our selection of Gerald J. Porter of the University of Pennsylvania for the post, the appointment was based, not on inheriting the office, but on our judgement that his current background and experience clearly made him the strongest candidate.

Apart from the MAA's being actively involved in developing a wide variety of projects addressing issues of interest to and concern of our diverse membership, we have sought, just as rigorously, external funding for these activities. We have been successful in receiving support, in diverse forms, from numerous sources. For example, the National Security Agency (NSA) produced You're Gonna Need Those Numbers, a promotional video aimed at encouraging students to remain in school and to study mathematics. Further, one of the largest grants came from IBM for the MAA's Interactive Mathematics Text Project (IMTP), which was launched recently at Morehouse College in Atlanta, Georgia, one of the six sites selected for this project. Our SUMMA (Strengthening Underrepresented Minority Mathematics Achievement) office has been awarded two major grants from the National Science Foundation (NSF): one, for its networking intervention program, and the other, for its project on attracting minorities into teaching (AMIT). The SUMMA office will receive some core support from the NSA.

Our relations with other mathematics organizations continue to develop and expand as our communication with them increases. With the concurrence of both the National Council of Teachers of Mathematics (NCTM) and the NSF, we hosted a reception at our Washington, DC headquarters for those high school mathematics teachers who were in the city to be honored as Presidential Awardees, and we hope to continue this practice annually. We are in regular contact with the NCTM and AMATYC. With the appointment of Richard H. Herman of the University of Maryland as Director of the Joint Policy Board for Mathematics (JPBM), that organization is now on firmer ground. Indeed, when the NSF issued its 1992 budget, the three presidents of the JPBM's member societies—the MAA, AMS, and SIAM—lost no time in meeting in Washington, DC with NSF Director Walter Massey to emphasize the mathematical community's unity and the need for greater support for mathematics. We thereby confirmed our commonality and solidarity as mathematics organizations.

Preliminary reports of our six Coordinating Councils attest to the fact that the new structure is functioning well. A workshop to review and coordinate activities concerning women's issues throughout the Association is currently in the planning stage. Also, committees listed under Administration are being reviewed and some changes are being considered. Further, the Committee on Committees is delegating, to the appropriate Council Chair, responsibility for identifying suitable candidates to fill committee vacancies. The Chairs are charged with consulting widely, gathering pertinent, detailed information, and providing a significant basis for suggesting nominees to the Committee on Committees for the final recommendations to the President.

The MAA continues in its leadership role as we actively address critical issues in mathematics. By specifically including mathematics in his agenda for the nation, President Bush has given our discipline unprecedented public attention which has been gaining increasing prominence. Our challenges arise on many fronts; we have much work ahead!

Award for Distinguished College or University Teaching of Mathematics

On 29 February 1992, members of the Northern California Section gathered at the University of the Pacific in Stockton for their 1992 Annual Section Meeting. During that meeting, MAA President Deborah Tepper Haimo presented the first Sectional Award for Distinguished College or University Teaching of Mathematics to Gulbank Donald Chakerian of the University of California at Davis. The citation President Haimo read during the award ceremony appears in full below. For additional information on the award's history and guidelines, please see the September 1991 issue of FOCUS, pages one and five.

In keeping with the resolve of the Mathematical Association of America to take substantive action each year to honor extraordinarily successful teaching at all postsecondary levels, the Northern California Section of the Association is pleased to identify Gulbank Donald Chakerian as the recipient of its Mathematical Association of America Sectional Award for Distinguished College or University Teaching of Mathematics.

Professor Chakerian of the University of California at Davis was chosen from a group of distinguished teachers whose nominations were submitted by our membership to a five-person committee appointed by the Chair of our Section.

Professor Chakerian is a multiple threat. His students praise his teaching and those students have gone on to their own high performance in our profession, thus providing a noteworthy measure of the correctness of their judgment. His colleagues praise him for his work with students at the university level, as well as for what their professional association with this charismatic professor means to them. His lectures, his writings, and his significant service to the broader professional community beyond his home campus have been witnessed not only throughout California, but also throughout the country and at most professional levels of our profession.

The Northern California Section of the Mathematical Association of America recognizes its exceedingly good fortune in having this gifted, energetic, and well-disposed colleague in its midst. We are most pleased to exercise this opportunity to trumpet the extraordinary merit of this extraordinary teacher of mathematics.

From the Executive Director's Desk

Marcia P. Sward

Can You See the Shape of the Future? The answer to the question posed in the title clearly is "no." Stunning developments on the international scene, such as the break-up of the Soviet Union, remind us almost daily that we cannot predict the future, yet somehow we must do our best to educate the next generation to live and work in a world we can't even imagine.

In an effort to reshape the MAA so that it can better serve the needs of today's young people, President Deborah Tepper Haimo appointed a task force on strategic planning, which has been at work since last August. She describes the work of the task force in her President's Message in this Annual Report. But, even as we struggle to envision and prepare for the MAA of the future, we are moving ahead with all deliberate speed to meet the challenges of today.

The Mathematical Center The renovation work on the MAA's historic three-building complex is essentially complete, and our dream of having a "mathematical center" in Washington, DC, is now a reality. In addition to housing our staff of thirty, the Dolciani Mathematical Center houses the Conference Board of the Mathematical Sciences (CBMS), the Joint Policy Board for Mathematics (JPBM), and, starting in August 1992, the Washington, DC offices of the American Mathematical Society (AMS). The generosity of the many MAA members who have made contributions to the Mathematical Center Fund has made all this possible and has provided us with an attractive and comfortable place to host meetings and other mathematical events.

Staff Nothing is accomplished without people, and the best things are accomplished by people with imagination and drive. The MAA has been blessed with staff members who devotedly labor from dawn to dusk making good things happen. At the director's level are Donald J. Albers, Rhoda Dechter Goldstein, William A. Hawkins, Jr., and James R. C. Leitzel, all handling multiple, complex tasks for the MAA. We hope soon to welcome Andrew Sterrett back to the MAA for his third "tour of duty" as our volunteer-in-residence. We are all supported in our work by an experienced and dedicated staff of managers and junior staff members.

The Computer System One of the most complex and time-consuming tasks during the past year has been the design and installation of a fully networked computer system with a direct link to Internet (soon to be completed). All MAA staff members have been actively involved in the process, and all are adapting to the new system with energy and enthusiasm. We are excited about the possibilities that our network and Internet connection will open up for new MAA member services.

Programs and Projects Be sure to read in this Annual Report about the many programs and projects of the MAA. During the past two years, we have received twenty-seven grants to support twenty-four projects. The grand total in external support is $5.6 million—$2.2 from federal sources and $3.4 million from private corporations and foundations. Obviously, these grants have enabled us to greatly expand the range of projects the MAA can undertake. We expect the Strategic Plan to further increase the number and scope of MAA projects. This will tremendously challenge the MAA staff, as well as our national and Sectional leaders and committee members. However, we believe that, with careful planning and timing, we will find the necessary resources, both externally and internally, to carry out those projects our Board of Governors deem essential.

Conclusion My favorite quote is from Clay Morgan in *Everybody Counts*: "Children are the future. Everything we do is for them, and everything that will be done, will be done by them." Undergraduate students aren't children any more, but Clay's statement is no less true of them. As our national leaders seek to reshape US education to better fit the future needs of the nation and the world, the MAA will play a central role. I am proud to be a part of an organization which is deeply committed to quality education for all students and is vigorously pursuing that goal. I hope that you are too.

Committee on Sections

The Association has charged the Committee on Sections with providing assistance to the Sections, encouraging communication amongst them, acting as liaison between the Sections and the Association's national headquarters, and representing the Sections to various constituencies. In its endeavors, the Committee works closely with James R. C. Leitzel, Visiting Mathematician at MAA headquarters in Washington, DC.

The Committee on Sections continues to review its service to the MAA's twenty-nine Sections, especially during its meetings at both the annual and summer conferences of the MAA. The Committee also hosts Section Officers' meetings during these conferences and, indeed, although only the annual meeting receives funding for officer attendance, many officers attend both meetings where lively discussions ensue. For the summer meeting, the national office subsidizes travel expenses for one officer from each Section.

Section officers will meet on Sunday, 16 August 1992 in Québec City, Québec, immediately before the Seventh Annual International Congress on Mathematics Education (ICME-7) opens. The Committee encourages officers to forward agenda items to the chair before the meeting; discussion topics will include the MAA's Award for Distinguished College or University Teaching of Mathematics (ADCUTM).

In 1991, the Committee on Sections assumed a new responsibility: scheduling the Pólya Lecturer. Each Section enjoys the opportunity, approximately every five years, of inviting the Pólya Lecturer to address a Section meeting. In 1991, the Committee also initiated, with Visiting Mathematician Leitzel's assistance, implementation of the Priming the Pump for Curricular Change program. Through this program, Sections may learn more about both undergraduate mathematics reform efforts and the National Science Foundation (NSF) and its programs related to undergraduate mathematics. Furthermore, in early 1992, the Committee revised Guidelines for the Fund for Aid to Sections. The Committee on Sections also edits a newsletter, Crossections, for Sections officers and, each year, produces the FOCUS on Sections insert for the September issue of FOCUS.

Women and Mathematics

The Women and Mathematics (WAM) program encourages female students, primarily in grades six through twelve, to explore mathematical and scientific topics and to develop their talents in these areas. The program seeks chiefly to free female students from the "women-can't-or-don't do mathematics" stereotype. WAM provides contacts with role models, career and academic counseling, workshops, corporate tours, and mentors as well as student-parent-teacher association meetings and classroom presentations. WAM participants are all women pursuing careers that require an extensive foundational knowledge of mathematics. The program was founded in 1975 with initial funding from IBM.

Active regions in the Women and Mathematics program include: Baltimore-Washington, Boston, Chicago, Greater Philadelphia, Hawaii, Kansas City, Michigan, Montana, New York-New Jersey, North Carolina, Northern California, Puget Sound, Texas, and Utah. The Connecticut and Southern California regions are reorganizing under a new director and the program will consider new regions in Georgia, New Hampshire, and South Carolina. WAM needs new coordinators to reopen the Central Ohio and Oregon regions. WAM is always interested in developing new regions where coordinators and funding can be established.

The WAM program and the Speakers Bureau of the Association for Women in Mathematics (AWM) continue to explore forming an alliance. Combining the school contact activities of these two organizations would benefit both groups and the students they serve. For example, volunteers available through AWM would enable WAM to reach a audience both geographically and academically more diverse. WAM's regional organization would assist AWM speakers to contact schools and arrange visits.

A WAM member has begun compiling a book of problems along with career descriptions and brief biographies of the WAM volunteers who submitted the problems. The book will answer typical questions from a secondary school audience concerning the uses of mathematics and various careers. The program will use any profits from the book to support its activities.

WAM has scheduled a Strategic Planning Workshop for 1992. After seventeen extraordinarily active years, the program must reevaluate its mission, goals, and activities to revise for the current decade. WAM will utilize advice from experts in the needs of female students and schools to direct future activities. The program seeks funding for this workshop.

In 1992, WAM contacted over 27,000 students, 1,500 teachers, and 800 other adults through more than 400 presentations. Currently, two national directors, 26 coordinators, and 520 role models administer and implement the program.

WAM receives funding from corporations and from contributions from both individuals and the MAA. In 1991, IBM, Hewlett-Packard, and Northern Telecom provided grants. Yearly, WAM receives more than one-third of its funding from inkind contributions from participants and coordinators, as well as contributions of time and other support from their employers. In addition, Hewlett-Packard contributed thirty 28S calculators for distribution as awards throughout the regions. Chevron reproduced over 1,000 career brochures for distribution to schools and students.

WAM regions, independently and in cooperation with other women's groups, also organize and participate in such career conferences as Sonya Kovalevskaya Day, Expanding Your Horizons, and Math Options. These conferences feature workshop leaders who first received encouragement to study mathematics at a similar conference or WAM presentation.

If you would like to participate in, or contribute to the Women and Mathematics program, or, if you wish to receive additional information on its activities, contact: Alice J. Kelly, National Director, Women and Mathematics (WAM) Program, Department of Mathematics, Santa Clara University, Santa Clara, California 95053-0001; telephone: (408) 554-4525;email: Akelly@scu.bitnet.; fax: (408) 554-2700.

Committee on Student Chapters

The number of MAA Student Chapters continued to grow in 1991; there are now approximately three hundred chapters and thirty-five hundred student members. The 1992 Annual Meeting in Baltimore, Maryland incorporated a variety of student-oriented activities. Highlights included an extremely successful Career Fair that attracted over four hundred fifty high school students as well as many undergraduate and graduate students registered for the meetings. Carolyn R. Mahoney of California State University at San Marcos delivered the special student lecture on Contemporary Problems in Graph Theory and Ben A. Fusaro of Salisbury State University conducted a workshop on Environmental Mathematics. The Student Hospitality Center was so heavily used that an arrangements committee consisting of Kathleen M. Shannon of Salisbury State University and Richard S. Neal of the University of Oklahoma has been appointed to oversee the Hospitality Center at future meetings.

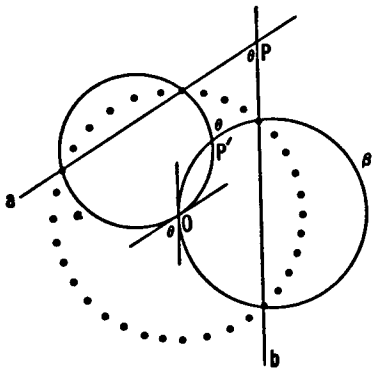
In 1991, the Exxon Education Foundation provided its third grant to the MAA's Student Chapters. The goal of the grant is to support efforts to increase student participation at national and Sectional meetings of the MAA. The grant also supported the Career Fair at the 1992 Annual Meeting.

Several exciting projects are on the horizon. In August 1992, the MAA's Student Chapters and Pi Mu Epsilon will jointly sponsor a Special Summer Meeting for Students at Miami University. The conference will include student papers, workshops, lectures, and social activities. We believe that this is the first national conference focused entirely on mathematics students. Plans are being coordinated by Aparna W. Higgins of the University of Dayton in cooperation with her Pi Mu Epsilon counterparts, David W. Ballew of Western Illinois University; Robert S. Smith of Miami University; J. Douglas Faires of Youngstown State University; and Robert M. Woodside of East Carolina University. Ronald F. Barnes of the University of Houston-Downtown will coordinate the MAA student papers.

At the 1993 Annual Meeting in San Antonio, Texas, the Committee on Student Chapters plans a special session on Student Chapter programming in which Section coordinators and chapter advisors will discuss their most successful activities. We expect the special session to provide a wealth of ideas for student-oriented efforts. Deborah A. Frantz of Kutztown University coordinates a committee that includes Karen J. Schroeder of Bentley College and William Howard Jones of the University of the District of Columbia, which will oversee this special session.

The Committee on Student Chapters is attempting to undertake joint activities with Canadian students at the 1993 Summer Meeting, jointly sponsored with the Canadian Mathematical Society (CMS) in Vancouver, British Columbia, 15–19 August 1992.

For additional information on the MAA's Student Chapters program, contact: Howard Anton, Chair, MAA Committee on Student Chapters, Department of Mathematics and Computer Science, Drexel University, Philadelphia, Pennsylvania 19104-2875; telephone: (609) 772-2999; email: antonh@duvm.bitnet.; fax: (609) 770-8297.



Membership

Since 1983, MAA membership has grown almost 73%. The Association largely attributes this phenomenal increase to direct mail marketing, member retention endeavors, and undergraduate recruitment campaigns accomplished primarily through the MAA's Student Chapters program.

In addition to individual members, the total membership includes 454 Life Members, 15 special Corporate Members, and 597 Institutional Members consisting of secondary schools, two- and four-year colleges, and universities.

Reciprocal agreements with the Canadian Mathematical Society (CMS) encourage joint membership and activities. CMS members not residing in the US may receive a 15% discount on MAA dues. Conversely, MAA members not residing in Canada may receive a 15% discount on CMS dues.

In addition, the MAA now offers a free, one-year membership to students who deliver papers at Section meetings and to winners of various competitions, as well as to each new recipient of a doctorate in mathematics or mathematics education from a US or Canadian institution.

1991 Year's-End Membership Demographics

Membership Category	1983	1991
Students	3,313	7,889
Secondary School Teachers	671	2,382
College and University Faculty	9,876	13,692
Industry or Government	2,464	3,984
Retired or Unemployed	1,384	2,492
Other	969	1,817
Total Membership	***18,677***	***32,256***

1991 Prizes and Awards

In 1991, the MAA honored several authors for their achievement in mathematical exposition. Each winner received a check, a certificate, and the recognition and esteem of his colleagues. Because so many mathematicians rely on written communication to learn of recent developments in our discipline, the efforts of these authors to explore such developments in lucid and engrossing prose deserve both our admiration and gratitude.

At the 1992 Annual Meeting in Baltimore, Maryland, Steven G. Krantz of Washington University received the 1991 Chauvenet Prize for "What is Several Complex Variables" in *The American Mathematical Monthly* **94** (1987): 236–256.

In addition to the Chauvenet Prize, the Association, through its journal awards committees, also honored outstanding articles from each of its periodicals: the Carl B. Allendoerfer Award for papers in *Mathematics Magazine;* the Lester R. Ford Award for papers in *The American Mathematical Monthly;* and the George Pólya Award for papers in *The College Mathematics Journal.* (For a more detailed discussion of 1991's winners and their exceptional expositions, see page twenty of the December 1991 issue of FOCUS).

The Carl B. Allendoerfer Award

- Ranjan Roy of Beloit College for "The Discovery of the Series Formula of Pi by Leibniz, Gregory, and Nilakantha" in *Mathematics Magazine,* **63** (1990): 291–306.

The Lester R. Ford Award

- Marcel Y. Berger of the Institut des Hautes Études Scientifiques in Bures-sur-Yvette, France for "Convexity" in *The American Mathematical Monthly,* **97** (1990): 650–678.
- Ronald L. Graham of AT&T Bell Laboratories and Frances Yao of Xerox Corporation for "A Whirlwind Tour of Computational Geometry" in *The American Mathematical Monthly,* **97** (1990): 687–701.
- Joyce Justicz of Emory University, Edward R. Scheinerman of Johns Hopkins University, and Peter Winkler of Bellcore's Research Group for "Random Intervals" in *The American Mathematical Monthly,* **97** (1990): 881–889.

The George Pólya Award

- William B. Gearheart and Harris S. Shultz, both of California State University at Fullerton, for "The Function of sin *x*/*x*" in *The College Mathematics Journal,* **21** (1990): 90–99.
- Mark Ford Schilling of California State University at Northridge for "The Longest Run of Heads" in *The College Mathematics Journal,* **21** (1990): 196–207.

The Merten M. Hasse Committee presents its journal award to authors under forty years of age at the time of publication. In 1991, Barry A. Cipra, freelance mathematics reporter, accepted the Hasse Prize for "An Introduction to the Isling Model" in *The American Mathematical Monthly,* **94** (1987): 937–959.

During the 1992 Annual Meeting in Baltimore, the MAA also recognized several mathematicians for their myriad and enduring contributions to both the Association and mathematics education. Recipients of the MAA's 1991 Meritorious Service Awards included: James C. Bradford of Abilene Christian University and the Texas Section; Franklin S. Brenneman of Tabor College and the Kansas Section; Robert Gilmer of Florida State University and the Florida Section; Delia Koo of Eastern Michigan University and the Michigan Section; A. Duane Porter of the University of Wyoming and the Rocky Mountain Section; and James J. Tattersall of Providence College and the Northeastern Section. (For additional information on the contributions of these dedicated members, see pages six and seven of the April 1992 issue of FOCUS.)

At the same meeting, Lynn Arthur Steen, Professor of Mathematics at Saint Olaf College and President of the MAA in 1985–1986, accepted the third Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics. An expanded version of the official citation read at the award ceremony appears in *The American Mathematical Monthly,* **99** (1992): 99 and 100. The April 1992 issue of FOCUS (page three) includes Steen's acceptance remarks.

Committee on the Undergraduate Program in Mathematics

During 1991, some National Science Foundation (NSF) projects—some proposed, some granted—took the attention of the Committee on the Undergraduate Program in Mathematics (CUPM). The Curriculum Action Project (CAP) moderators and writers completed their reports and prepared the resulting volume. In addition, a panel on CAP was held at the 1992 Annual Meeting in Baltimore, Maryland. Details on the next phase of this project appear below, on this page of FOCUS.

In late August, NSF declined a large proposal submitted by the MAA in 1991 on curricular initiatives. In the space of just two weeks—all that was available between the first NSF rejection and its following deadline—the proposal was cut significantly, reshaped, and resubmitted around a theme of developing "world-class" standards for undergraduate mathematics.

As the new Council on Education assumes many of the "forum" aspects of the CUPM, the relationship between the CUPM, its subcommittees, and the Concil will continually merit attention and scrutiny. As usual, most of the CUPM's work operates through its many subcommittees. What follows are highlights from these subcommittees' individual reports.

Subcommittee on Services Courses Barbard A. Jur of Macomb Community College, Chair. This Subcommittee sponsored two contributed paper sessions at the 1992 Annual Meeting in Baltimore and is currently preparing a report on *Service Courses for Business.*

Subcommittee on Calculus Reform and the First Two Years Thomas W. Tucker of Colgate University, Chair. At the 1991 Summer Meeting in Orono, Maine, CRAFTY discussed a proposal from Donald B. Small of Colby College for a National Science Foundation (NSF) supported series of calculus workshops. NSF subsequently funded these workshops and they will be conducted during the summer of 1992. At the 1992 Annual Meeting in Baltimore, the Subcommittee sponsored a contributed paper session on the first two-year sequence, a panel on the Advanced Placement (AP) Calculus program, and an extensive subcommittee discussion of the first two-year sequence.

Subcommittee on Symbolic Computer Systems Zaven A. Karian of Denison University, Chair. This subcommittee, jointly with the Committee on Computers in Mathematics Education (CCIME), sponsored a special presentation by David Tall of the University of Warwick at the 1992 Annual Meeting in Baltimore. The Subcommittee also is developing two volumes—a collection of annotated problems and classroom demonstrations and a collection of articles on the pedagogic uses of symbolic computation.

Subcommittee on Quantitative Literacy Linda R. Sons of Northern Illinois University, Chair. This Subcommittee held an informal discussion session at the 1991 Summer Meeting in Orono where attendees expressed an urgent need for guidelines. The Subcommittee is analysing a survey on the current status of requirements which every baccalaureate recipient must meet. It discussed a first draft of its recommendations on guidelines at the 1992 Annual Meeting in Baltimore and hopes to present a final draft in August 1992.

Subcommittee on Assessment of Undergraduate Majors Bernard L. Madison of the University of Arkansas, Chair. The Subcommittee will submit a proposal to the NSF to develop guidelines for assessment of undergraduate mathematics programs, conducted sessions at the annual meeting of the American Association for Higher Education (AAHE), and will sponsor a contributed paper session at the 1993 Annual Meeting in San Antonio, Texas. The MAA's Executive and Finance Committees have expressed some concern over the assessment and testing issues which feature in the National Education Goals. The Subcommittee will review this issue.

Subcommittee on the Basic Library List Lynn Arthur Steen of Saint Olaf College, Chair. The Subcommittee completed its two volumes of library recommendation during the fall of 1992. The four-year volume, *Library Recommendations for Undergraduate Mathematics,* contains approximately 3,000 titles arranged into 25 chapters, encoded with asterisks to reflect priorities. The two-year volume, *Two-Year College Library Recommendations,* contains a subset of 1,200 of these titles, selected by a committee of two-year college reviewers. A much smaller volume with recommendations for high school libraries remains to be completed.

In October 1991, the Association named James R. C. Leitzel of Ohio State University as Chair of the CUPM. For additional information on this committee, contact him at: The Mathematical Association of America, 1529 Eighteenth Street Northwest, Washington, DC 20036-1385; telephone: (202) 387-5200; email: maa@athena.umd.edu.; fax: (202) 265-2384.

Curriculum Action Project

The work of the MAA's Curriculum Action Project (CAP) has resulted in publication of *Heeding the Call for Change: Supporting Curricular Action.* Five chapters in this volume reflect the discussions of last year's Focus Groups on Assessment, Geometry, Mathematics and the Environment, Quantitative Literacy, and Statistics. Other chapters explore themes in research in undergraduate mathematics education and issues in ethnomathematics and multiculturalism. The volume also contains a recent report from the Committee on the Undergraduate Program in Mathematics (CUPM) entitled The Major in the Mathematical Sciences.

CAP builds a foundation for a comprehensive national effort to strengthen the mathematical sciences at the undergraduate level. The project's next phase will initiate a broad-based dialogue within and among the mathematical community and its various external constituencies. Lynn Arthur Steen of Saint Olaf College is Project Director; James R. C. Leitzel is MAA Staff Liaison.

CAP is now actively pursuing its next phase. In late February 1992, presentations were made at the annual conference of the American Association of Colleges for Teacher Education (AACTE). At that meeting, the MAA joined the Mathematical Sciences Education Board (MSEB) and the National Council of Teachers of Mathematics (NCTM) in staffing an information booth on curricular change in mathematics at both the school and the undergraduate levels. In addition, materials developed through CAP were distributed. At the National Higher Education Conference, sponsored by the American Association of Higher Education (AAHE), John A. Thorpe, Vice Provost at the State University of New York at Buffalo, and MAA Past President Lida K. Barrett made presentations. In June 1992, members of the CAP Focus Group on Assessment will make presentations at another conference of the AAHE. Project Director Steen has prepared articles for publication in newsletters and journals of various higher education associations and the MAA. Furthermore, the project encourages MAA Sections to include discussions of curricular change on their meeting programs.

For additional information on the Curriculum Action Project, contact: James R. C. Leitzel, MAA Staff Liaison for CAP, The Mathematical Association of America, 1529 Eighteenth Street Northwest, Washington, DC 20036-1385; telephone: (202) 387-5200; email: cap@hilda.umd.edu.; fax: (202) 265-2384.

SUMMA

The MAA's Strengthening Underrepresented Minority Mathematics Achievement (SUMMA) program is a national effort focused on increasing minority participation in mathematics at every level, from elementary through graduate school and beyond. The program has developed a series of projects to implement SUMMA's goals—increased representation of minorities in mathematics, science, and engineering and the improvement of the mathematics education of minorities. MAA Executive Director Marcia P. Sward and the MAA Committee on Minority Participation in Mathematics (CMPM), cochaired by Manuel P. Berriozábal of the University of Texas at San Antonio and Sylvia T. Bozeman of Spelman College, oversee the SUMMA program. As a result of consultation between MAA leadership and the SUMMA staff and members of the CMPM, an increased number of minority mathematicians now serve on MAA committees and councils.

Carnegie Intervention Grants The Carnegie Corporation of New York awarded the MAA a two-year grant (now in its second year) of $327,000 through 1993 to encourage college and university mathematics faculty to initiate intervention projects serving minority middle- and secondary-school students. A round of Small Planning Grants in April 1991 and again in March 1992 distributed $100,000 in twenty-four grants. Recipients included: California (two), Georgia (two), Illinois, Maryland (two), Massachusetts, Mississippi, Missouri, New York (two), North Dakota, Ohio, Pennsylvania (two), South Carolina, Texas (two), Virginia (two), and the District of Columbia. These twenty-four grant recipients include thirteen minority institutions and a tribally controlled college. Three community colleges received awards. We should note that twelve nonminority mathematicians also received awards.

The Carnegie grant has also supported intervention workshops at the 1991 Summer Meeting in Orono, Maine and the 1992 Annual Meeting in Baltimore, Maryland. Furthermore, since fall 1991 (to continue through spring 1993), the grant has subsidized similar workshops at meetings of twelve MAA Sections: Florida, Maryland-District of Columbia-Virginia, Michigan, Missouri, North Central, Northeastern, Ohio, Rocky Mountain, Seaway, Southeastern, Texas, and Wisconsin.

The SUMMA staff assists the planning grant awardees and other mathematicians in developing proposals for intervention projects involving underrepresented groups. Nine of the twelve first-round awardees will launch projects in the summer of 1992. All will have projects in place by the summer of 1993. The first-round awardees have received funding from several sources including the Young Scholars Program of the National Science Foundation (NSF) (two), the Eisenhower Program of their state Departments of Education (two), the GTE Foundation, the National Security Agency (two), and the Puget Sound Water Authority. These proposals raised over $1 million, excluding cost sharing. The other first-round awardees await funding decisions. Awardees submitted a total of twenty proposals.

In addition, the SUMMA office has assisted three mathematicians who did not receive planning grants; two of their intervention project proposals received $300,000 in funding. SUMMA also assisted two other mathematicians with teacher enhancement proposals linked to intervention projects. One of these proposals has received $120,000 funding.

Nationwide, mathematicians directed sixty-three intervention projects in 1992. Despite attrition for various reasons, the number of projects expected for the summer of 1992 will grow to seventy-one. In fact, the introduction of projects SUMMA directly advised prevented a net loss. (For additional information on SUMMA intervention activities, see the December 1991 issue of FOCUS, pages six and seven)

Other Grants to SUMMA SUMMA has received a National Science Foundation (NSF) grant of $703,000 for three years, through 1995, to network existing mathematics-based intervention projects with those projects SUMMA assists. Activities under the grant include annual conferences of project directors to seek support for level funding as well as to share information about what works; the publication and dissemination of a descriptive directory of projects; a directors' handbook; a quarterly newsletter; dissemination of new curricular materials; and development of a database on projects and their participants.

Committee on Testing

The mission of the Committee on Testing (COT) involves mathematics testing and assessment for grades eleven and twelve and the undergraduate level. It also maintains and routinely improves the MAA's Placement Testing (PT) Program. In addition, COT develops position statements on issues in mathematics testing and assessment (e.g., the use of calculators on placement tests); initiates and oversees externally funded projects relevant to its mission; and cooperates with other MAA committees with related missions (e.g., the Committee on the Undergraduate Program in Mathematics' (CUPM) Subcommittee on Assessment).

MAA Placement Testing (PT) Program Since the PT Program's inception in 1977, COT has overseen its activities. In March 1992, more than five hundred postsecondary institutions subscribed to the PT Program. In 1986, the PT Program test packet included six college-level placement tests and two prognostic tests targeted at high schools. During the ensuing years, the PT Program test packet expanded and now contains fourteen tests including calculator-based versions of its *Arithmetic and Skills, Basic Algebra, Algebra,* and *Calculus Readiness* tests. The Committee is also developing a new *Basic Algebra* test and three calculator-based prognostic tests. Two of these calculator-based prognostic tests will require students to use a graphing calculator and the third test, the *Calculator-Based Advanced High School* test will, for the first time, examine high school juniors enrolled in calculator-based precalculus courses. In 1992, the Committee will begin development of calculator-based versions of the *Advanced Algebra* and *Trigonometry and Elementary Functions* tests.

Funded Projects COT continues to oversee three externally funded projects for the MAA: the Calculator-Based Placement Test Program (CBPTP) Project, the Computer-Generated Placement Test (CGPT) Project, and Teaching Mathematics with Calculators: A National Workshop (TMC).

Grants from Texas Instruments, Incorporated fund the CBPTP Project. This project, initiated in late 1986, develops calculator-based placement tests and prognostic tests for the PT Program test packet. When the Committee completes this project in 1993, the PT program will feature six calculator-based placement tests and three calculator-based prognostic tests.

Strengthening Underrepresented Minority Mathematics Achievement

SUMMA also received a grant of $97,000 from the NSF for its project on Attracting Minorities into Teaching Mathematics (AMIT). It will conduct a study to determine the characteristics of undergraduate programs successful in attracting minorities into teaching secondary-level mathematics. SUMMA will particularly emphasize two-year colleges and articulation concerns because a large number of minorities attend these institutions. Upon its completion, the MAA will publish the study's results.

In another direction, the MAA and SUMMA, as part of its subcontract in a pending NSF cooperative agreement with the Charles A. Dana Center for Mathematics and Science Education, will develop a minority student database and recruit minority faculty and students for a research summer school at the University of California at Berkeley. The National Security Agency (NSA) has agreed to provide $50,000 in core support for SUMMA.

Funding Sought Several SUMMA projects still seek funding. The program has submitted proposals for the Mentoring Minorities in Mathematics project to several foundations. This project involves minority professionals in mathematics-based careers and provides new opportunities for attracting minorities into mathematics and mathematics-based fields through school visits, Mathematics Awareness Week (MAW) activities, general information for students on career paths, and one-on-one mentoring. The professionals would furnish information on scholarships, intervention projects, and minority mathematicians.

SUMMA has also designed a project to enhance the proven ability of departments of mathematics at minority institutions to nurture minority mathematical talent. It will involve 258 departments of mathematics at historically black colleges and universities, Hispanic-serving institutions, and tribally controlled colleges. The project will emphasize their needs, concerns, and strengths.

In addition, SUMMA's Archival Record has gathered more than three hundred names of minority PhDs in mathematics or mathematics education. A gallery of photographs of some of these mathematicians occupies a wall of the SUMMA offices; the program seeks additional photographs for its collection. SUMMA also seeks funding to research and record the educational accomplishments of all known minorities who were US citizens at the time they received doctorates in the mathematical sciences; SUMMA will subsequently publish this information.

Impact on the MAA The interaction between SUMMA and the structure and members of the MAA has affected the Association markedly. The list of minority presentations at the 1991 Annual Meeting in San Francisco, California filled a page of the program; the list for the 1992 Annual Meeting in Baltimore, Maryland filled two. Planning for the October 1990 Symposium on Underrepresented Groups, sponsored by the Eastern Pennsylvania-Delaware Section, began before the establishment of SUMMA, but two participants in follow-up meetings at Swarthmore College later received SUMMA Small Planning Grants to initiate intervention projects. The Pacific Northwest Section has planned its Section meeting in cooperation with a tribally controlled college in Montana. A volunteer "SUMMA Coordinator" acts informally as a liaison between the Ohio Section and SUMMA. Every day, from inside and outside the mathematics community, the SUMMA staff receives requests for information about minority participation in mathematics.

Clearly, several projects of the SUMMA program are well underway. As important as external funding is and will remain to its mission, however, the participation of the MAA membership and other members of the mathematical community is even more important. The changes in attitudes and practices necessary to effect SUMMA's goals must begin within the mathematics community. It is being said more and more often that making mathematics work for minorities is the only way to make it work for other students as well. It should certainly be recognized now by all that the old ways created the current morass and need to be drastically modified. For additional information on SUMMA, contact: William A. Hawkins, Jr., Executive Director of SUMMA, The Mathematical Association of America, 1529 Eighteenth Street Northwest, Washington, DC 20036-1385; telephone: (202) 387-5200; email: maa@athena.umd.edu.; fax: (202) 265-2384.

The Fund for the Improvement of Postsecondary Education (FIPSE) funds the CGPT Project. This Project uses the item-generating functions COT developed to produce software that, with monitoring, will generate PT Program tests. During these production years, the Project has also conducted research on the statistical parallelism of PT Program test items and has adjusted the parameters associated with each item-generating function to produce the desired parallelism. Furthermore, the software facilitates customization of PT Program tests, and COT will soon offer PT Program subscribers an opportunity, on a trial basis, to order custom-made placement tests.

The MAA and the National Council of Teachers of Mathematics (NCTM) administer the Teaching Mathematics with Calculators: A National Workshop; both the National Science Foundation (NSF) and Texas Instruments, Incorporated provide financial support. This Workshop prepares middle and secondary mathematics faculties in the Mesquite and Fort Worth, Texas school districts to use calculators effectively in their classes. The workshop has also developed two instructional packages containing a videotape and printed materials to aid teachers from other school districts. During 1992–1993, the workshop will conduct summer institutes in both school districts and develop two additional instructional packages.

Outreach and Training COT members continue to address mathematics and assessment testing issues at national meetings; during the past twelve months, COT members have delivered talks at the annual meetings of the National Association of Developmental Education (NADE), the National Council of Teachers of Mathematics (NCTM), the International Conference on Technology in Collegiate Mathematics, and at the MAA's own 1992 Annual Meeting in Baltimore, Maryland. COT continues to offer its successful minicourse on placement testing at the Association's annual meetings. It also offered a similar minicourse at NADE's annual meeting.

To receive an MAA Placement Testing (PT) Program informational packet, contact: Hanta V. Ralay, MAA Placement Test Coordinator, The Mathematical Association of America, 1529 Eighteenth Street Northwest, Washington, DC 20036-1385; telephone: (202) 387-5200; email: maa@athena.umd.edu.; fax: (202) 265-2384. For additional information on COT activities and projects, contact: John G. Harvey, Chair, MAA Committee on Testing (COT), Department of Mathematics, University of Wisconsin at Madison, 480 Lincoln Drive, Madison, Wisconsin 53706-1388; telephone: (608) 262-3746; email: harvey@math.wisc.edu.; fax: (608) 238-4477.

Committee on the Visiting Lecturers

The Association's Visiting Lecturers Program serves departments of mathematics across the country. Its objectives include:

- stimulating and expanding the mathematics programs in two-year colleges and in those four-year colleges not offering a PhD in math ematics;
- affording staff and students at such colleges with opportunities to meet and converse with creative mathematical scientists;
- communicating new and relevant applications of mathematics and computer science to not only the physical sciences and engi neering, but also the biological and social sciences; and
- strengthening the rapport among mathematicians working for gov ernment, industry, and educational institutions of all varieties.

The program's *1992–1993 Information Booklet* includes the names of participating lecturers. These lecturers agree to remain in the program for four years, after which they must take at least a two-year hiatus before the Committee invites them to participate again. MAA Visiting Lecturers not only deliver formal presentations, but also meet with students and faculty informally. They will happily discuss opportunities for graduate study and employment with students, and they will cooperate with departments to further the aims of their mathematics programs.

The Committee on Visiting Lecturers has improved its *Information Booklet* in several respects. First, it now covers a two-year term, valid from January 1992 through December 1993. Approximately one-fourth of the lecturers will rotate off the active list as of January 1993, but the Committee will issue a supplemental list of new lecturers early that year. To conserve pages and expenses, the booklet has omitted individual biographies. Departments may obtain these details directly from the lecturer. One or more letters follow each topic—E, I, or A—to indicate that the lecturers can adapt their presentations for an elementary, intermediate, or advanced audience.

The Committee encourages departments to establish departmental colloquiums with an appointed chair. Such colloquiums will foster faculty dialogues and presentations and increase participation in the Visiting Lecturers program. Consequently, the Committee addressed its *Information Booklet* to "Colloquium Chairperson" at each department of mathematics in the United States and Canada with the hope that, if no such person exists, the department would appoint one!

Interested departments should arrange for a visit directly with the desired lecturer; at that time, they should agree upon expenses. Some lecturers' home institutions have indicated a willingness to subsidize some visiting lecturers' expenses (asterisks distinguish these listings in the booklet). Some institutions maintain faculty development funds. To assist you, the *1992–1993 Information Booklet* discusses guidelines for financial considerations.

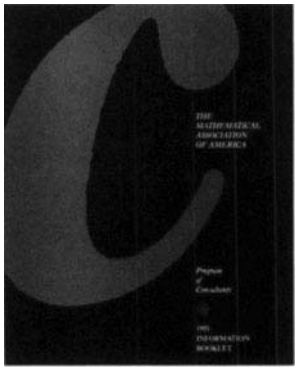
Members of the Committee on Visiting Lecturers urge departments to take advantage of the opportunities this program provides. Furthermore, the Committee welcomes suggestions and comments to improve the program; you may contact any Committee member at the appropriate address provided inside the Information Booklet. The Committee also solicits names of potential lecturers, particularly from states and provinces currently without representation. If you have heard an outstanding speaker whom you think might further the programs objectives as stated above, or, if you wish to receive additional information on the program, contact: James G. Ware, Chair, MAA Committee on Visiting Lecturers, Department of Mathematics, University of Tennessee at Chattanooga, Chattanooga, Tennessee 37403-2598; telephone: (615) 755-4545.

Cohen Reaches Century Mark

The Mathematical Association of America extends its special congratulations and best wishes to Dr. Teresa Cohen on the occasion of her one hundredth birthday, 14 February 1992. Dr. Cohen has been a member of the Association for sixty-seven years. She received her AB from Goucher College in 1912 and her MA (1915) and PhD (1918) from Johns Hopkins University. In 1920, she joined the faculty of Pennsylvania State University as an instructor and continued in her appointment there until her (official) retirement in 1961. Even after retiring, she remained active in teaching and tutoring students at the University until age 94. MAA staff members conveyed greetings on behalf of the Association to Dr. Cohen at the nursing home in Pikesville, Maryland where she currently resides.

Committee on Consultants

In early 1991, the MAA Committee on Consultants completed production of its informational Program of Consultants brochure. Currently, eighty-six consultants represent the forty-eight contiguous states. Their areas of expertise encompass mathematics, mathematics education, statistics, emerging doctoral programs, two- and four-year college programs, and university programs. In addition, the Program of Consultants also includes individuals with expertise in such timely topics as funding, and calculators and computers in the classroom. The Committee hopes that each department of mathematics in the United States will examine the Program of Consultants and decide if it would like some consultants to visit its campus and, if so, for what purpose. For additional information on this program, contact: Richard S. Millman, Chair, MAA Committee on Consultants, Vice President for Academic Affairs, California State University at San Marcos, San Marcos, California 92096; telephone: (619) 752-4050; email: Richard_Millman@CSUSM.Edu.; fax: (619) 752-4033.



1991 American Mathematics Competitions and Mathematical Olympiads

In 1991, the American Mathematics Competitions (AMC) realized another remarkable year under the savvy leadership of its Executive Director, Walter E. Mientka of the University of Nebraska. In September 1990, the MAA's Committee on the American Mathematics Competitions (CAMC) administered the American Junior High School Mathematics Examination (AJHSME) to 242,300 students from 3,547 middle schools in the US and Canada. Then, in March 1991, the CAMC administered the American High School Mathematics Examination (AHSME) to 363,532 students from 6,120 secondary schools in the US and Canada. According to scores on the AHSME, the Committee then selected 4,195 students from 1,705 secondary schools to sit for the American Invitational Mathematics Examination (AIME).

Top performers on these two examinations—the AHSME and the AIME—then progressed to the next tier in the competition sequence—the twentieth Annual United States of America Mathematical Olympiad (USAMO). In April 1991, 139 students from 118 schools competed on this sophisticated examination designed to test both mathematical knowledge and ingenuity. From this select group, eight remarkably talented students emerged as Olympiad champions: J. P. Grossman of Toronto, Ontario, Canada; Ruvim Y. Breydo of Rego Park, New York; Kiran S. Kedlaya of Silver Spring, Maryland; Joel E. Rosenberg of West Hartford, Connecticut; Robert D. Kleinberg of Wales Center, New York; Lenhard Lee Ng of Chapel Hill, North Carolina; Michail G. Sunitsky of Jackson Heights, New York; and Dean R. Chung of Mountain Lakes, New Jersey.

In early June 1991, the USAMO winners travelled to Washington, DC to participate in the whirlwind festivities associated with the Olympiad. During an elegant awards ceremony at the National Academy of Sciences (NAS), MAA President Deborah Tepper Haimo conferred an Olympiad medal upon each student. This intricately crafted medal honors Gerhard C. Arenstorff, twice a winner of the USA Mathematical Olympiad and a member of the first US team in the International Mathematical Olympiad. Its design symbolizes the timelessness of mathematics by intertwining a tetrahedron, representative of the mathematical contributions of ancient civilizations, with a Möbius strip, suggestive of modern mathematical developments. The fitting Greek inscription, "APETH," translates as "Excellence Through the Contest." Each winner also received an engraved silver Lunt tray from IBM's representative, Marc Brodsky.

Keith J. Devlin, Carter Professor of Mathematics at Colby College, delivered a lively USAMO Invited Address on Alan Turing and the Childlike Simplicity of Mathematical Genius and the guests then adjourned for a reception and dinner in the Diplomatic Functions Area of the United States Department of State where many treasures of early American history permanently reside. D. Allen Bromley, Assistant to the President for Science and Technology, delivered the keynote address. On 5 June 1991, the winners and their families gathered at the MAA's Dolciani Mathematical Center for a casually elegant, Sunday evening Sponsor's Reception and informally met with the members of the Committee on the USAMO, representatives of the Olympiad's sponsors, and others affiliated with the AMC.

The next day, these eight winners joined sixteen other students who had performed with distinction on the Olympiad examination at the United States Military Academy in West Point, New York. There, they embarked on an intensive, four-week mathematical during which Coaches Cecil C. Rousseau of Memphis State University and Daniel Ullman of George Washington Universtiy conditioned the students, both as individuals and members of a team, for the demands of the Thirty-second Annual International Mathematical Olympiad (IMO).

Following this rigorous preparation, six of the twenty-four trainees traveled to Sigtuna, Sweden—site of the Thirty-second Annual IMO, conducted 17 and 18 July 1991. Ruby Y. Breydo, Kiran S. Kedlaya, Robert D. Kleinberg, Lenhard L. Ng, Joel E. Rosenberg, and Michail G. Sunitsky formed the US team. Rosenberg won a gold medal; Kedlaya, Kleinberg, Ng, and Sunitsky earned silver medals, and Breydo achieved a bronze medal. These students, as a team, captured fifth place in the competition with a combined score of 212 points out of a possible 252 points. The USSR secured first place with a score of 241, followed by China (231), Romania (225), and Germany (222). Coach Rousseau proudly observed, "We have a young team this year with only two seniors, and we knew that we would face strong teams from China, the new Germany, and such experienced competitors as the Soviet Union, Romania, and Hungary."

The IMO teams competed by tackling solutions to six formidable mathematical problems in two, four and one-half hour sessions held over two consecutive days. The cutoff scores for gold, silver, and bronze medals range as follows: 34–42 for gold; 23–33 for silver; and 16–22 for bronze. One of this year's IMO problems asked:

> "Let $S = \{1, 2, 3, \ldots, 280\}$. Find the smallest integer n such that each n-element subset of S contains five numbers which are pairwise relatively prime."

In each of its last five years, the IMO has surpassed previous participation records and, in 1991, the inaugural team of a unified Germany proved, as expected, a formidable contender. Since 1974 when the first US team participated in the IMO, the country has always placed sixth or higher.

Eight national organizations serving mathematical scientists from diverse professions sponsor the Olympiad activities: the American Mathematical Association of Two-Year Colleges (AMATYC), the American Mathematical Society (AMS), the Casualty Actuarial Society (CAS), the Mathematical Association of America (MAA), Mu Alpha Theta, the National Council of Teachers of Mathematics (NCTM), and the Society of Actuaries. The MAA administers the Olympiad program and its awards ceremonies. Both public and private agencies provide financial support; these generous and much appreciated groups include the Army Research Office, Hewlett-Packard, IBM, the Matilda R. Wilson Fund, and the Office of Naval Research.

For additional information on these Olympiads and the AMC program, contact: Walter E. Mientka, Executive Director, American Mathematics Competitions (AMC), 917 Oldfather Hall, MAA, University of Nebraska, Lincoln, Nebraska 68588-0322; telephone: (402) 472-2257; email: WALTER@UNLAMC or AMC.UNL.EDU.; fax: (402) 472-6087.

Once Upon a Time

Anneli Lax and the New Mathematical Library

Anneli Lax, the mathematics graduate, before she became editor of the New Mathematical Library.

SECRETS OF INEQUALITIES

ALBERS What's been the best part of being the editor of the New Mathematical Library (NML) over the past thirty-one years?

LAX I feel good about having sort of achieved our main purpose, which was to get good mathematical expositions to interested people in a language that they could understand without having to immerse themselves for years in big mathematical tomes. Our hope was to involve mathematicians in writing such books. The United States had been criticized for having textbooks written by hacks and many textbooks were considered to be pretty bad. We did not want to produce textbooks. We wanted the NML to be a series that treated topics that were not part of traditional syllabi, but were traditional good mathematics. And I think we were true to that goal. NML books were to be solid mathematical expositions written by mathematicians.

NML Beginnings . . .

In 1961, the School Mathematics Study Group (SMSG) began the New Mathematical Library (NML) to make short expository books on various topics not usually covered in the high school syllabus available to secondary school students. Since then, the NML has matured into a steadily growing series of thirty-four titles of interest not only to the originally intended audience, but also to college students and teachers at all levels. The NML, previously published by Random House and L. W. Singer, became a publications series of the Mathematical Association of America in 1975. Under the auspices of the MAA, the NML will continue to grow while remaining dedicated to its original and expanded purposes.

These mathematicians hadn't written for such an audience before. There was a question of possibly having to educate them to use the right language and become comprehensible and so on. That was our mission and I think that was, to a great degree, accomplished.

ALBERS Have you had any memorable moments with NML authors?

LAX The last chapter of Inequalities by [Edwin] Beckenbach and [Richard] Bellman is an interesting story. I wrote the last chapter and inserted it in the manuscript. Each of them thought that the other had written it and never said boo.

There's a nice thing about the [M. M.] Schiffer and [Leon] Bowden book, *The Role of Mathematics in Science.* The manuscript contained the logistics equation for populations and Verhulst's Law in the form of the difference equation $x_{n+1} = qx_n - rx_n^2$. Peter [Lax] looked at it and steered me into varying the parameter q and calculating solutions. This was at the time when strange attractors were coming onto the scene, and the calculations, performed on a hand calculator, exhibit all these phenomena of bifurcations and new stable points and so on. So we put that in, and Schiffer and Bowden were pleased. It's nice when you feel you have something to contribute to a book.

ALBERS Where would you like to see the NML go in the next century?

LAX There are always trends and probably they should, to some extent, be reflected in a series like the NML—fractals, chaos, and that sort of thing. On the other hand, a lot has been written on those topics; there are now many more people who write good exposition and I no longer feel that there's such a crying need for that type of thing.

I'd like to see us continue publishing good problems—not short answer ones, but things like the Hungarian problem books and the Olympiad problem books. I would also like to see some NML volumes on new, exciting combinatorics, robotics and computers, perhaps geometry applied to computers. Another wonderful thing the NML has done is to make its books available at affordable prices. I want to see that preserved.

ORIGINS OF THE NML

ALBERS In 1958, Ed [Edward G.] Begle, head of the School Mathematics Study Group (SMSG) appointed a special panel of twelve people to produce a series of new books that would soon be called the New Mathematical Library. How did you get involved?

LAX The Physical Sciences Study Committee had just developed an excellent series of monographs for high school students and Begle wanted a similar thing in mathematics. He talked to a number of people about a possible editor and Lipman Bers suggested me.

ALBERS What editorial work had you done when Bers suggested you as editor?

LAX I had worked on the English translation of Courant-Hilbert [*Mathematical Methods of Physics*] and I guess that was known in the Department of Mathematics at New York University (NYU). Courant often asked me to edit things that other people had written. In fact, he claimed that he hired me because I seemed more literate than most people.

In the fifties, publishers didn't have people who could do mathematical copy editing or anything like that, so I ended up doing everything. I even made page dummies. That was kind of fun; it was like playing with paper dolls.

ALBERS Wow. Copyediting, layout, and cover design. So, in fact, you were doing everything except printing the books yourself?

LAX Oh, no, not at all. I had tremendous help from other people—mostly the other NML editors, especially Basil Gordon and Ivan Niven. Occasionally other people, not on the editorial committee, assisted me also. Peter Ungar has contributed enormously at all stages, from soliciting and commenting on manuscripts to implementing the typesetting with his newly acquired TeXpertise. And then, of course, in the old days, the pre-electronic days, I had some part-time assistants, mainly graduate students, and my secretary, Gloria Lee, singlehandedly typed manuscripts and correspondence. Of course, many, many other people, too numerous to recognize individually, helped me with many of the details. I appreciate their assitance and support greatly.

ALBERS How did you end up at NYU in the first place?

LAX I graduated from Adelphi College during the second world war and got a job uptown at the Guggenheim Institute of Aeronautics, which was part of NYU. I spent my time calculating lift and drag coefficients of aircraft that were tested in the wind tunnel there. I next took a course in applied mathematics downtown at NYU's graduate mathematics department which Courant had started. That was my first encounter with him.

ALBERS Lift and drag coefficients sound very applied. Did you, as an undergraduate, have any inkling that you would have an interest in applied mathematics?

LAX No. In fact, I had trouble with analysis because, in those days, calculus was taught from Granville and it didn't make too much sense. I felt very bad about getting A's and not understanding what I was doing. I always thought I was being dishonest somehow and fooling people into thinking that I knew it when I knew that I didn't know it. I It was only when I read Courant's [Calculus] calculus book that I began to understand what calculus was.

COURANT AS MENTOR

ALBERS Do you remember your first encounters with Courant?

LAX Oh, yes. I first met him in his class. He knew I was working in aeronautics for somebody named Professor Klemin. One of the first things that I had to do with Courant involved a young man who had invented a dome that was kept up by air pressure. Courant, that young man, and James Stoker [a professor at NYU] came to the Aeronautics Department, where they found me, to see if they could do some tests. They thought that I should use a certain German book to check some calculations. I did that and I found a small error in the book. That impressed Courant. So, then he thought I should start working with his applied math group downtown at NYU. At that time, I wasn't a citizen, so there was some delay. After I was naturalized, I left the School of Aeronautics and started working down there.

ALBERS So you exhibited natural editorial tendencies at an early point.

LAX I think it had to do with my being very slow when I read. I don't instantly get the gist of it. I have to understand every darn little step, which slows me down terribly and which is one of the reasons that I never learned very much, but it is good for checking errors and making sure everything is okay.

ALBERS I think you're a little modest; you must have learned quite a bit along the way. Do you have any other memories of Courant in those early days?

LAX My relations with him were very good and he was very kind to me. He went out of his way to make sure that I was happy and learning math.

ALBERS How would he go about ensuring your happiness?

LAX Well, for example, he was very encouraging. I had complained to him that I had a terrible memory and could never remember any mathematics. He said, "Oh, you know, that's not so bad. Hilbert had a very bad memory."

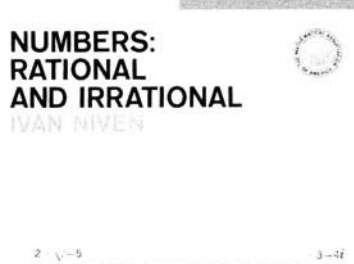
Anneli, the young editor of the New Mathematical Library in 1961, with her husband, Peter D. Lax.

Until meeting Courant, I hadn't been serious about getting a degree at all. I didn't care if I ever got it or not. Courant said, "You really should get the degree." Then he posed a problem where I had some initial success. When that happened, it put the wind into my sails and I completed a dissertation. So, he took care of me in a number of ways.

Albers So, in spite of the fact that you had never really intended to get a doctorate, you did.

Lax Yes, in 1954.

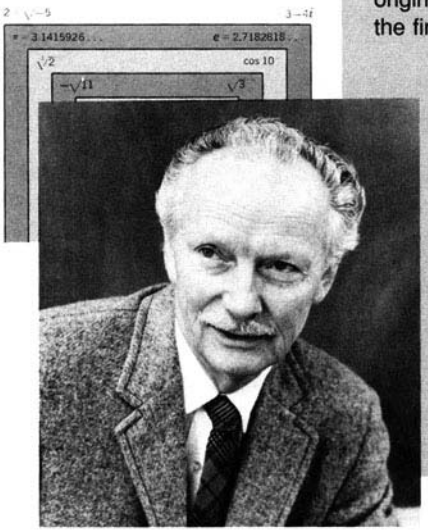
The First NML



Ivan Niven recalls how he came to write the first NML, *Numbers: Rational and Irrational:*

"I was attending the International Congress of Mathematicians (ICM) at Edinburgh, Scotland in 1958 when Lipman Bers and Paul Halmos, who were members of the original NML committee, asked me to write the first NML. They suggested a book on elementary number theory. Since [H. S.] Zuckerman and I had just signed a contract with John Wiley to write *An Introduction to the Theory of Numbers,* I had to be careful not to write a competing book.

"I soon met Anneli Lax, editor of the new series. She was very good on details and an excellent negotiator. Apart from the authors, Anneli has been the key person in developing the New Mathematical Library. The MAA is fortunate to have someone of her abilities at the helm."



Perils of Perfect Lectures

Albers The next step? Did you stay at NYU?

Lax Yes. I started teaching at NYU in the midforties, before I had the degree. In fact, I'd been teaching people who were older than I because of the GI Bill; the soldiers had come home. On the other hand, in all of the many years I've taught, I, now in retrospect, think that I didn't really understand teaching until the last ten years or so.

Albers But you liked it.

Lax I always liked it, but it was strictly traditional lecture. It was only when NYU got lots of so-called remedial students and lots of people with problems in mathematics that I changed my attitude completely about what kind of teaching I should be doing.

For example, I used to overprepare for my classes. When I would teach a course a second time, I was determined to do it differently from the first time. It occurred to me years later that I learned a great deal in this process of preparing classes, but whether my students profited from such a polished lecture was not at all obvious to me. I discovered later that, in fact, students need to do a little struggling to learn something. I should have known that because I remember taking classes from Emil Artin, who was a perfect lecturer. I sat in his class thinking that I understood absolutely everything in a crystal-clear way. After a few days, when I wanted to do the problems, I noticed that things were not so crystal-clear and, in fact, it was kind of difficult to reconstruct his exposition. I attribute that to the fact that his lectures were too highly polished; there was no room for students to struggle on their own.

I've always been interested in the interplay between language and mathematics. A few years ago, I persuaded the English Department and the Mathematics Department to allow a writer, Erika Duncan, and me to teach a combined course of expository writing and mathematical thinking. That meant the same fifteen kids would be registered in both classes and we'd both meet them four times a week. The students got full credit for two courses and we would alternately emphasize writing and mathematics.

We worked a lot with word problems. You know how kids are scared of word problems. They often immediately start working on a problem without having read what the problem says. If you get them to play with the wording of the problem, paraphrase it, make it more interesting, and don't say anything about solving it, if you just slow them down—then, after a while, they'll be solving the problem.

Albers And reading NMLs.

Lax [Laughing] I hope so.

Anneli and Peter Lax relaxing at Loon Lake.

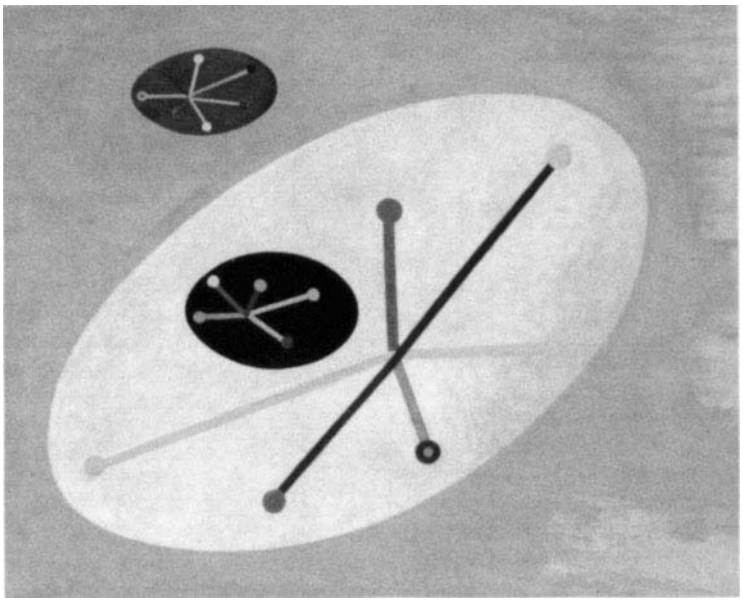
1991 MAA Publications Break Half-Million Dollar Mark!

In 1991, MAA Publications released thirteen new volumes, more than a dozen new videos, and two titles in collaboration with the American Mathematical Society (AMS). By way of comparison, eleven volumes were produced in 1990 and nine in 1989.

Publications sales broke the half-million dollar mark for the first time and were up by 27 percent over 1990. In March 1992, the MAA distributed its most recent publications catalogue to the membership; the cover, a full-color reproduction of Laszlo Moholy-Nagy's *Leuk 5*, resplendent in its intricate geometric relations, intimates the elusive beauty of mathematics.

You may consult this catalogue, available upon request, to learn more about the titles mentioned below as well as for ordering information and instructions, or contact: Kathy Knust, Publications Assistant, The Mathematical Association of America, 1529 Eighteenth Street Northwest, Washington, DC 20036-1385; telephone: (202) 387-5200; email: maa@athena.umd.edu; fax: (202) 265-2384.

Dolciani Mathematical Expositions This series, appropriate for the undergraduate and even the mathematically inclined secondary student, introduced two winsome volumes, both devoted to the charms and frustrations of problem-solving: *Old and New Solved and Unsolved Problems in Geometry and Number Theory* from Victor Klee of the University of Washington and Stan Wagon of Macalester College and *Problems for Mathematicians Young and Old* from Paul R. Halmos of Santa Clara University. Both these volumes are selling briskly, underscoring the interest of Association members in good problems.



MAA Notes and Reports This series, designed to disseminate topical information rapidly and inexpensively, published seven volumes in 1991, including *A Call for Change: Recommendations for the Mathematical Preparation of Teachers of Mathematics* from the Committee on the Mathematical Education of Teachers (COMET) (James R. C. Leitzel, MAA Director of Special Projects, editor); *The Laboratory Approach to Teaching Calculus* from L. Carl Leinbach of Gettysburg College, editor; *Models for Undergraduate Research in Mathematics* from Lester J. Senechal of Mount Holyoke College, editor; revised editions of *Library Recommendation for Undergraduate Mathematics Programs* and *Two-Year College Mathematics Library Recommendations,* both from the Committee on the Basic Library List (Lynn Arthur Steen of Saint Olaf College, editor); *Perspectives on Contemporary Statistics* from David C. Hoaglin of Harvard University and David S. Moore of Purdue University; and *Visualization in Teaching and Learning Mathematics* from the Committee on Computers in Mathematics Education (CCIME) (R. Steve Cunningham of California State University at Stanislaus and Walter S. Zimmermann of the University of the Pacific, editors). Sales for this series are up by 50 percent over 1990.

Special thanks go to retiring Editor of Notes and Reports, Warren Page of New York City Technical College of The City University of New York, for the fine job he has done.

Spectrum This series, the Association's most recent and delightfully eclectic addition, released three irresistible volumes: *Journey into Geometries* from Marta Sved of the University of Adelaide; *Polyominoes* from George E. Martin of the State University of New York at Albany; and *Student Research Projects in Calculus* from Marcus Sanford Cohen, Edward D. Gaughan, Arthur Knoebel, Douglas S. Kurtz, and David John Pengelley, all of New Mexico State University. All three volumes are doing very well. Seven Spectrum titles are scheduled for 1992.

Hats off to James W. Daniel of the University of Texas at Austin, who is leaving the editor's chair.

Miscellaneous The MAA addressed the issue of women in mathematics with *Winning Women into Mathematics* from the Committee on the Participation of Women in Mathematics (Patricia Clark Kenschaft of Montclair State University, editor). This volume explores the inequities and the advances women confront as they join the mathematics community.

Videos In 1991, the MAA premiered fourteen videos featuring invited addresses delivered during the Association's 1990 Seventy-fifth Anniversary Meeting in Columbus, Ohio; the 1991 Annual Meeting in San Francisco, California; and four video Classics. These tapes, ideal for mathematics club meetings as well as classroom discussions, explore an impressive sweep of subjects from problem-solving to the current status of mathematics education in the United States. The Classics series includes gems from the MAA's film library: *Courant in Göttingen and New York; The Moore Method: A Documentary on R. L. Moore; George Pólya's Let Us Teach Guessing;* and *John Von Neumann: A Biography.*

Seventy-fifth Anniversary *The Contribution of Mathematics to Education* from Peter J. Hilton of the State University of New York at Binghamton; *Has Progress in Mathematics Slowed Down* from Paul R. Halmos of Santa Clara University; *The Last Seventy-Five Years: Giants of Applied Mathematics* from Cathleen S. Morawetz of the Courant Institute of Mathematical Sciences; *Mathematics and Computation: Proliferation and Fragmentation* from Wade Ellis, Jr. of West Valley College; *Problems for All Seasons* from Ivan Niven of the University of Oregon; *The Seventy-fifth Anniversary Celebration* from G. Baley Price of the University of Kansas; and *Was Newton's Calculus Just a Dead End? Maclaurin and the Scottish Connection* from Judith V. Grabiner of Pitzer College.

1991 Annual Meeting *Algebraic Curves and Error-Correcting Codes from a Modern Point of View* from Carlos Julio Moreno of Baruch College of the City University of New York; *An Analogue of Hüber's Formula for Riemann's Zeta Function* from Floyd L. Williams of Williams College; and *Developing the Next Generation of Mathematicians* from Uri Treisman of the University of California at Berkeley.

Minicourses

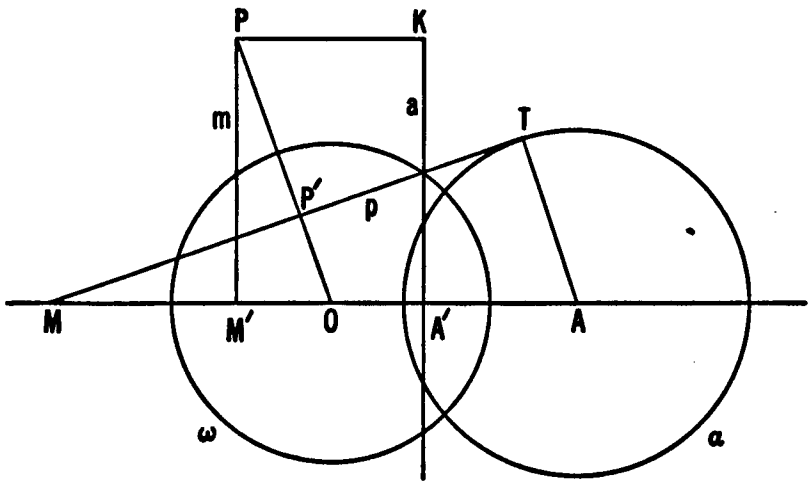
The appealing program of MAA minicourses continues to attract a large and enthusiastic group of participants who view the program as a stimulating and rewarding adjunct to the annual and summer meetings of the Association. From its modest beginning in 1981 with only one minicourse offered, the program has undergone a rapid expansion. At the 1991 Annual Meeting in San Francisco, California, 664 participants enrolled in 17 minicourses; the 1991 Summer Meeting in Orono, Maine featured 9 minicourses with a total enrollment of 253.

These numerical profiles, however, represent only a portion of the full influence of the MAA's minicourse program. Many Sections now offer their own programs of minicourses or summer short courses which complement those the Committee on Minicourses organizes for the national meetings. Other regional minicourse programs, based at the newly established sites of the Interactive Mathematics Text Project (IMTP) will likely appear in the future. Indeed, these regional programs exemplify the cooperative and mutually beneficial relationship among the Sections, the IMTP, and the Committee on Minicourses. Many Sections adapt courses first offered at national meetings for their own meeting programs; conversely, some national offerings originated as Sectional minicourses. In addition, the Committee on Minicourses will happily consult with Sections planning minicourse programs and will participate in selecting courses for the IMTP sites.

In selecting courses, the Committee strives to balance courses focused primarily on mathematical content with those concerned with pedagogical issues. It also maintains a similar balance between "hot" topics of current interest and traditional topics of perennial interest. The following list of 1991 minicourses and their instructors illustrates the inviting assortment of subjects within this balance.

Actuarial Mathematics, Jonathan M. Kane of the University of Wisconsin at Whitewater ■ *Calculus as a Laboratory Science,* Marcelle Bessman of Frostburg State University ■ *Chaotic Dynamical Systems,* Robert L. Devaney of Boston University ■ *Combinatorial Designs,* Walter D. Wallis of Southern Illinois University ■ *Conceptualizing, Organizing, and Seeking Funding for Teacher Education Projects,* Joan Ferrini-Mundy of the University of New Hampshire and Carole Lacampagne of the National Science Foundation (NSF) ■ *Elementary Robotics,* Walter J. Meyer of Adelphi University ■ *Great Theorems from Mathematical Analysis: 1689–1881,* William W. Dunham of Hanover College (offered at both the 1991 Annual and Summer Meetings) ■ *Instituting a Mathematics Placement Program: Creating Order out of Chaos in Freshman Mathematics,* Mary McCammon of Pennsylvania State University ■ *Integrating Calculus and Physics for Freshmen,* Joan Rohrer Hundhausen and F. Richard Yeatts, both of the Colorado School of Mines ■ *Julia Sets and the Mandelbrot Set,* Robert L. Devaney of Boston University ■ *Knot Theory for Undergraduates,* Stefanos P. Gialamas of Columbia College ■ *Learning Abstract Algebra by Programming in ISETL,* Ed Dubinsky of Purdue University and Uri Leron of the Israel Institute of Technology ■ *Making Mathematics More Concrete,* Agnes Azzolino of Middlesex County College ■ *A Mathematician's Introduction to the HP-48SX Scientific Expandable Calculator for First-Time Users,* John W. Kenelly and Donald R. LaTorre, both of Clemson University ■ *The Mathematics of Computer Graphics,* Jay E. Goldfeather of Carleton College ■ *Pedagogical Uses of Derive and GyroGraphics,* Jerry A. Johnson and Benny Evans, both of Oklahoma State University ■ *A Survey of Educational Software,* Virginia E. Knight and Vivian Yoh Kraines, both of Meredith College ■ *Symmetry Analysis of Repeated Patterns,* Donald W. Crowe of the University of Wisconsin at Madison (offered at both the 1991 Annual and Summer Meetings) ■ *Teaching Mathematical Modeling,* Frank R. Giordano of the United States Military Academy and Maurice D. Weir of the Naval Postgraduate School ■ *The Theory and Application of Discrete Dynamics,* James T. Sandefur, Jr. of Georgetown University ■ *Unifying Themes for Discrete Mathematics,* Ralph P. Grimaldi of Rose-Hulman Institute of Technology ■ *The Use of Computing in Teaching Linear Algebra,* Eugene A. Herman and Charles H. Jepsen, both of Grinnell College ■ *Using Pocket Computers to Enhance the Teaching and Learning of Precalculus and Calculus,* Bert K. Waits and Franklin D. Demana, both of Ohio State University ■ *Writing in Mathematics Courses,* George D. Gopen and David A. Smith, both of Duke University.

Persons interested in presenting minicourses at the Association's annual meetings in January or its summer meetings in August should contact: Richard F. McDermot, Chair, MAA Committee on Minicourses, Department of Mathematics, Allegheny College, Meadville, Pennsylvania 16335-3902; telephone: (814) 332-5341; email: rmcdermo @alleg.edu. Fax: (814) 337-0988.



1991 MAA Board of Governors

The following directory includes all members of the Association's Board of Governors, along with their current institutional affiliation, just prior to the conclusion of the MAA Business Meeting in Baltimore, Maryland, 8 January 1992.

Carol B. Adjemian, Pepperdine University
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Gerald L. Alexanderson, Santa Clara University
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Lida K. Barrett, Mississippi State University
Lowell W. Beineke, Indiana University-Purdue University
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Kenneth A. Ross, University of Oregon
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Martha J. Siegel, Towson State University

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Linda R. Sons, Northern Illinois University
Olaf P. Stackelberg, Kent State University
Lynn Arthur Steen, Saint Olaf College
Anne K. Steiner, Iowa State University
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Maureen A. Callanan, Development Assistant

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Jane S. Heckler, Assistant to the Director of Special Projects
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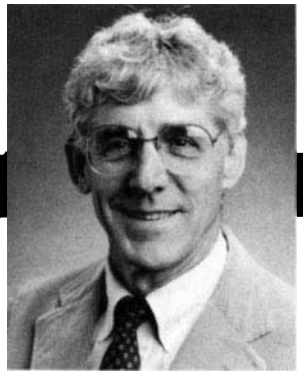
SUMMA Office
Strengthening Underrepresented Minority Mathematics Achievement

William A. Hawkins, Jr., ***Director***

Florence D. Fasanelli, Director of SUMMA Intervention Projects
Lisa Johnson, Administrative Assistant for SUMMA



1991 MAA Financial Report

Donald L. Kreider, Treasurer

In 1991, the MAA experienced a surplus of $527,673 in its total budget of approximately $5.2 million. This surplus in the total budget includes: $52,182 in the general fund, which is the MAA's operating fund; about $165,000 related to investments; about $160,000 in increases in the American Mathematics Competitions (AMC) fund; and about $97,000 in increases to the building fund (which includes contributions toward the renovation of the MAA's buildings in Washington, DC). In a year that otherwise presented a poor economic environment, these are welcome results.

The year 1991 continued the trend toward greater grant activity by the MAA in support of its programs to improve mathematics education and to strengthen the mathematics achievement of all students. Major new funding was obtained for the SUMMA program (Strengthening Underrepresented Minority Mathematics Achievement) and more funding is pending. The American Mathematics Competitions continue to thrive under the tireless leadership of Executive Director Walter E. Mientka of the University of Nebraska. Grants have been received in support of Teaching Mathematics with Calculators, Preparing College Mathematics Teachers, and a very large project on Interactive Mathematics Texts (IMTP) under the direction of Gerald J. Porter of the University of Pennsylvania and James E. White of the University of North Carolina at Chapel Hill. Grant supported activity of the MAA has increased from approximately $300,00 in 1989, $650,00 in 1990, and $932,000 in 1991, to an estimated $1,200,000 in 1992.

The MAA has an able staff in its Washington, DC headquarters offices. Executive Director Marcia P. Sward is now assisted by the two Associate Executive Directors: Donald J. Albers and Rhoda Dechter Goldstein. Don is also Director of Programs and Publications and Rhoda is also Director of Finance and Administration. Andrew Sterrett will return to the headquarters offices in June as a visiting mathematician; James R. C. Leitzel will continue as a visiting mathematician for several more years; and William A. Hawkins, Jr. continues his able leadership of the SUMMA program. And, this year, we should take off our hats to Elaine Pedreira Sullivan, Production and Marketing Manager for the MAA. The publications program set a new record in 1991, breaking the $500,000 barrier for the first time.

The level of mathematical activity in our Washington, DC offices still grows. The MAA buildings at 1527 and 1529 Eighteenth Street Northwest, together with the adjoining carriage house, serve all of our own needs. They are also the headquarters of the Conference Board of the Mathematical Sciences (CBMS) and the Joint Policy Board for Mathematics (JPBM). And we are hopeful that, in the near future, the new Washington, DC office of the American Mathematical Society (AMS) will also be located in our buildings. The buildings are thus supporting valuable interaction among many mathematical organizations. We are grateful for the strong support from our many contributors; their generosity made it possible to renovate our headquarters buildings in such a way that they can serve the larger mathematical community.

Revenues and Expenditures

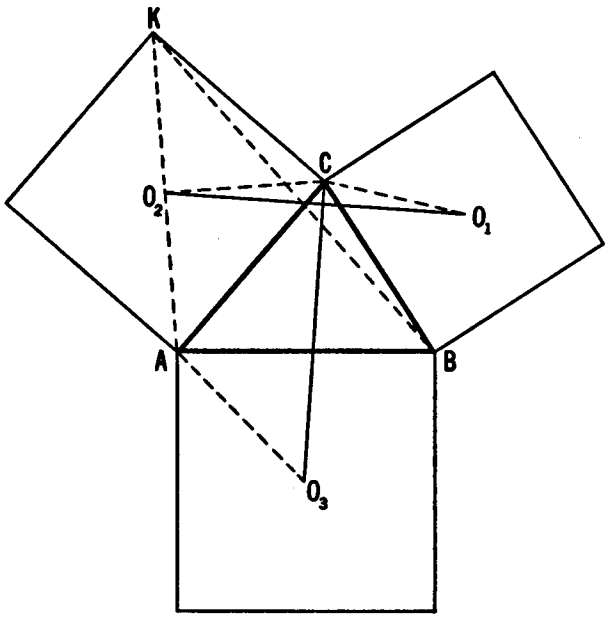
Revenues	1990	1991
Dues	$1,819,000	$1,964,000
Subscriptions	430,300	445,000
Book Sales and Advertising	533,000	661,000
Interest, Dividends, and Capital Gains	123,000	268,000
Contributions	347,000	233,000
Grants and Direct Cost Reimbursements	633,000	945,000
Contest Fees and Sales	606,000	725,000
Space Rental	65,000	101,000
Miscellaneous	174,000	172,000
Total Revenues	***$4,730,300***	***$5,514,000***

Expenditures	1990	1991
Journals and FOCUS	$1,382,000	$1,422,000
Membership Department	340,000	475,000
Books	613,000	723,000
Sections, Meetings, and Joint Programs	357,000	232,000
Development	57,000	59,000
Grant-Supported Programs	650,000	1,095,000
Mathematical Competitions	507,000	610,000
Building Operations	173,000	146,000
Miscellaneous Programs	183,000	225,000
Total Expenditures	***$4,262,000***	***$4,987,000***

Consolidated MAA Balance Sheet

Assets	1990	1991
Current Assets		
Cash	$115,207	$126,541
Liquid Assets	992,039	1,449,788
Accounts Receivable	578,151	512,577
Publications Inventory	208,861	243,828
Prepaid Expenses	284,323	241,571
Total Current Assets	**$2,178,581**	**$2,574,305**
Noncurrent Assets		
Investments (at cost)	$867,763	$1,009,595
Furniture and Equipment	524,803	655,431
Building (at cost)	816,456	816,456
Building Improvements (at cost)	685,722	897,310
Accumulated Depreciation	(614,240)	(693,509)
Deferred Development Costs	80,407	134,364
Total Noncurrent Assets	**$2,360,911**	**$2,819,647**
Total Assets	***$4,539,492***	***$5,393,952***

Liabilities and Fund Balances	1990	1991
Current Liabilities		
Accounts Payable	$322,446	$259,028
Accrued Royalties	28,683	32,247
Other Accrued Liabilities	104,597	235,975
Prepaid Dues and Subscriptions	1,742,887	1,963,391
Total Current Liabilities	**$2,198,613**	**$2,490,641**
Long-Term Liabilities		
Mortgage Payable	$502,368	$448,714
Unexpended Grant Receipts	248,008	336,421
Total Long-Term Liabilities	**$750,376**	**$785,135**
Total Liabilities	***$2,948,989***	***$3,275,776***
Fund Balances		
Unrestricted Fund Balances	$575,811	$784,833
Restricted Fund Balances	586,329	842,947
Endowment	428,363	490,396
Total Fund Balances	**$1,590,503**	**$2,118,176**
Total Liabilities and Fund Balances	***$4,539,492***	***$5,393,952***



The MAA's Technical Advisory Committee made its recommendations last year on new computing facilities for the Washington, DC headquarters. Contracts were signed in January 1992 with Morant Data Company of Washington, DC. The new system will be based on a Novell network within our headquarters buildings and will run Morant's Ampac software system designed for association management and customized for our special needs. A Sun Station running UNIX will provide a gateway to Internet, permitting the MAA to develop electronic services for members. During the next year, we can expect announcements relating to such new services

This is my last report as Treasurer of the Association. I have enjoyed the privilege of serving the MAA in this capacity for the last six years and look forward to my term as President. The MAA is a wonderful organization. It is one of the largest organizations of mathematicians in the world and it enjoys enormous support from its members in their volunteer activities aimed at communicating mathematics and improving the teaching of mathematics. The Sections are a vital part of the MAA, becoming more active in their own meetings and programs with each year

The Greater MAA Fund

In 1991, 939 donors contributed $44,774 to the Greater MAA Fund. The Officers of the Association express their gratitude to the membership for its generous support of this fund. The names of all 1991 donors, except of those wishing to remain anonymous, appear below.

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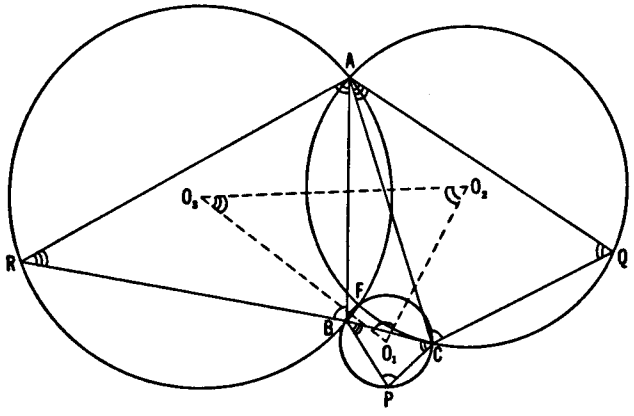


In Memoriam

Frank J. Arena, Professor Emeritus, North Dakota State University, died 29 November 1991 at the age of 74. He was an MAA member for forty-eight years.

Douglas R. Bey, Professor Emeritus, Illinois State University, died 28 January 1991. He was an MAA member for forty-seven years.

Richard Harland Brown, Professor Emeritus, Washington College, died 13 October 1991 at the age of 69. He was an MAA member for thirty-one years.

Nancy Cole, Associate Professor Emeritus, Syracuse University, died 7 July 1991 at the age of 88. She was an MAA member for fifty-four years.

Rene J. De Vogelaere, Professor, University of California at Berkeley, died 14 December 1991 at the age of 65. He was an MAA member for five years.

Trevor Evans, Professor, Emory University, died 20 May 1991 at the age of 65. He was an MAA member for thirty-nine years.

Sol L. Feigenbaum, Professor, University of Bridgeport, died 7 November 1991 at the age of 72. He was an MAA member for twenty-seven years.

Lawrence F. Guseman, Jr., Professor, Texas A& M University, died 5 November 1991 at the age of 53. He was an MAA member for thirty-three years.

William R. Hodnett, Senior Engineer, Ball Systems Engineering, died 25 August 1991 at the age of 33. He was an MAA member for five years.

J. Emmert Ikenberry, Professor and Vice President Emeritus, James Madison University, died in 1991. He was an MAA member for fifty-three years.

Carey M. Jensen, Associate Professor, Minnesota State Teachers College, died 6 October 1986. He was an MAA member for forty-nine years.

Lawrence S. Kennison, Professor, Southeastern Massachusetts University, died 2 December 1991 at the age of 86. He was an MAA member for sixty years.

Lawrence Kuipers, Professor Emeritus, Southern Illinois University at Carbondale, died 30 September 1991 at the age of 82. He was an MAA member for twenty-seven years.

David E. Logothetti, Associate Professor, Santa Clara University, died 20 July 1991 at the age of 56. He was an MAA member for twenty-four years.

Gustave H. Lundberg, Professor Emeritus, Vanderbilt University, died 11 June 1991 at the age of 89. He was an MAA member for forty-eight years.

Gottfried E. Noether, Professor Emeritus, University of Connecticut, died in August 1991 at the age of 76. He was an MAA member for twenty-nine years.

J. L. Olpin, Associate Professor Emeritus, Brigham Young University, died 16 October 1991 at the age of 91. He was an MAA member for fifty years.

Richard S. Pierce, Professor Emeritus, University of Arizona, died 15 March 1992 at the age of 65. He was an MAA member for thirty-seven years.

Richard S. Pieters, instructor, Phillips Academy, died 23 January 1992 at the age of 81. He was an MAA member for thirty-eight years.

Joel Pitcairn died in March 1991. He was an MAA member for thirty-nine years.

Boris D. Rakover, Professor, Saint John Fisher College, died 9 December 1990 at the age of 59. He was an MAA member for eight years.

John M. Reiner, Professor and Consultant, Albany Medical College of Union University, died 19 July 1991. He was an MAA member for thirty-three years.

Maynard L. Riegel, teacher, Thompson School District, died 10 June 1991 at the age of 56. He was an MAA member for five years.

Fred D. Rigby, Professor Emeritus, Texas Technical University, died 20 July 1991 at the age of 73. He was an MAA member for thirty-two years.

Ruth M. Schickel, teacher, Mercy Academy, died in 1992 at the age of 77 years. She was an MAA member for thirty-six years.

Erik A. Schreiner, Professor, Western Michigan University, died 8 September 1991 at the age of 55. He was an MAA member for thirty-one years.

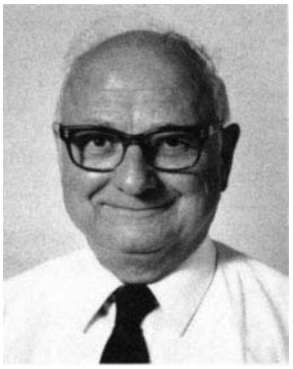
William Raymond Scott, Professor Emeritus, University of Utah, died 15 February 1991 at the age of 72. He was an MAA member for forty-three years.

Bernard Smilowitz, Associate Professor, Hofstra University, died 17 November 1991 at the age of 58. He was an MAA member for thirty-six years.

Murray R. Spiegel died 8 April 1991. He was an MAA member for nineteen years.

Helen Farnam Story, retired, died 20 June 1991 at the age of 87. She was an MAA member for fifty years.

Thomas R. Volk, Professor, Sonoma State University, died 18 January 1992. He was an MAA member for nineteen years.



Professor Joseph Konhauser died earlier this year at the age of 67. An active member of the MAA, he was perhaps best known nationally as an Associate Editor of the American Mathematical Monthly and as a member of the national committees that designed and evaluated tests for the USA Mathematical Olympiad and Putnam Competition.

Born in Ford City, Pennsylvania, Konhauser earned bachelor's, master's, and doctorate degrees from Pennsylvania State University. He taught mathematics at Penn State from 1949 to 1955, and later spent four years at the University of Minnesota before moving to Macalester College in 1968. He was chair of the Department of Mathematics at Macalester from 1970 to 1981, from where he retired last year.

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Department of Mathematical Sciences

The Mathematical Sciences Department of Worcester Polytechnic Institute, Worcester, MA, invites applications for several visiting positions to begin August 1992. These positions require a strong research record or potential, and evidence of quality teaching. Areas of interest are applied discrete mathematics and operations research, optimal design and composite materials, scientific computing, and/or numerical mathematics, PDE, fluid mechanics, and stochastic control of control.

WPI is a highly selective private engineering and science institute granting degrees through the PhD. The Department of Mathematical Sciences currently grants bachelor's degrees and master's degrees in applied mathematics and applied statistics. A proposal for a PhD program in the mathematical sciences is pending.

Interested applicants should send a curriculum vitae along with the names of at least three references to: Samuel M. Rankin, III, Head, Department of Mathematical Sciences, 100 Institute Rd., Worcester, MA 01609. Applications will be accepted until the positions are filled. EOE/AA. This advertisement has been placed on E-math and has appeared there before appearing in print.

The Mathematical Association of America prints FOCUS on recycled paper containing ten percent postconsumer waste.

Figures on Tight Job Market Released

Each year, the Annual AMS-MAA Survey collects information concerning departments, faculties, and students in the mathematical sciences in the United States and Canada. The results are released in the form of two reports. The *First Report* for 1992 was published in full in the November 1991 issue of the *Notices of the American Mathematical Society.* FOCUS reprinted highlights from that report in its December 1991 issue, pages ten through fifteen. The *Second Report*, published in the May–June 1992 *Notices,* confirms what everyone knows by now: new PhDs in the mathematical sciences continue to face enormous difficulties in finding academic positions.

The 40 doctorate-granting departments in the survey report 28 full-time doctoral faculty positions currently affected by temporary hiring freezes and anticipate elimination of 16 positions. Among all doctorate-granting mathematics departments, an estimated 106 positions are currently affected by freezes and an estimated 48 positions will be eliminated.

There is a substantial influx of highly trained mathematicians from abroad. Citizens of Eastern European countries and the former Soviet Union accounted for 13 percent of all newly-hired faculty and 15 percent of the tenured and tenure-eligible new hires. 71 percent of the Eastern European and Soviet citizens received their doctorates in Eastern Europe or the Soviet Union.

In addition, many foreign citizens trained in the US joined the nation's academic job market. Citizens of Asian countries accounted for 22 percent of all newly-hired faculty and 16 percent of the tenured and tenure-eligible new hires. 91 percent of the Asian citizen new hires received their doctorates in the US.

US citizens accounted for 37 percent of all newly-hired faculty in doctorate-granting mathematics departments. Among the tenured and tenure-eligible new hires, 46 percent were US citizens, a proportion comparable to the representation of US citizens among new doctorates awarded in the US.

Estimates of the number of candidates available and of the number of positions to be filled indicate that the current job market will be at least as difficult as last year's. The 40 departments in the survey estimate that 385 current graduate students are likely to complete degree requirements in time for 1992–1993 employment. In 1990–1991, the same 40 departments awarded a total of 383 new doctorates.

Further details concerning the US academic job market can be found in the April 1992 issue of the *Notices of the American Mathematical Society,* pages 311–316. For a reprint, at no cost, contact: Monica Foulkes, The American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940; telephone (401) 455-4000.

New From the MAA

Heeding the Call For Change: Suggestions for Curricular Action

Lynn Arthur Steen, Editor

In 1991 the MAA Board of Governors issued the publication of a MAA Report, A CALL FOR CHANGE, which heralded sweeping reform in all aspects of collegiate mathematics.

Just published, HEEDING THE CALL FOR CHANGE provides the first in a series of challenges concerning where and how to begin the process of change. The themes covered in this volume are quite diverse, ranging from disciplinary discussions (e.g., statistics, geometry) to curricular systems (e.g., the undergraduate major), from administrative concerns (e.g. assessment) to policy debates (e.g., multiculturalism). Yet beneath the surface of these varied papers lie many of the fundamental themes found in A CALL FOR CHANGE; that instruction needs to become an active, constructive process in which students learn to communicate about mathematics, to build mathematical models, and to connect mathematical ideas with the world around them.

260 pp., 1992, Paperbound
ISBN-0-88385-079-6
List: $20.00

Catalog Number NTE-22

From Zero to Infinity
Fourth Edition

Constance Reid

FROM ZERO TO INFINITY has dazzled readers with its freshness and clarity since being published in 1955. It shows how interesting the everyday natural numbers 0, 1, 2, 3,...have been for over two thousand years, and still are today. It combines the mathematics and the history of number theory with descriptions of the mystique that has on occasion surrounded numbers even among great mathematicians.

Each chapter takes one of the ten digits as a starting point. In some cases, as with 0 and 1, the numbers are in themselves special and unique. In other cases, as with 4 (the first square) or 6 (the first perfect number), each digit serves to inroduce an infinite series of very interesting numbers and very interesting mathematical questions that arise in connection with them.

Constance Reid has written many highly acclaimed books on mathematicians and mathematics, but this little classic—her first book—has earned a special place in popular mathematical literature.

200 pp., Paperbound, 1992
ISBN 0-88385-505-4
List: $19.00 MAA Members: $14.00

Catalog Number ZTI

Problems For Mathematicians: Young and Old

Paul R. Halmos

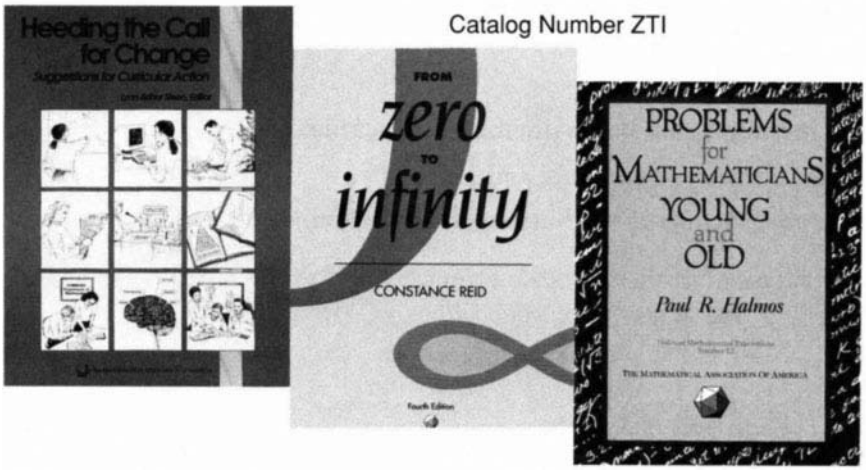
This is a book of problems for mathematicians at all levels. Halmos says: "I wrote this book for fun. It was fun indeed—the book almost wrote itself. It consists of some of the many problems that I started saving and treasuring a long time ago. Problems came up in conversations with friends, and in correspondence, and in books and in lectures. I enjoyed them, thought about them, tried to solve them, tried to change them, and tried to think of new ones, and then I tried to organize and write down the ones I was fondest of—and this book is the result."

The problems come complete with their statements, hints, and solutions. The purpose of the statements is to stimulate thought. The reader is asked to think of extensions and improvements of the results asked for. The hints are intended to get the reader to look in a possibly profitable direction.

Some of the problems can be solved by high school students. Others require the maturity of a professional mathematician, who can be a second year graduate student or someone who has been earning a living by thinking about mathematics for a long time. All of them are challenging and fun.

328 pp., 1991, Paperbound
ISBN 0-88385-321-3
List: $24.00 MAA Member: $16.00

Catalog Number DOL-12



(Order form on page 47)

New From the MAA

Perspectives on Contemporary Statistics

David C. Hoaglin and David S. Moore, Editors

This book is a must for anyone who teaches statistics, particularly those who teach beginning statistics–mathematicians, social scientists, engineers–as well as for graduate students and others new to the field. The authors focus on topics central to the teaching of statistics to beginners, and they offer expositions that are guided by the current state of statistical research and practice.

Statistical practice has changed radically during the past generation under the impact of ever cheaper and more accessible computing power. Beginning instruction has lagged behind the evolution of the field. Software now enables students to shortcut unpleasant calculations, but this is only the most obvious consequence of changing statistical practice. The content and emphasis of statistics instruction still needs much rethinking.

The book opens with a contemporary overview of statistics as the science of data–a view much broader than the "inference from data" emphasized by much traditional teaching. The next two chapters discuss the philosophy and some of the tools used in data analysis and inference, and its implications for teaching. Other chapters examine the science of survey sampling, essential concepts of statistical design of experimentation, contemporary ideas of probability, and the reasoning of formal inference. The book concludes with introductions to diagnostics and to the alternative approach embodied in resistant and robust procedures.

252 pp., Paperbound, 1991
ISBN 0-88385-075-3
Price: $20.00

Catalog Number: NTE-21

Student Research Projects in Calculus

Marcus Cohen, Edward D. Gaughan, Arthur Knoebel, Douglas S. Kurtz, and David Pengelley

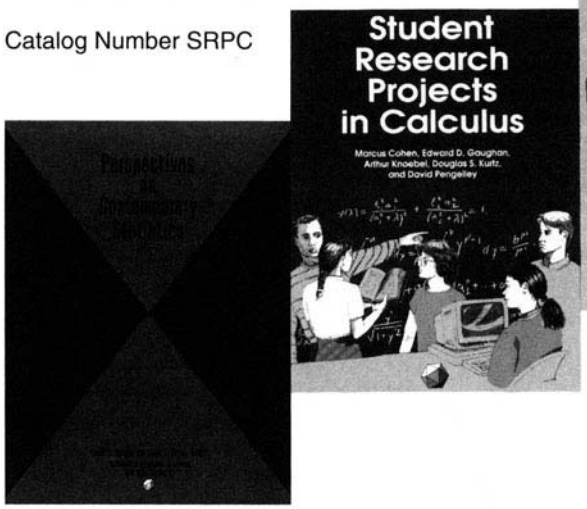
Changing the way students learn calculus was the goal of five mathematicians at New Mexico State University. In the Spring of 1988, they began work on a student project approach to teaching calculus.

You can use their methods in teaching your own calculus courses. Over 100 projects are presented, all of them ready to assign to students in single and multivariable calculus. The projects were designed with one goal in mind: to get students to think for themselves. Each project is a multistep, take-home problem allowing students to work both individually and in groups.

Each project has accompanying notes to the instructor, reporting students' experiences. The notes contain information on prerequisites, list the main topics the project explores, and suggest helpful hints. The authors have also provided several introductory chapters to help instructors use projects successfully in their classes and begin to create their own.

232 pp., 1992, Paperbound
ISBN 0-88385-503-8
List: $21.00 MAA Member: $14.00

Catalog Number SRPC



Old and New Unsolved Problems in Plane Geometry and Number Theory

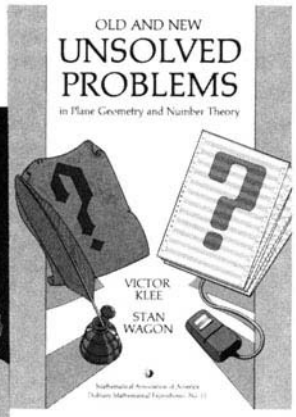
Victor Klee and Stan Wagon

Part of the broad appeal of mathematics is that there are simply stated questions that have not yet been answered. These questions are plentiful in the areas of plane geometry and number theory, and the purpose of this book is to discuss some unsolved problems in these fields. Many of the questions can be understood by readers with a very modest mathematical background.

The presentation is organized around 24 central problems, many of which are accompanied by other, related problems. The authors place each problem in its historical and mathematical context, and the discussion is at the level of undergraduate mathematics.

352 pp., Paperbound, 1991
ISBN 0-88385-315-9
List: $22.00 MAA Member: $16.00

Catalog Number DOL-11



(Order form on page 47)

New From the MAA

MATHEMATICAL CIRCUS

Drawn from Martin Gardner's "Mathematical Games" column in SCIENTIFIC AMERICAN

Martin Gardner

A circus suggests fun and enjoyment and there is plenty of both to be found here. The book should certainly be in the school library. It will also be a valuable resource for the teacher.

The Mathematical Gazette

His puzzles exercise the mind and not only fascinate puzzle fanatics but are also capable of amusing and intriguing serious professional mathematicians, scientists, and astronomers.

Science Reporter

Martin Gardner is once again the skillful ringmaster of a fast-paced variety show. There is something here for everyone; indeed, there are dozens of things here for everyone. The twenty chapters of this book are nicely balanced between all sorts of stimulating ideas, suggested by down-to-earth objects like matchsticks and dollar bills as well as by faraway objects like planets and the infinite random walks. We learn about ancient devices for arithmetic and about modern explanations of artificial intelligence. There are feasts here for the eyes and hands as well as for the brain.

P.T. Barnum correctly observed that people like to be hoodwinked once in awhile, and Martin the Magician is full of tricks and amusing swindles. But the important thing is that he is scrupulously fair. He painstakingly checks all of his facts and provides excellent historical background. These essays are masterpieces of scholarship as well as exposition. They are thoroughly reliable and carefully researched.

300 pp., Paperbound, 1992
ISBN 0-88385-506-2

List: $17.50
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A CENTURY OF CALCULUS
In two parts

Part I—1894-1968

T.M. Apostol, H.E. Chrestenson, C.S. Ogilvy, D.E. Richmond, N.J. Schoonmaker
500 pp., Paperbound, 1992,
ISBN 0-88385-205-5
List: $36.00 MAA Member: $25.00

Part II—1969-1991

T.M. Apostol, D.H. Mugler, D.R. Scott, A. Sterrett, Jr., A.E. Watkins
500 pp., Paperbound, 1992,
ISBN 0-88385-206-3
List: $36.00 MAA Member: $25.00

An essential reference for all teachers of calculus.

This two-volume collection of papers on calculus will provide teachers with easy access to a wealth of interesting and informative articles. Many of the papers contain material that has direct application to the classroom and is especially useful for beginning teachers. For example, there are papers on the basic elementary functions and their inverses, maxima and minima, indeterminate forms, integration by parts, polynomial approximations, numerical methods, infinite series, and applications of calculus to geometry and to mechanics. Some articles describe matters of pedagogy or class experiments that have had various degrees of success. Others provide insights, historical background or source material that extends beyond the classroom, or beyond the level of elementary calculus.

Volume I (published in 1969) as SELECTED PAPERS IN CALCULUS contains articles reprinted from the MONTHLY and MATHEMATICS MAGAZINE. Volume II contains articles reprinted from the MONTHLY, MATHEMATICS MAGAZINE, and the COLLEGE MATHEMATICS JOURNAL. It is a collection all calculus teachers will want on their desks.

BUY BOTH VOLUMES
AND SAVE.

List: $61.00
MAA Member: $42.00

MAA VIDEO CLASSICS

Let Us Teach Guessing

George Pólya

"Teaching is not a method, it is not a system. Teaching is not a science—it is an art." With these words, Pólya reveals his approach to teaching mathematics. In a remarkable tour de force, Pólya shows us how to teach guessing. In this classic film, master teacher Pólya leads an undergraduate class to discover the number of parts into which 3—space is divided by five arbitrary planes.

1966, color, 61 minutes
List: $36.95 MAA Member: $29.95
Catalog LTG

John Von Neumann
A Biography

Rare footage and photographs of the legendary von Neumann are to be found in this film biography. Halmos, Morgenstern, Teller, Wigner and Ulam contribute insights about and memories of Johnny. Set theory, computing, game theory, quantum mechanics—how broad were his interests? After viewing this video classic, your picture of von Neumann will enlarge.

1966, b & w, 63 minutes
List: $36.95 MAA Member: $29.95
Catalog Number JVN

Courant in Göttingen and New York

Colleagues of Courant describe his great influence as mathematician, author, and administrator. Part of the film contains footage of Courant in action, lecturing on soap bubbles and minimal surfaces. A significant portion of the film consists of reminiscences of his work at New York University and Göttingen where he succeeded Felix Klein. Forced to flee Hitler's Germany, Courant came to New York University in 1934, where he worked tirelessly to develop the Courant Institute of Mathematical Sciences.

1966, b & w, 43 minutes
List: $36.95 MAA Member: $29.95
Catalog Number CIG

The Moore Method
A Documentary on R.L. Moore

The Moore Method of teaching is presented by Moore himself. In his long career at the University of Texas at Austin, R.L. Moore produced a long list of distinguished mathematicians, and all of them were Moore Method graduates. In this film shot in his classroom, Moore passionately explains his methods of teaching which placed preeminent value on students discovering mathematics on their own. Moore also reflects on the beginnings of his own mathematical education in 1877.

1966, color, 55 minutes
List: $36.95 MAA Member: $29.95
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Calendar

National MAA Meetings

17–23 August 1992 Seventh International Congress on Mathematical Education (ICME-7), Université Laval, Québec, Canada. For additional information, see *Other Meetings* on this page. Immediately before ICME-7 opens, the MAA Board of Governors will meet in Québec, on Saturday, 15 August 1992.
13–16 January 1993 Seventy-sixth Annual Meeting, San Antonio, Texas (Board of Governors, 12 January 1993)
15–19 August 1993 Sixty-eighth Summer Meeting, Vancouver, British Columbia (Board of Governors, 14 August 1993)
12–15 January 1994 Seventy-seventh Annual Meeting, Cincinnati, Ohio (Board of Governors, 11 January 1994)
25–28 January 1995 Seventy-eighth Annual Meeting, Denver, Colorado (Board of Governors, 24 January 1995)
10–13 January 1996 Seventy-ninth Annual Meeting, Orlando, Florida (Board of Governors, 9 January 1996)

Sectional MAA Meetings

Eastern Pennsylvania and Delaware Muhlenberg College, Allentown, Pennsylvania: November 1992
Louisiana and Mississippi University of Southern Mississippi, Biloxi, Mississippi: 5 and 6 March 1993
Northeastern Trinity College, Hartford, Connecticut: 20 and 21 November 1992; University of Massachusetts at Dartmouth, Dartmouth Massachusetts: 11 and 12 June 1993; Westfield State College, Westfield, Massachusetts: 5 and 6 November 1992
Ohio Xavier University, Cincinnati, Ohio: 30 and 31 October 1992; Kent State University, Kent, Ohio: 16 and 17 April 1993
Seaway Cornell University, Ithaca, New York: 6 and 7 November 1992
Southern California University of Southern California, Los Angeles, California: 7 November 1992; *location not yet determined*: 6 March 1993; The Claremont Colleges, Claremont, California: 6 November 1993

Other Meetings

6–10 July 1992 *NSF Regional Institute in Dynamical Systems,* "Strange Attractors and Knots," Boston University, Boston, Massachusetts. For additional information, contact: Dynamical Systems InstituteDepartment of Mathematics, Boston University, 111 Cummington Street, Boston, Massachusetts 02215. (Also see page fourteen of the April 1992 issue of FOCUS.)
12–17 July 1992 *Computer Algebra System (CAS) Workshop,* Colby College, Waterville, Maine 04901. For additional information, contact: Donald B. Small, Department of Mathematical Sciences, United States Military Academy, West Point, New York 10996. (Also see page fifteen of the April 1992 issue of FOCUS.)
12–16 July 1992 *NSF Regional Institute in Dynamical Systems,* "Dynamics of Annulus Maps," Boston University, Boston, Massachusetts. For additional information, contact: Dynamical Systems Institute, Department of Mathematics, Boston University, 111 Cummington Street, Boston, Massachusetts 02215. (Also see page fourteen of the April 1992 issue of FOCUS.)
19–23 July 1992 *NSF Regional Institute in Dynamical Systems,* "Complexity and Computability Over the Reals," Boston University, Boston, Massachusetts. For additional information, contact: Dynamical Systems Institute, Department of Mathematics, Boston University, 111 Cummington Street, Boston, Massachusetts 02215. (Also see page fourteen of the April 1992 issue of FOCUS.)
26–20 July 1992 *NSF Regional Institute in Dynamical Systems,* "Dynamics, Competition, and Neural Networks," Boston University, Boston, Massachusetts. For additional information, contact: Dynamical Systems Institute, Department of Mathematics, Boston University, 111 Cummington Street, Boston, Massachusetts 02215. (Also see page fourteen of the April 1992 issue of FOCUS.)
2–7 August 1992 *Computer Algebra System (CAS) Workshop,* Clemson University, Clemson, South Carolina 29634. For additional information, contact: John W. Kenelly of the Department of Mathematical Sciences at Clemson University. (Also see page fifteen of the April 1992 issue of FOCUS.)

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