

FOCUS

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THE NEWSLETTER OF THE MATHEMATICAL ASSOCIATION OF AMERICA

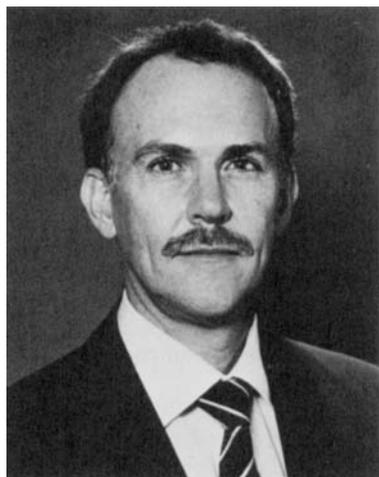
March-April 1987

President's Science Advisor Addresses the Joint Meetings

On January 21, within four months after joining the Administration, Dr. William R. Graham spoke to attendees at the Joint Mathematical Meetings on "Challenges to the Mathematics Community." His remarks were tightly connected to recent initiatives in the community springing from the 1984 David Report (RENEWING U.S. MATHEMATICS, published by the National Academy of Sciences) and linked to the Mathematical Sciences Education Board (MSEB). Dr. Graham gave ample evidence of his knowledge of and enthusiasm for mathematics. His challenges, outlined below, are those that the community must meet if it is to prosper as it should.

Graham's first challenge was to the research community: to maintain the momentum of the David Report and to fulfill the promise of that report in pure science and applications. Dr. Graham noted that the Administration and Congress have moved to meet the needs of the community as outlined in the David Report. He expressed the hope that this support would result in progress in applications of mathematics, particularly in multi-disciplinary areas. He mentioned NSF-supported work at existing engineering centers and 1988 plans for an additional fifty million dollars to support further technology centers. He urged the community to become involved in these efforts.

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*Dr. William R. Graham,
Presidential Science
Advisor, speaker at
the Joint Mathematical
Meetings in San
Antonio, Texas on
January 21, 1987*

Smokestack Classrooms

Lynn A. Steen

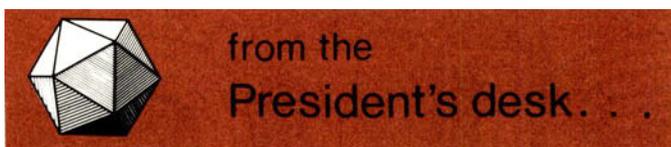
As Wall Street tracks the health of American business by monitoring indicators of economic productivity, so should parents and taxpayers heed indicators of educational productivity. A recent convocation sponsored by the National Research Council produced a cornucopia of evidence that our nation's classrooms, like many of our smokestack industries, can no longer compete with our international rivals.

The subject of these recent studies was mathematics, the central enabling discipline for science and technology. Because of its widespread utility in industrial, military, and scientific applications, mathematics is a crucial indicator of future economic competitiveness. The evidence is overwhelming, however, that the mathematics yield of U.S. schools is substantially less than that of other industrialized nations. For example:

- The mathematics achievement of the top five percent of 12th grade students—almost all of whom are enrolled in similar college-bound curricula in all countries—is lower in the United States than in other industrialized nations. The average 12th grade mathematics student in Japan outperforms 95 percent of comparable U.S. 12th graders.
- U.S. 8th graders are at about the international average in rote computation, but well below international norms in solving problems that require higher-order thinking skills.
- In fifth grade, the *highest* average mathematics achievement in U.S. schools (in Chicago and Minneapolis) is below the lowest average scores from similar schools in China (Beijing) and Japan (Sendai).
- Even Japanese children entering kindergarten are ahead of U.S. children in mathematical skills.

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Leonard Gillman, University of Texas, Austin

Approval Voting and the Coming MAA Elections

THE COMING ELECTIONS The procedure for electing the President-Elect and the two Vice-Presidents of the Association has been changed. All three elections will be conducted by what is known as **approval voting**. In this method, you may vote for **as many candidates as you wish—one vote to each**. The new procedure will be used this spring.

These will be "single-ballot" elections—that is, there is no runoff (except in the unlikely event of a tie). (The three-stage system used heretofore consisted of a primary plurality election followed by a committee selection followed by a runoff).

There are special changes in the election of the **Second Vice-President**. (1) This will now take place **at the same time** as the elections for President-Elect and First Vice-President (instead of in alternate years). (2) The electorate will be the **entire membership** (instead of the Board of Governors). (3) There will be **at least three candidates** (instead of just two).

As before, a nominating committee prepares a slate for each office. As before, you do not rank the candidates but simply vote for your choices. Note that since you may choose any subset of the n candidates, you have 2^n possible voting strategies (effectively, $2^n - 1$, since voting for every candidate is tantamount to abstaining). The winner of the election is the candidate with the most votes.

STRATEGIES IN APPROVAL VOTING Approval voting offers several attractive options. In the simplest case of only two candidates, you vote for the one you prefer, as usual. This generalizes to the case of two preference classes, where by definition you regard all candidates in the same class as essentially equal. In this case, you vote for every candidate in the preferred class. (If it has only one member, you vote for that one.)

How should you proceed if you recognize more than two preference levels? By the way, I suspect that voters will rarely classify beyond three levels, no matter how many candidates are running. Note that with exactly three, there is only one decision to make: whether or not to include a vote for your second choice.

In simple situations, your intuition is a good guide. Consider the common predicament in which your hero has only a poor chance of beating the knave, while a lesser choice has a reasonable chance; under approval voting, you may vote for both, simultaneously proclaiming your true feelings and helping to defeat the knave. Approval voting thus invites greater voter participation by offering viable options to many voters who might otherwise have been discouraged from voting at all. Moreover, the results are highly informative, since they will provide an accurate picture of how every candidate stands among the electorate.

The Reagan–Carter–Anderson race of 1980 offers a good example. The election percentages were 51-41-7. According to a poll taken at the time, the results under approval voting would have been 61-57-49. Thus, half the voters in the nation found Ander-

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Board of Governors and Business Meeting Actions

Meeting in San Antonio in January, the Board approved an official summer meeting in Providence, Rhode Island, in 1988. Here, the MAA will primarily serve a supporting role in the AMS's centennial celebration, although there will be an MAA business meeting and a meeting of the Board of Governors. The MAA program will be limited, but there will be three jointly sponsored lectures and there may be some MAA Minicourses.

The Committee on the Mathematical Education of Teachers (COMET) presented a proposal for endorsement that incorporated many of the recommendations of the Holmes and Carnegie reports on teacher education. The strength of these recommendations is suggested by the first of them: "The undergraduate education major must be abolished in our universities." Vigorous debate ensued on individual points. The whole proposal was sent back to COMET for clarification and refinement.

At the 1987 Board of Governors meeting held at Berkeley during the ICM, the Board directed the Investment Committee and the Executive and Finance Committees to work on a motion covering South African related investments. The proposal as perfected and passed by the Board is as follows:

The Board of Governors directs the Finance Committee, in its best judgment, to implement the following policy.

1. The MAA shall not purchase securities of any company that operates primarily in South Africa or shares of any mutual fund that has over 1% of its assets invested in such securities and shall divest of any such current holdings by June 30, 1988.
2. The MAA shall not purchase securities of companies that have an investment in South Africa and shall divest of current holdings in such companies by June 30, 1988.

The report of the Long Range Planning Committee was received and adopted in principle as a general framework for Association program and budget priorities; however, some substantive and editorial changes were made by the Board. This report, as modified, will be presented in summary in FOCUS.

The Board elected Judith Broadwin and Zaven Karian Governors-at-large. The changes in the Bylaws that were published in FOCUS, Volume 6, Number 6, were approved at the business meeting, and this approval carried through the Board's appointment of Gerald Alexanderson as the journal editor to serve on the Executive Committee and the Board's election of Ann Watkins as Second Vice President.

The Board approved an increase in annual dues for 1988. The average individual dues are now \$40 and will increase to \$45 for 1988. Dues for an ordinary member subscribing to the MONTHLY will increase to \$58 from the present \$48. These increases primarily reflect the Association's expanded activities, including those that increase public awareness of mathematics and other special projects, rather than mere inflation; however, increases in travel and meeting costs, real estate taxes, and publication costs have affected the MAA more than the official low rate of inflation would suggest.

At the business meeting, Association Secretary Kenneth Ross noted that the strength of the Association is manifest not only

in the fact that membership stands at a new high (above 25,000), but also in the fact that ten former MAA presidents were at the San Antonio meetings: Henry Alder, Richard Anderson, Ralph Boas, Victor Klee, Saunders MacLane, Edwin Moise, Ivan Niven, Henry Pollak, G. Baley Price, and Gail Young.

The Board received with sadness the news of the unexpected death of Governor Walter Kaufmann-Bühler and endorsed the appreciation, reprinted in this issue, that Paul Halmos offered on behalf of the community for Kaufmann-Bühler's many contributions.

Tribute to Walter Kaufmann-Bühler

Walter Kaufmann-Bühler, a member of the Board of Governors of the Mathematical Association of America, died suddenly on December 23, 1986. He was 42 years old.

Walter Kaufmann-Bühler was a rare kind of editor, an imaginative, creative, hard working, and effective mathematical editor—an outstanding credit to his profession. To many mathematicians Springer-Verlag New York was Kaufmann-Bühler. He started new journals, he started new series of books, and he oversaw the publication of hundreds of volumes of mathematics. He created the editorial boards, he usually soon became a personal friend of each author, and, with his prodigious memory, he could run his office while travelling all over the world staying in touch with the mathematical community.

Walter Kaufmann-Bühler came to the publishing world from mathematics, and he never gave up his first love, which is, no doubt, one reason he was a great *mathematical* editor. He knew about the history of mathematics, he had an accurate feeling for how mathematics was growing today, its interconnections and its applications, and, though it is a wonder how he found the time, he kept working at being a mathematician as well as an editor. He wrote a highly respected book on Gauss, just a year ago he published an article on his favorite subject, the hypergeometric function), and his death put a stop to his plan of following the Gauss book with one on Euler.

His contributions to the world of mathematics, and in particular to the American world of mathematics, were great and greatly appreciated. All of us will miss him as a member of our profession, and those of us who were lucky enough to know him personally as well as professionally will miss him as a friend.—*Paul R. Halmos*

Scores Lower on AJHSME

Stephen B. Maurer

The second annual American Junior High School Mathematics Examination (AJHSME), the newest of the American Mathematics Competitions, was held on December 9, 1986. Whereas the mean score in 1985 was 8.98 out of 20, the mean this time was 8.19. There were 66 perfect papers on the first AJHSME, only three this time.

The extra difficulty was not intended, but according to AJHSME Chairman Professor Thomas Butts of the University of Texas at Dallas, with hindsight it can be explained: this year there were no absolutely standard, turn-the-crank questions. In 1985, the easiest question (86.5% correct responses) was: "What is $90 + 91 + 92 + 93 + 94 + 95 + 96 + 97 + 98 + 99$?" In 1986, the easiest question (61.8% correct responses) was:

In the product shown, B is a digit.	B2
What is its value?	$\times 7B$
	6396

Despite the greater difficulty, enthusiasm for the exam remained high. As a teacher in North Dakota wrote, "Most of my students like the AJHSME, especially my 8th graders. The questions make them think and yet can be figured out." Schools were also pleased that this year, it was not required for all participants to take the exam at the same time—this allowed the exam to be given in class. There were 138,385 official participants.

Progress is being made on working out the kinks associated with any new large-scale endeavor. This year, all score reports were returned on schedule (the AJHSME is graded centrally). However, to make all information fit on one computer card, the AJHSME has used a compact recording scheme that caused some difficulty. Initial plans for next year include revisions to the card so that it is easier to fill out.

For a copy of the national Summary of Results and Awards, as well as a copy of the test and solution manual, send \$5 (\$6 for first-class mailing) to Professor Walter E. Mientka, CAMC Executive Director, Department of Mathematics and Statistics, University of Nebraska, Lincoln, NE 68588-0322.

Computers and Mathematics Subject of October Conference

The Fifteenth Annual Mathematics and Statistics Conference at Miami University, Oxford, Ohio, will be held October 9 and 10, 1987. The title is "Computers and Mathematics." Featured speakers will include Robert E. Tarjan, AT&T Bell Laboratories and Princeton University; Anthony Ralston, SUNY at Buffalo; and A. K. Dewdney, University of Western Ontario and editor of the "Computer Recreations" column of SCIENTIFIC AMERICAN. There will be contributed paper sessions, suitable for a diverse audience. Send abstracts by June 15, 1987 to Professor Zevi Miller, Department of Mathematics and Statistics, Miami University, Oxford, OH 45056. Information regarding preregistration and housing may also be obtained from Professor Miller.

Ohio Section Short Course on Applied Linear Algebra

July 15-17, 1987, Professor Alan C. Tucker will present a short course titled "A New Unified Approach to Linear Algebra." Professor Tucker will show how mathematical models, computation, and theory are closely linked in this subject. He will give a view of linear algebra that includes Markov chains, computer graphics methods, input-output models in economics, linear regression, eigenvalues and eigenvectors, matrix norms, and much more—all done in a fresh and unified way. Course registration is \$65 with lodging and meals at \$16 per night (single), \$12 per night per person (double), and \$21 per person for 5 meals. To register send \$30 (plus \$25 for lodging, if applicable) to: Professor Dwight Olson, Department of Mathematics and Computer Science, John Carroll University, University Heights, OH 44118.

Smokestack (continued from page 1)

The unanimity of these studies, from different countries and different investigators, underscores their significance. Because we have responded so often in the past with simplistic remedies to complex problems, the investigators responsible for these recent studies made a special point of examining many of the factors that are commonly suggested to explain or excuse our relatively poor performance. They found that most of these attractive explanations are, in fact, deceptive.

For example, there is no consistent correlation internationally between student achievement and time spent in mathematics instruction. Many countries devote *less* classroom time to mathematics than we do, but they use it more efficiently. Class size, similarly, seems to be quite unrelated to achievement.

Contrary to popular myth, the United States is not among the world leaders in the percentage of its youth who receive advanced education in mathematics. At the 8th grade, virtually all students in industrialized countries take mathematics. At the 12th grade level, most countries (including the United States) enroll about 12 to 15 percent of the age group in college-preparatory mathematics courses. Thus, our lower scores are not due to averages taken over a higher percentage of our population.

Finally, there is the conjecture that the enormous cultural diversity of American society makes it more difficult to achieve uniform excellence in education. Yet even in culturally homogenous Minneapolis-area schools, average performance is way below comparable schools in China and Japan. And among Chicago schools, the one that came closest to matching the Asian performance was a school with a minority population of more than 90 percent.

So what's left after simplistic explanations are eliminated? The major difference seems to be one of attitude and resolve. Despite our ringing historical declaration that all men (and women) are created equal, Americans, more than any other people, attribute success in mathematics to innate ability rather than to hard work.

The fact is that mathematics *can* be learned by Americans as well as by others, but it takes hard work. Students, parents, and teachers in other countries accept this and structure their schools accordingly. Americans must come to understand that achievement in mathematics is possible for all students—not only for the rich or talented.

Equality of opportunity will not be possible until we make a national commitment to dramatic improvement in the respect, expectations, and standards of school mathematics. It won't be easy or cheap, but it is the only viable strategy for ensuring long-term leadership in an increasingly competitive international arena.

This is not to say that we should simply imitate present world leaders. Mathematics is changing, and so must mathematics education. The pervasive nature of computing is changing the role of mathematics, requiring corresponding changes in school curricula. Computers now compute, so students must learn to think.

Indeed, solving complex problems, rather than rote learning alone, is becoming the new international standard of success in school mathematics. It must become our own national goal for school mathematics in the year 2000.

EDITORIAL COMMENT This article is based on a symposium on international comparisons held at the National Academy of Sciences under the auspices of the Mathematical Sciences Edu-

cation Board. The central findings of these recent international studies are summarized in *THE UNDERACHIEVING CURRICULUM* by Curtis C. McKnight et al. (Stipes Publishing, 1986), which is available from the MAA (see the Spring 1987 MAA Catalog).

Northeast Section Short Course on Discrete Mathematics

June 15-19, 1987, Professor Fred Roberts of Rutgers University will lecture on Applications of Discrete Mathematics at the annual Northeast Section Short Course at the University of Maine. Early lectures in the course will present a variety of applications of simple ideas from discrete mathematics, for instance, graph coloring, Eulerian paths, the multiplication rule of combinatorics, and the notion of generating function. Later lectures will give deeper treatments of several applied topics. Well-known techniques of combinatorics and graph theory will be quickly reviewed (though prior knowledge of combinatorics and graph theory will not be necessary). Less well-known techniques will be covered in detail. The emphasis in the course will be on applications. Roberts's most recent book, *APPLIED COMBINATORICS*, is closely related to the subject of this course.

The cost of this course, including room and board and the mid-week trip to Bar Harbor, is \$200 for MAA members. Family accommodations are available. For further information, contact Clayton W. Dodge, Mathematics Department, University of Maine, Orono, ME 04469 (Tel. 207-581-3908).

In Memoriam

Richard H. Balomenos, University of New Hampshire, died December 30, 1986 at the age of 56. He was an MAA member for 26 years.

Jacob Benson, Rutgers University, died November 21, 1986 at the age of 65. He was an MAA member for 39 years.

Frank Cleaver, University of South Florida, died January 29, 1987. He was an MAA member for 23 years.

Oscar Goldman, University of Pennsylvania, retired, died December 1986 at the age of 51. He was an MAA member for 33 years.

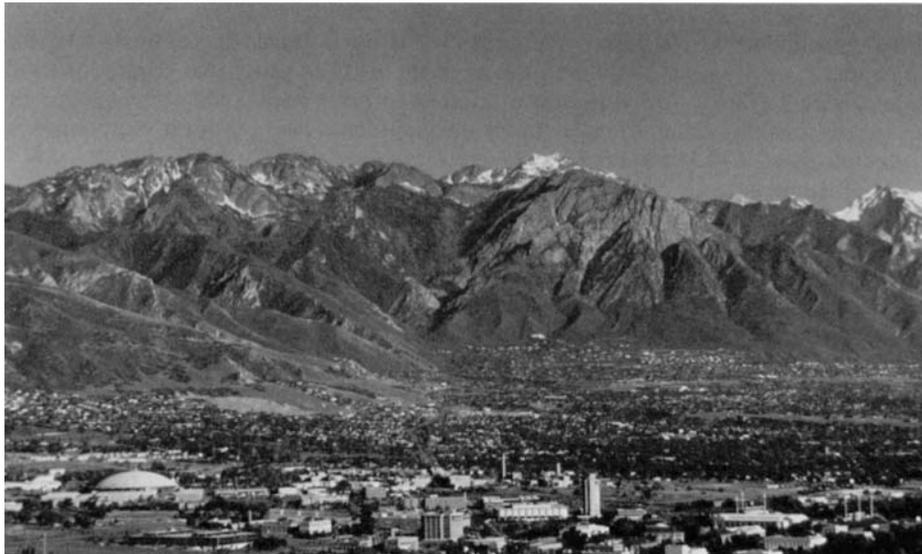
Clarence B. Lindquist, University of Wisconsin, retired, died February 2, 1987 at the age of 73. He was an MAA member for 34 years.

Charles D. Miller, American River College, died December 15, 1986 at the age of 44. He was an MAA member for 24 years.

Harold Wolfe, Professor Emeritus, Indiana University, died May 1986 at the age of 94. He was an MAA member for 72 years.

Word has also been received of the deaths of the following MAA members.

Charles Bramble; **Geoffrey J. Butler**, University of Alberta; **K. W. Crain**, Purdue University; **Patrick Hayes**, Federal Reserve Bank of New York; **Ernst Schwandt**, University of Wisconsin; **Hermann Simon**, University of Miami; **Wyman Williams**, University of South Carolina.



SALT LAKE CITY

Summer Meeting
August 5 to 8
1987

66th SUMMER MEETING OF THE MATHEMATICAL ASSOCIATION OF AMERICA

The August 1987 Joint Mathematics Meetings, including the 66th Summer Meeting of the Mathematical Association of America, the 90th Summer Meeting of the AMS, the 1987 Annual Meeting of Pi Mu Epsilon, and the 1987 Summer Meeting of the Association for Women in Mathematics, will be held August 5–8, 1987 (Wednesday–Saturday), at the University of Utah, Salt Lake City. Sessions will take place on the campus of the University of Utah, Salt Lake City.

Hedrick Lectures

The 35th Earle Raymond Hedrick Lectures will be given by William P. Thurston of Princeton University. The title of this series will be announced later. These lectures will be given at 11:15 a.m. on Thursday, Friday, and Saturday, August 6–8.

Invited Addresses

There will be at least seven invited fifty-minute addresses. The names of the speakers, their affiliations, times and days of their talks, and some of the titles follow:

Edward G. Effros, University of California, Los Angeles, title to be announced, 9:05 a.m. Thursday.

Aaron Fogelson, University of Utah, *Mathematical aspects of blood clotting*, 1:15 p.m. Friday.

John P. Hempel, Rice University, title to be announced, 3:20 p.m. Wednesday.

Charles R. Johnson, Clemson University, *Modern research trends in matrix analysis*, 9:05 a.m. Saturday.

Erwin Lutwak, Polytechnic University of New York, *Larger bodies with smaller cross-sectional areas*, 2:30 p.m. Friday.

Paul J. Steinhardt, University of Pennsylvania, *Introduction to quasi crystals: A new form of matter*, 2:15 p.m. Wednesday.

Walter Tape, University of Alaska, Fairbanks, title to be announced, 8:00 a.m. Thursday.

Minicourses (Form on Page IV)

Seven Minicourses are being offered by MAA. The names and affiliations of the organizers, the topics, the dates and times of their meetings, and the enrollment limitations of each are as follows:

Minicourse #1: *Applied mathematics via classroom experiments* is being organized by Herbert R. Bailey, Rose-Hulman Institute of Technology. Part A is scheduled from 9:00 a.m. to 11:00 a.m. on Wednesday, August 5, and Part B from 7:00 p.m. to 9:00 p.m. on Wednesday, August 5. Total enrollment for this MAA Minicourse is limited to 80 persons.

This Minicourse is based on a junior level applied mathematics course which has been developed to encourage students to combine their knowledge of physics, calculus, and differential equations. Students are asked to derive and solve the equations that model simple classroom experiments. For example, the first experiment is to let a ball bounce until it stops. The problem is to relate “percent rebound” and “time to stop bouncing”. The student must combine the concepts of time of fall and summation of geometric series. The full course includes five units: I–The Chain, II–Rotation, III–Fluid Flow, IV–Heat Flow, and V–Calculus of Variations. The Minicourse will begin with a brief description of each unit including demonstrations of most of the experiments. Participants will then be asked to work through some of the units either individually or in small groups. Each participant will be given a writeup and a solution manual for each of the units. The writeups include review sections covering the necessary mathematics and physics.

Minicourse #2: *Using computer spreadsheet programs in calculus, differential equations, and combinatorics* is being organized by Donald R. Snow, Brigham Young University. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Tuesday, August 4, and Part B from 7:00 p.m.

to 9:00 p.m. on Wednesday, August 5. Total enrollment for this MAA Minicourse is limited to 30 persons.

Computer spreadsheet programs such as Lotus 1-2-3 can be used in many places in mathematics where a table or matrix format occurs. Examples in Calculus include the evaluation and graphing of functions illustrating parameter changes, illustrations of limits of sequences or functions, approximate integration, summation of series, and for iteration processes such as Newton's method for root finding. In differential equations the applications include computation of approximate solutions from the corresponding difference equations and graphing allowing comparison with exact solutions. In combinatorics the uses include computation of tables such as Pascal's triangle and generalizations, r-permutations, Stirling number tables, and other recurrence relation problems, difference tables, and determining and expanding generating functions for various sequences such as the Fibonacci and Lucas numbers.

This Minicourse will begin with an introduction to Lotus 1-2-3 on the IBM PC. Student copies of Lotus which will handle all of the above problems can now be purchased very inexpensively. Participants will have hands-on experience using Lotus with some of the above examples and will receive a disk containing the worksheets (but not Lotus itself) which they can use in their own classes or research.

Minicourse #3: *A microcomputer linear algebra course using Linear-Kit* is being organized by Howard Anton, Drexel University. Part A is scheduled from 9:00 a.m. to 11:00 a.m. on Wednesday, August 5, and Part B from 3:30 p.m. to 5:30 p.m. on Wednesday, August 5. Total enrollment for this MAA Minicourse is limited to 30 persons.

Linear-Kit is a powerful microcomputer package which can do linear algebra operations in either exact rational arithmetic (without the distraction of round-off error) or floating point arithmetic (facilitating study of computational aspects). Its data storage and retrieval capabilities lend themselves to self-paced courses.

The Minicourse will consist of (1) a "hands-on" session on the use of Linear-Kit, (2) a problem-solving session, making application of Linear-Kit, (3) a session on design of courses to meet various needs, and (4) a summary session devoted to discussion and perhaps design of a new computer-based linear algebra course. Microcomputers will be used extensively by participants, but prior experience is **not** required.

Minicourse #4: *A survey of educational software* is being organized by David P. Kraines, Duke University, and Vivian Kraines, Meredith College. Part A is scheduled from 8:00 a.m. to 9:55 a.m. on Thursday, August 6, and Part B from 8:00 a.m. to 9:55 a.m. on Friday, August 7. Total enrollment for this MAA Minicourse is limited to 30 persons.

The variety and the quality of software for IBM compatible computers has been increasing steadily. The objective of this Minicourse is to allow the participants to experiment with a representative collection of the better programs in calculus, linear algebra, differential equations, and other mathematical subjects. A variety of classroom applications will be demonstrated from a number of different computer packages. At the end of each two hour

session, the participants will have the opportunity for "hands-on" use of some of these programs. Handouts will provide information on other educational software on the market or under development. No computer experience is required.

Minicourse #5: *Introduction to computer graphics* is being organized by Joan P. Wyzkoski, Fairfield University. Part A is scheduled from 1:30 p.m. to 3:30 p.m. on Friday, August 7, and Part B from 8:00 a.m. to 9:55 a.m. on Saturday, August 8. Total enrollment for this MAA Minicourse is limited to 30 persons.

Graphs and illustrations of geometrical objects are useful tools in the teaching of mathematics. Computer graphics simplifies the production of these teaching aids. This Minicourse will present some of the mathematical techniques used to produce realistic pictures on graphics display devices. Some of the topics to be discussed are curve and surface sketching, 2D and 3D transformations, perspective drawing, and hidden line removal. Suggestions will be given for the use of these techniques to complement mathematics instruction. Since personal computers will be available for demonstrations and in-class implementations, programming experience is necessary.

Minicourse #6: *A calculus lab course using MicroCalc* is being organized by Harley Flanders, University of Michigan, Ann Arbor. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, August 7, and Part B from 2:30 p.m. to 4:30 p.m. on Saturday, August 8. Total enrollment for this MAA Minicourse is limited to 30 persons.

This will be a hands-on introduction to MicroCalc, a commercially available interactive package of about 30 programs designed to stimulate mathematical experimentation, minimize the drudgery of calculation, and test results of hand calculation. The programs include extensive graphing capability, symbolic differentiation, and function editing, including composition. Part of each session will be devoted to working out projects and experiments. Take-home demo disks of MicroCalc will be given to the students.

Minicourse #7: *For all practical purposes* is being organized by Solomon A. Garfunkel, COMAP, Inc. Part A is scheduled from 1:30 p.m. to 3:30 p.m. on Friday, August 7, and Part B from 1:30 p.m. to 3:30 p.m. on Saturday, August 8. Total enrollment for this MAA Minicourse is limited to 40 persons.

This course deals with introducing contemporary applications throughout the undergraduate curriculum. Materials presented will include tapes from the soon-to-be-released PBS telecourse *For all practical purposes* as well as print modules from the UMAP series. Applications will cover a wide variety of fields with special emphasis on discrete mathematics and applications to management science and decision making.

Please note the new procedure for registering for MAA Minicourses. Participants interested in attending any of the MAA Minicourses should complete the MAA Minicourse Preregistration Form. Send the form along with payment **directly to the MAA Office at the address given on the form so as arrive prior to the June 1 deadline. DO NOT SEND THIS FORM TO PROVIDENCE.**

Please note that prepayment is now required. Payment can be made by check payable to MAA (Canadian

checks must be marked "in U.S. funds") or Visa or MasterCard credit cards.

The MAA Minicourses are open only to persons who have registered for the Joint Mathematics Meetings and paid the Joint Meetings registration fee.

If the only reason for registering for the Joint Mathematics Meetings is to gain admission to a MAA Minicourse, this should be indicated by checking the appropriate box on the MAA Minicourse Preregistration Form. Then, if the MAA Minicourse is fully subscribed, full refund can be made of the Joint Mathematics Meetings preregistration fee(s). Otherwise, the Joint Meetings preregistration will be processed, and then be subject to the 50 percent refund rule. PREREGISTRATION FORMS FOR THE JOINT MATHEMATICS MEETINGS SHOULD BE MAILED TO PROVIDENCE PRIOR TO THE DEADLINE OF JUNE 1.

The registration fee for MAA Minicourses #2-#6 is \$40 each. The registration fee for MAA Minicourses #1 and #7 is \$30 each. This fee entitles the registrant to attend all sessions of the MAA Minicourse for which he/she has registered. Participants are limited to two MAA Minicourses each. It is advised that alternate choices be given in the event the first and/or second choice MAA Minicourse(s) are full. (Form on Page IV)

Contributed Papers

Contributed papers are being accepted on five topics in collegiate mathematics for presentation in contributed paper sessions at the MAA Summer Meeting in Salt Lake City. The topics, organizers, their affiliations, and days they will meet are:

- *Teaching strategies involving computers* (Chris Avery, DeAnza College), Friday morning, August 7.

Papers should focus on new and innovative ways microcomputers can be used in the teaching of mathematics. Possible topics may include but are not limited to: innovative classroom presentation of concepts, new content made accessible to students by computers, change in emphasis for traditional curriculum, or actual classroom experience with a CAI model. Particular software description is relevant to the degree that it applies to the above pedagogical concerns.

- *In search of the lean and lively calculus*, Katherine A. Franklin, Los Angeles Pierce College, Wednesday morning, August 5.

Papers which describe attempts to implement some of the recommendations of the Tulane workshop on the calculus, or which consider the merits of those recommendations, or which present specific alternative plans for reviving the calculus are solicited.

- *The teaching of mathematics and computer science in one department*, Zaven Karian, Denison University, Wednesday morning, August 5.
- *New models for the mathematical preparation of teachers*, Bruce E. Meserve, Pleasant Hill, TN, Saturday afternoon, August 8.
- *Using computer algebra in the classroom*, Warren Page visiting Ohio State University, Saturday afternoon, August 8.

All papers related to the use of computer algebra systems in the classroom will be considered.

Presentations are normally limited to ten minutes, although selected contributors may be given up to twenty minutes. Individuals wishing to submit papers for any of these sessions should send the following information to the MAA Washington office (1529 Eighteenth Street, NW, Washington, DC 20036) by **May 27**.

1. Title
2. Intended session
3. A one-paragraph abstract (for distribution at the meeting)
4. A one-page outline of the presentation

This information will be sent to session leaders who will arrange for refereeing. Selection of papers will be announced by June 15.

Undergraduate Student Paper Session

On an experimental basis, there will be an Undergraduate Student Paper Session sponsored by the MAA in conjunction with Pi Mu Epsilon, the undergraduate mathematics honorary society. The session will be held on Friday, August 7. Nominations for papers from sections of the MAA, mathematics departments, and other interested parties, with a brief abstract, should be sent to Ron Barnes, Department of Applied Mathematics, University of Houston-Downtown, 1 Main Street, Houston, TX 77002. **Deadline for nominations is May 15, 1987.**

Other MAA Sessions

The Committee on the Mathematical Education of Teachers (COMET) is sponsoring a panel discussion on *New directions in teacher education—pros and cons*. The session is scheduled from 8:30 a.m. to 9:55 a.m. on Friday, August 7. The participants are Henry L. Alder, University of California, Davis (moderator), Alphonse Buccino, University of Georgia, Shirley A. Hill, University of Missouri, Kansas City, Katherine P. Layton, Beverly Hills High School, and Billy E. Rhoades, Indiana University.

The Committee on Placement Examinations (COPE) is sponsoring a panel discussion on *Using placement examinations to create order in freshman placement*. The moderator is John W. Kenelly, Clemson University. The session will take place at 2:30 p.m. on Saturday, August 8.

The Mathematical Sciences Education Board and the Board on Mathematical Sciences of the National Research Council are sponsoring a panel discussion on *The mathematical sciences in the year 2000: Assessment for renewal in U.S. colleges and universities*. The moderator is Bernard L. Madison, University of Arkansas. The panel is scheduled for 9:30 a.m. to 11:00 a.m. on Wednesday, August 5.

The Committee on the Participation of Women is sponsoring a panel discussion on Friday, August 7, from 8:30 a.m. to 9:55 a.m. on *What are the problems? What are the solutions?*

Audio-Visual Equipment

Rooms where MAA sessions will be held are equipped with one overhead projector and screen. (Invited 50-minute speakers are automatically provided with two overhead projectors.) Blackboards are also available in most of

(continued on page v)

MAA MINICOURSE PREREGISTRATION FORM, Salt Lake City, Utah
August 5-8, 1987

Please complete this form and return it WITH YOUR PAYMENT to:

John Gilliland
Mathematical Association of America
1529 Eighteenth Street, N.W.
Washington, DC 20036
Telephone: 202-387-5200

(Please print) Surname First Middle

Street address City State Zip

IMPORTANT NOTES:

1. Deadline for Minicourse preregistration: June 1, 1987
2. Deadline for 50% refund: July 31, 1987
3. Registration for the Joint Meetings is a requirement in order to participate in the Minicourses. Complete the Preregistration/Housing Form included in the meeting announcement and return it to Providence with the applicable Joint Meetings preregistration fee. DO NOT SEND MINICOURSE FORM OR FEES TO PROVIDENCE.
4. Each participant must fill out a separate Minicourse form.
5. Enrollment is limited to two Minicourses, subject to availability.
6. Please complete the following and send both form and payment to John Gilliland at the above address:

- a. I would like to attend 1 Minicourse
 2 Minicourses

b. Please enroll me in MAA Minicourse(s): # _____ and # _____

c. In order of preference, my alternatives are: # _____ and # _____

7. PAYMENT:

a. Check enclosed: \$ _____

b. Credit card type: MasterCard VISA

Credit card number _____ Expiration date _____

Employing institution _____ Signature (as it appears on credit card) _____

Number	Minicourse	Organizer	Fee
1.	Applied mathematics via classroom experiments	Herbert R. Bailey	\$30
2.	Using computer spreadsheet programs in calculus, differential equations, and combinatorics	Donald R. Snow	\$40
3.	A microcomputer linear algebra course using Linear-Kit	Howard Anton	\$40
4.	A survey of educational software	David P. Kraines Vivian Kraines	\$40
5.	Introduction to computer graphics	Joan P. Wyzkoski	\$40
6.	A calculus lab course using MicroCalc	Harley Flanders	\$40
7.	For all practical purposes	Solomon A. Garfunkel	\$30

I plan on preregistering for the Joint Meetings only in order to attend the MAA Minicourse(s) indicated above. It is my understanding that, should the course(s) of my choice be filled, full refund of the Joint Meetings preregistration fee will be made.

MINI COURSE FORM

these rooms, but speakers are urged to use the overhead projector for maximum visibility by the audience. these rooms, but speakers are urged to use the overhead projector for maximum visibility by the audience.

Upon written request, the following projection equipment will be made available: one additional overhead projector/screen, 35 mm carousel slide projector, 16 mm film projector, or VHS video cassette recorder with one color monitor. Speakers requiring any of the equipment listed in this paragraph are required to submit their needs **in writing prior to June 30** to John Balletto, Meetings Department, AMS, P.O. Box 6248, Providence, RI 02940. Please be certain to include your name, affiliation, telephone number, name of session or session organizer, and explicit equipment needs.

No other equipment can be made available for these sessions without approval of the MAA Secretary. Requests for equipment not listed above should also be addressed to John Balletto (again, prior to June 30), who will forward them to the Secretary for possible approval.

Films

The MAA Film Program will take place on Friday, August 7, at 7:00 p.m. The program includes *Hypothesis testing, inferential statistics, Part II; Regular homotopies in the plane, Part II; Symmetries of the cube*. The program will also include some COMAP films.

Business Meeting

The Business Meeting of the MAA will take place at 2:30 p.m. on Thursday, August 6. The 1987 Carl B. Allendoerfer, Lester R. Ford, and George Pólya Awards for expository writing will be presented. Six Certificates of Meritorious Service will also be presented. This meeting is open to all members of the Association.

Board of Governors

The MAA Board of Governors will meet at 9:00 a.m. on Tuesday, August 4. This meeting is open to all members of the Association.

Section Officers

There will be a Section Officers' Meeting at 4:30 p.m. on Wednesday, August 5.

Banquet for 25-year Members

The MAA is planning its twelfth annual banquet for individuals who have been members of the Association for twenty-five years or more. The banquet will be preceded by a reception from 6:15 p.m. to 6:45 p.m. on Wednesday evening, August 5 in the Tanner Dining Room of the Alumni House. Dinner will be served at 7:00 p.m. The menu includes fresh strawberries, hearts of palm salad with vinaigrette dressing, beef Wellington, parsley potatoes, broccoli spears with hollandaise sauce, rolls, muffins, butter, chocolate mousse cake, and beverages. State law prohibits the serving of alcoholic beverages; therefore, no alcoholic beverages will be served at this function.

Please note that all tickets for this banquet must be purchased through preregistration, since a guarantee must be given to the caterer. Tickets are \$17 each; the price includes the gratuity. Interested participants should complete the appropriate section of the preregistration

form. In the event of cancellations, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence prior to July 31. After that date, no refund can be given.

90th Summer Meeting of the AMS August 5 - 8, 1987

The **American Mathematical Society (AMS)** program will feature a series of four Colloquium Lectures presented by Edward Witten. There will be eight invited addresses given by Donald G. Aronson, University of Minnesota, Minneapolis; Edward W. Formanek, Pennsylvania State University; David Jerison, Massachusetts Institute of Technology; Stephen Kerchoff, Stanford University; Paul C. Roberts, University of Utah; Karen Vogtmann, Cornell University; Brian C. White, Stanford University; and Robert Lee Wilson, Rutgers University.

Joint AMS - MAA Sessions

By invitation of the AMS-MAA Joint Program Committee (Judith V. Grabiner, Reuben Hersh, Paul H. Rabinowitz (chairman), and John M. Smith), the following speakers will address the joint meeting of the AMS and MAA on the history and development of mathematics. The names of the speakers, their affiliations, and one of their titles are:

Robert Finn, Stanford University and Max-Planck Institut, title to be announced, 10:10 a.m. Thursday.

Michael Starbird, University of Texas, Austin, *R H Bing's mathematical vitality*, 10:10 Friday.

Activities Of Other Organizations

The **Association for Women in Mathematics (AWM)** will sponsor a panel discussion at 8:30 a.m. on Thursday, August 6, on *Gender and science*. The AWM Membership Meeting will follow at 9:30 a.m. The AWM Party will be held on Thursday evening, August 6.

The **Interagency Commission for Extramural Mathematics Programs (ICEMAP)** will present a session at 8:00 p.m. on Wednesday, August 5.

The **Joint Policy Board for Mathematics (JPBM)** Committee for Mathematics Department Heads has organized a National Meeting of Department Heads at 7:45 p.m. on Wednesday, August 5. This session will feature a presentation organized by Bernard Madison, University of Arkansas, on *Faculty renewal and talent flow: Linked, critical, and at risk*. This will be followed by Birds-of-a-Feather sessions on *The Ph.D. college teacher: An endangered species?* organized by John Fulton, Clemson University, including a large department session presented by Frank Gilfeather, University of Nebraska; and a small department session presented by Lynn A. Steen, St. Olaf College. Colin Bennett, University of South Carolina, will organize a second Birds-of-a-Feather session *Does calculus belong in a university wide core curriculum?*

The Committee for Department Chairs of the JPBM will also cosponsor a workshop for department chairs with the American Council on Education (ACE) on Tuesday, August 4, from 9:00 a.m. to 5:00 p.m. Participants

who are interested in this workshop should see **News and Announcements** in the April issue of *Notices*.

Pi Mu Epsilon (PiME) will hold its annual meeting on Wednesday, Thursday, and Friday, August 5–7. The J. Sutherland Frame Lecture will be given at 8:30 p.m., on Friday, August 7. The name of the speaker and the title of the lecture will be announced later. There will also be sessions for contributed papers on Thursday morning and Friday morning and afternoon.

The **National Science Foundation** (NSF) will sponsor a presentation at 4:25 p.m. on Wednesday, August 5.

Other Events or Items Of Interest

Book Sales

Books published by the AMS and MAA will be sold at discounted prices somewhat below the cost for the same books purchased by mail. **These discounts will be available only to registered participants wearing the official meeting badge.** VISA and MASTERCARD credit cards will be accepted for book sale purchases at the meeting. The book sales will be open the same days and hours as the exhibits and are located in the Center Ballroom in the A. Ray Olpin University Union Building.

Exhibits

The book and educational media exhibits will be open from 1:00 to 5:00 p.m. on Wednesday, August 5, 9:00 a.m. to 3:00 p.m. on Thursday, August 6, 9:00 a.m. to 5:00 p.m. on Friday, August 7, and from 9:00 a.m. to noon on Saturday, August 8. All participants are encouraged to visit the exhibits during the meeting.

Summer List of Applicants

At the direction of the AMS-MAA-SIAM Committee on Employment Opportunities, which is charged with operation of the Employment Register and with the publication of *Employment Information in the Mathematical Sciences*, the Society will publish a Summer List of mathematical scientists seeking employment for distribution at the Salt Lake City meeting.

Copies of the 1987 summer list of applicants will be available at the Transparencies section of the registration desk for \$4. Following the meeting, they may be purchased from the AMS office in Providence for \$6. This list should prove useful to employers who have last-minute openings in the latter part of the summer or in the fall.

The deadline for receipt of applicant forms to appear in this summer list is June 1.

The applicant preregistration résumé and instructions on its completion can be found in this issue.

Instead of an Employment Register at the Summer Meeting in Salt Lake City, there will be an opportunity for posting of both applicant résumé forms and employers' announcements of open positions in or near the main meeting registration area. There will be no special room set aside for interviews. No provisions will be made by the Society for interviews: arrangements will be the responsibility of each employer and applicant. Messages may be left in the message box located in the registration area.

Special applicant and employer forms will be available at the Transparencies section of the registration desk both

for applicants to post résumés and for employers to post forms announcing positions.

Applicants who submit an applicant form, but do not plan to attend the meeting, will appear on the printed list only. There is no provision made for posting résumés for participants who do not attend the meeting. No printed lists of employers or applicants who register at the meeting will be available after the meeting.

Accommodations

University Housing

Participants desiring confirmed reservations for on-campus housing **must preregister** and send payment in full for housing to the Mathematics Meetings Housing Bureau **prior to the June 1, 1987 deadline.** Participants in the Joint Mathematics Meetings may occupy residence hall rooms at the University of Utah during the period August 4 to August 9 only. **All must check out by August 9.** A limited number of rooms on campus will be available for those participants who do not preregister but plan on attending the Salt Lake City meetings and registering on site. Rooms will be assigned at the Meetings Registration Desk during registration hours and at the check-in desks of designated residence halls (see below) after meeting registration hours. Onsite payments for residence hall rooms can be made with cash, personal checks, travelers' checks, and credit cards (VISA and MasterCard only).

Participants requesting housing on the University of Utah campus will be assigned to one of three residence halls: Austin Hall, Ballif Hall, or Van Cott Hall. (Please refer to the section below titled Room Rates.)

Families with children will be allowed to stay in the dormitories; however, there is a maximum of one child per room. Sleeping bags for children five years and younger staying with **both** parents will be permitted at a child rate. Any child occupying a bed in a room with a parent must pay the adult rate. (See section on **Hotel Accommodations** below for alternate housing for families.)

Residence halls at the University of Utah have three floors; however, there are no elevators. It is expected that helpers will be available at the check-in desks to assist with luggage. Of the three residence halls assigned to the meetings, Austin Hall is the only air-conditioned building. Handicapped persons will be assigned to Austin and Van Cott Halls. Sleeping rooms are good size, very well maintained, and contain two single beds, desks, chairs, and closets. Some rooms have reading lamps; others have overhead lamps. Rooms will be prepared for occupancy in advance. In addition to bed linen, pillow, and blanket, participants will receive a towel, soap, and glass (exchangeable upon request at the check-in desk). Participants are advised to bring their own washcloths and hangers. There is no daily maid service in the sleeping rooms.

There are two bathrooms with showers on each floor; one for each gender. Walls separate shower stalls and curtains screen the interiors. Hooks are placed on the outside of stall dividers where robes can be hung. Each hall is equipped with washers (\$50) and dryers (\$25); however there is no provision for purchasing detergents. Vending machines are available for soft drinks, candy, and ice cream in each residence hall.

No pets are allowed in the residence halls. Alcoholic beverages are not permitted. Smoking is permitted in participants' rooms only. The hallways as well as the rooms are equipped with heat sensors.

Check-In Locations and Times

A check-in desk will be maintained in the lobby of each residence hall. These desks will be staffed from 7:00 a.m. to midnight seven days per week. Telephone numbers for assistance will be posted on the door of each hall for those participants arriving after midnight. Phones are located outside of each main entrance. Parking stickers for nearby university lots may be purchased at the residence hall check-in desks for a daily rate of \$1.50. (Parking is free on Saturday.)

Directions to the residence halls are as follows:

BALLIF HALL - Take 400 South (South Campus Drive) to traffic light on 1900 East (Wasatch Drive), turn left onto Wasatch Drive, proceed 3/10 mile and turn left on Ballif Road (130 South) and take immediate left.

VAN COTT HALL - Same directions as above, except go straight on Ballif Road instead of taking an immediate left.

AUSTIN HALL - Same directions as above, except go 4/10 mile and turn left on Austin Road (100 South).

At the time of check-in, participants assigned rooms through the Mathematics Meetings Housing Bureau will present their receipt which will enable them to receive two keys: one for the outside door and one for the room. Those participants being assigned a room directly by the check-in desk (only **after** meeting registration hours) will be required to fill out a housing form, thus enabling them to receive keys. Spouses desiring a room key must follow this procedure also. **Please note that, although there is no deposit required for keys, a penalty of \$25 will be imposed for each key lost or not returned.** It is the responsibility of the Mathematics Meetings Housing Bureau to collect this penalty. Therefore, it is requested that proper caution be exercised to avoid this charge. At checkout, all keys must be returned to the main desk in the lobby. Should the clerk not be present, please ensure that your name is left at the check-in desk with the key.

Room Rates

The following rates apply for residence hall accommodations at the University of Utah. Please note that there is no room tax applicable to these rates.

There is a \$5 daily rate for a child five years of age and younger in the same room with parents, provided a sleeping bag is used. Children six years of age and older must occupy a bed and are subject to the adult rate. The university allows a maximum of three occupants only in each room. Should a family with two children request accommodations, two rooms would be required and the double rate applies in each case. A family of three (with a child six years of age and older) would require one double room at the double rate plus a second room for the third occupant at the single rate. Adult rates are as follows:

Residence Hall	Type	Singles (1 person)	Doubles (2 persons)
Austin	a/c	\$13	\$19 (or \$9.50 p/p)
Ballif	no a/c	\$12	\$17 (or \$8.50 p/p)

Van Cott no a/c \$12 \$17 (or \$8.50 p/p)

Note: Van Cott Hall has three double-bedded rooms per apartment with six apartments per floor; one bath per apartment.

Changes/Cancellations

Please make all changes to or cancellations of residence hall reservations with the Housing Bureau in Providence **before August 4, 1987, in order to receive a 90% refund of housing payment.** After that date, refunds for cancellations or no shows will equal 90% of the amount paid minus one night's room charge. No cancellations can be made between 5:00 p.m. on Tuesday, August 4, and 4:00 p.m. on Thursday, August 6, after which changes or cancellations may be called in to Penny Pina at the Telephone Message Center number in Salt Lake City. Changes in reservations may be made at any time by notifying the Housing Bureau in Providence.

Food Services

The A. Ray Olpin University Union Building offers a variety of food services from fast foods to full dinners on a cash basis in the Union Terrace (see below). The average prices for meals would be: \$3.50 for breakfast, \$4.50 for lunch, and \$5.50 for dinner. Serving hours and locations are as follows:

Breakfast	Cafe	6:30 a.m.–10:30 a.m.
Lunch	Deli	11:00 a.m.–2:00 p.m.
	Cafe	10:30 a.m.–2:00 p.m.
	Foreign	
	Exchange	11:00 a.m.–2:00 p.m.
Dinner	Panorama Rm.	11:30 a.m.–2:00 p.m.
	Int'l Side of	
	Foreign	
	Exchange	5:00 p.m.–7:00 p.m.
	Cafe	6:00 p.m.–8:00 p.m.

Servings are generous, well prepared, and reasonably priced. Choices for breakfast would include eggs to order any style, cold or hot cereals, biscuit sandwiches, and assorted beverages. Lunch and dinner include Italian pasta, stuffed baked potatoes, grilled and fried sandwiches, Mexican cuisine and other ethnic specialties (alternating daily), fresh baked pizza, salads, fresh vegetables, fresh fruit, pies, and cakes.

For those participants who wish to go off campus to get their meals, please be advised that there are only a few restaurants within walking distance. Among these are a pizza parlor and a seafood restaurant.

Hotel Accommodations

Since most of the hotels in Salt Lake City are not within easy walking distance of the campus, it is recommended that participants planning to stay in a hotel be prepared to provide their own transportation to the university campus. The hotels listed below are approximately 2–3 miles from the extreme western end of campus. Buses frequently connect the University with downtown. Wait at any of the well marked bustops along Main or State Streets between 400 South and South Temple and inquire of the driver. Buses stop on campus on the "U" in front of the Park building (about 1450 East 200 South), and on the "Business" loop just South of the Business Lecture

Hall. Currently, the average taxi fare for a distance of approximately three miles is \$5.15 regardless of the number of passengers. The following is a partial list of hotels and their approximate distance from the University of Utah campus. Rates are subject to a 9-3/4% state room tax. Rates quoted are firm.

Little America—2 1/2 miles to extreme west of campus

500 South Main
Salt Lake City, UT 84101
801-363-6781
800-453-9450

Single occupancy	\$59
Double occupancy	\$59
Triple occupancy	\$59
Quadruple occupancy	\$59

Full service hotel. Swimming pool, health spa, shopping mall, restaurant, lounge, free parking. Rooms have queen and king-size beds. All major credit cards accepted.

Salt Lake City Marriott (Headquarters)—2 1/4 miles to extreme west of campus

75 South West Temple
Salt Lake City, UT 84101
801-531-0800

Single occupancy	\$52
Double occupancy	\$52
Triple occupancy	\$62
Quadruple occupancy	\$62

Full service hotel. Swimming pool, free parking, restaurant, lounge. All major credit cards accepted.

Peery Hotel—2 1/2 miles to extreme west of campus

110 West 300 South
Salt Lake City, UT 84101
801-521-4300
1-800-331-0073 (toll free for room reservations only)

Single occupancy	\$45
Double occupancy	\$55

N/C for child in same room with parents.

Full service hotel. Continental breakfast included in rates, jacuzzi, fitness room, restaurant, lounge, free parking. Rooms have queen-size beds only. All major credit cards accepted.

Shilo Inn—2 1/4 miles to extreme west of campus

206 South West Temple
Salt Lake City, UT 84101
801-521-9500
1-800-222-2244 (toll free for room reservations only)

Single occupancy	\$41
Double occupancy	\$41
Triple occupancy	\$45
Quadruple occupancy	\$49

Children 12 years and younger are free in same room with parents.

Rollaways—\$6 additional.

Full service hotel. Free parking, continental breakfast included in rates, swimming pool, public laundry, restaurant, lounge. Rooms have double or queen-size beds. All major credit cards accepted.

Howard Johnson's at Temple Square—2 miles to extreme west of campus

122 West South Temple
Salt Lake City, UT 84101
801-521-0130

Single occupancy	\$34
Double occupancy	\$39
Triple occupancy	\$44
Quadruple occupancy	\$49

Children 14 years and younger are free in same room with parents.

Full service hotel. Free parking, jacuzzi, exercise room, 24-hour restaurant. All major credit cards accepted.

Registration At The Meetings

Meeting preregistration and registration fees only partially cover expenses of holding meetings. All mathematicians who wish to attend sessions are expected to register, and should be prepared to show their meeting badge, if so requested. **Badges are required to obtain discounts at the AMS and MAA Book Sales**, to cash a check with the meeting cashier, and to attend sessions scheduled in the Fine Arts Auditorium. (If a preregistrant should arrive too late in the day to pick up his/her badge, he/she may show the acknowledgment received from the Mathematics Meetings Housing Bureau as proof of registration.) The fees for Joint Meetings registration at the meetings (listed below) are 30 percent higher than the preregistration fees.

Joint Mathematics Meetings

Member of AMS, MAA, IIME	\$ 77
Emeritus Member of AMS, MAA	\$ 21
Nonmember	\$117
Student/Unemployed	\$ 21

MAA Minicourses

(if openings available)

Minicourses #2—#6	\$40 each
Minicourses #1 & #7	\$30 each

Registration fees may be paid at the meetings in cash, by personal or traveler's checks, or by Visa or MasterCard credit card. Canadian checks must be marked for payment in U.S. funds.

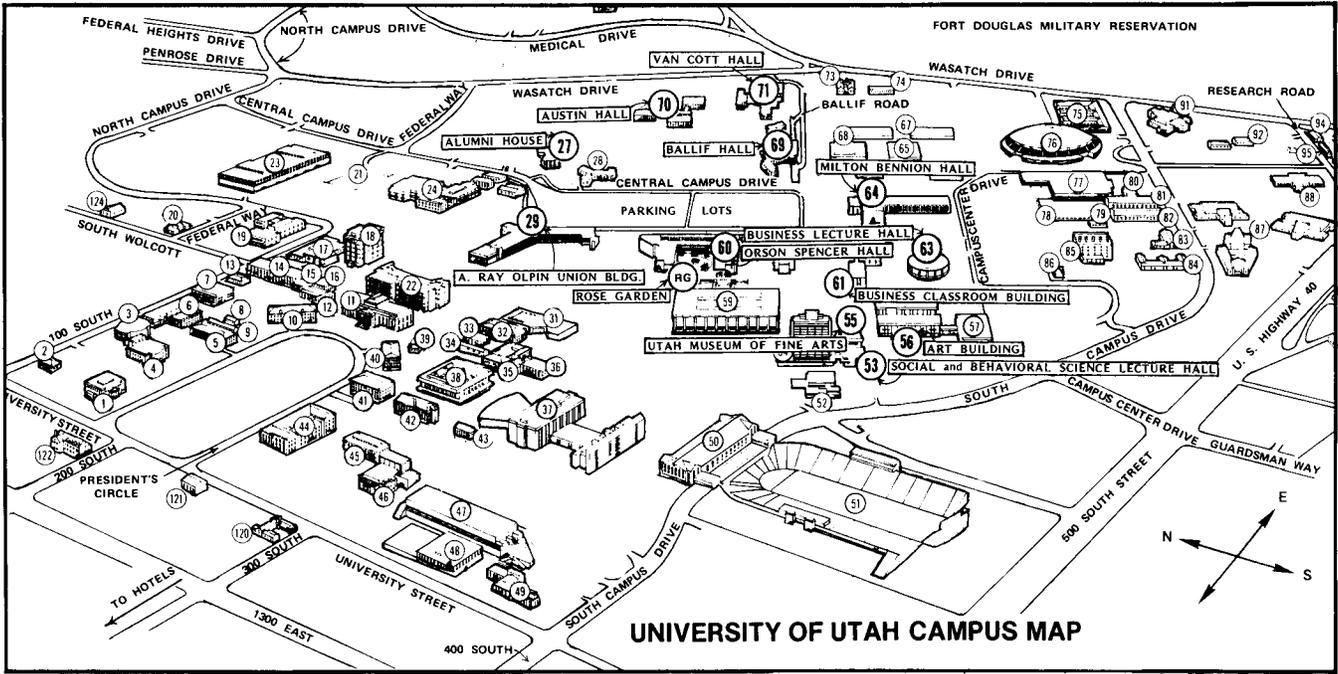
There is no extra charge for members of the families of registered participants, except that all professional mathematicians who wish to attend sessions must register independently.

All **full-time** students currently working toward a degree or diploma qualify for the student registration fees, regardless of income.

The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include any person who has voluntarily resigned or retired from his or her latest position.

Persons who qualify for emeritus membership in either the Society or the Association may register at the emeritus member rate. The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more, and is retired on account of age from his or her latest position.

(continued on page xii)



UNIVERSITY OF UTAH CAMPUS MAP

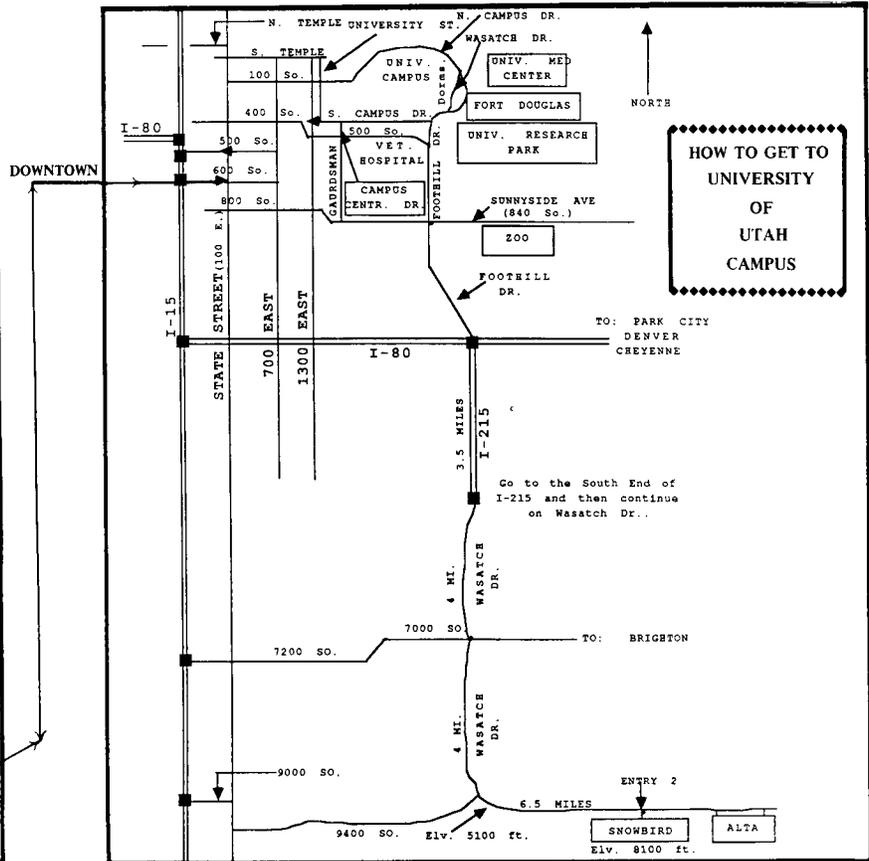
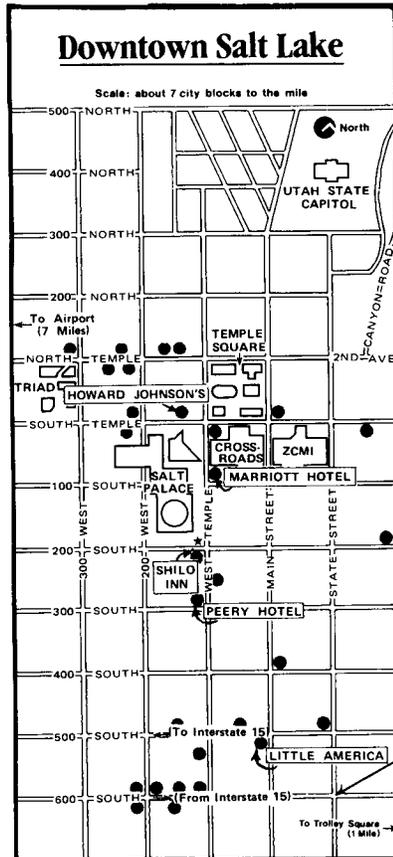
UNIVERSITY OF UTAH CAMPUS

- 27-ALUMNI HOUSE
- 29-A. RAY OLPIN UNION BLDG.
- 53-SOCIAL and BEHAVIORAL SCIENCE LECTURE HALL
- 55-UTAH MUSEUM of FINE ARTS
- 56-ART BLDG.
- 60-ORSON SPENCER HALL
- 61-BUSINESS CLASSROOM BLDG.

- 63-BUSINESS LECTURE HALL
- 64-MILTON BENNING HALL
- 69-BALLIF HALL
- 70-AUSTIN HALL
- 71-VAN COTT HALL
- RG-ROSE GARDEN

OTHER KEY BUILDINGS

- 19-Kennecott Research Center
- 23-Joseph Merrill Engineering Bldg.
- 37-Henry Eyring Bldg.
- 47-Law Library
- 50-Einar Nielsen Fieldhouse
- 51-Rice Stadium
- 57-Sculpture Bldg.
- 59-Marriott Library
- 76-Special Events Center



MAA PROGRAM

Tuesday, August 4

- 9:00 a.m. – 4:00 p.m. **Board of Governors' Meeting**
 7:00 p.m. – 9:00 p.m. **Minicourse #2 (Part A):** *Using computer spreadsheet programs in calculus, differential equations, and combinatorics*, Donald R. Snow, Brigham Young University

Wednesday, August 5

- morning – **Contributed Paper Session:** *In search of the lean and lively calculus*, Katherine A. Franklin, Los Angeles Pierce College
 morning – **Contributed Paper Session:** *The teaching of mathematics and computer science in one department*, Zaven Karian, Denison University
 9:00 a.m. – 11:00 a.m. **Minicourse #1 (Part A):** *Applied mathematics via classroom experiments*, Herbert R. Bailey, Rose-Hulman Institute of Technology
 9:00 a.m. – 11:00 a.m. **Minicourse #3 (Part A):** *A microcomputer linear algebra course using Linear-Kit*, Howard Anton, Drexel University
 9:30 a.m. – 11:00 a.m. **Panel Discussion:** *The mathematical sciences in the year 2000: Assessment for renewal in U.S. colleges and universities*, Bernard L. Madison, University of Arkansas
 2:15 p.m. – 3:05 p.m. **Invited Address:** *Introduction to quasi crystals: A new form of matter*, Paul J. Steinhardt, University of Pennsylvania
 3:20 p.m. – 4:10 p.m. **Invited Address:** *Title to be announced*, John P. Hempel, Rice University
 3:30 p.m. – 5:30 p.m. **Minicourse #3 (Part B):** *A microcomputer linear algebra course using Linear-Kit*, Howard Anton, Drexel University
 4:30 p.m. – 6:30 p.m. **Section Officers' Meeting**
 6:15 p.m. – 10:00 p.m. **Banquet for 25-year Members**
 7:00 p.m. – 9:00 p.m. **Minicourse #1 (Part B):** *Applied mathematics via classroom experiments*, Herbert R. Bailey, Rose-Hulman Institute of Technology
 7:00 p.m. – 9:00 p.m. **Minicourse #2 (Part B):** *Using computer spreadsheet programs in calculus, differential equations, and combinatorics*, Donald R. Snow, Brigham Young University

Thursday, August 6

- 8:00 a.m. – 8:50 a.m. **Invited Address:** *Title to be announced*, Walter Tape, University of Alaska, Fairbanks
 8:00 a.m. – 9:55 a.m. **Minicourse #4 (Part A):** *A survey of educational software*, David P. Kraines, Duke University and Vivian Kraines, Meredith College
 9:05 a.m. – 9:55 a.m. **Invited Address:** *Title to be announced*, Edward G. Effros, University of California, Los Angeles
 10:10 a.m. – 11:00 a.m. **AMS-MAA Invited Address:** *Title to be announced*, Robert Finn, Stanford University and Max-Planck Institut
 11:15 a.m. – 12:15 p.m. **Hedrick Lecture I:** *Title to be announced*, William P. Thurston, Princeton University
 2:30 p.m. – 3:20 p.m. **Prize Session and Business Meeting:** Allendoerfer, Ford and Pólya Awards, Certificates of Meritorious Service

Friday, August 7

- morning – **Contributed Paper Session:** *Teaching strategies involving computers*, Chris Avery, DeAnza College
 8:00 a.m. – 9:55 a.m. **Minicourse #4 (Part B):** *A survey of educational software*, David P. Kraines, Duke University and Vivian Kraines, Meredith College
 8:00 a.m. – 9:55 a.m. **Undergraduate Student Paper Session**
 8:30 a.m. – 9:55 a.m. **Committee on the Mathematical Education of Teachers (COMET) Panel Discussion:** *New directions in teacher education – pros and cons*
 8:30 a.m. – 9:55 a.m. **Committee on the Participation of Women Panel Discussion:** *What are the problems? What are the solutions?*
 10:10 a.m. – 11:00 a.m. **AMS-MAA Invited Address:** *R H Bing's mathematical vitality*, Michael Starbird, University of Texas, Austin
 11:15 a.m. – 12:15 p.m. **Hedrick Lecture II:** *Title to be announced*, William P. Thurston, Princeton University
 1:00 p.m. – 4:00 p.m. **Undergraduate Student Paper Session**
 1:15 p.m. – 2:05 p.m. **Invited Address:** *Mathematical aspects of blood clotting*, Aaron Fogelson, University of Utah
 1:30 p.m. – 3:30 p.m. **Minicourse #5 (Part A):** *Introduction to computer graphics*, Joan P. Wyzkoski, Fairfield University

- 1:30 p.m. – 3:30 p.m. **Minicourse #7 (Part A)** For all practical purposes, Solomon A. Garfunkel, COMAP, Inc.
- 2:30 p.m. – 3:20 p.m. **Invited Address:** *Larger bodies with smaller cross-sectional areas*, Erwin Lutwak, Polytechnic University of New York
- 7:00 p.m. – 9:00 p.m. **Films:** *Hypothesis testing, inferential statistics, Part II; Regular homotopies in the plane, Part II; Symmetries of the Cube*; and a couple of COMAP films
- 7:00 p.m. – 9:00 p.m. **Minicourse #6 (Part A):** *A calculus lab course using MicroCalc*, Harley Flanders, University of Michigan, Ann Arbor

Saturday, August 8

- 8:00 a.m. – 9:55 a.m. **Minicourse #5 (Part B):** *Introduction to computer graphics*, Joan P. Wyzkoski, Fairfield University
- 9:05 a.m. – 9:55 a.m. **Invited Address:** *Modern research trends in matrix analysis*, Charles R. Johnson, Clemson University
- 11:15 a.m. – 12:15 p.m. **Hedrick Lecture III:** *Title to be announced*, William P. Thurston, Princeton University
- afternoon – **Contributed Paper Session:** *New models for the mathematical preparation of teachers*, Bruce E. Meserve, Pleasant Hill, TN
- afternoon – **Contributed Paper Session:** *Using computer algebra in the classroom*, Warren Page, visiting Ohio State University
- 1:30 p.m. – 3:30 p.m. **Minicourse #7 (Part B)** For all practical purposes, Solomon A. Garfunkel, COMAP, Inc.
- 2:30 p.m. – 4:00 p.m. **Committee on Placement Examinations (COPE) Panel Discussion:** *Using placement examinations to create order in freshman placement*, John W. Kenelly, Clemson University
- 2:30 p.m. – 4:30 p.m. **Minicourse #6 (Part B):** *A calculus lab course using MicroCalc*, Harley Flanders, University of Michigan, Ann Arbor

AMS-MAA Joint Program Committee: Judith V. Grabiner, Reuben Hersh, Paul H. Rabinowitz (chairman), and John M. Smith

MAA Program Committee: James W. Cannon, Kenneth R. Goodearl, James P. Keener, Warren Page, T. Benny Rushing, John M. Smith, and Calvin H. Wilcox (chairman).

Local Arrangements Committee: C. Edmund Burgess (chairman); E. Allan Davis, William J. LeVeque (ex-officio), Deanne Randall, Kenneth A. Ross (ex-officio), Hugo Rossi (ex-officio), Peter C. Trombi, and Carolyn Tucker.

SALT LAKE CITY AND ENVIRONS

Salt Lake City is favorably situated just west of the Wasatch Range on what was during the Pleistocene era the bed of Lake Bonneville, an enormous body of water that stood over eight hundred feet deep above the present site of the City. Salt Lake City takes its name from the Great Salt Lake, which along with Bonneville Salt Flats (seventy-five miles to the east) and the ancient shoreline terraces in the mountains above the City survive as remnants of that wetter era.

The Wasatch Mountains capture rain and snowfall in this arid region and harbor at least one glacier. The City was founded on July 24, 1847 by Brigham Young and his followers on the Jordan River, which is one of many flowing from the Wasatch Mountains and watering what are now lush agricultural areas at the eastern edge of a salt desert. It may have been this potential that led Brigham Young to exclaim "this is the place."

The City is in the heart of the Western States with convenient road, rail, and air links to all major western centers. There are more than ten national parks within a day's drive (see pages xiv and xv for details). The City lies 4390 feet above sea level with peaks in the eight to ten thousand foot level and easily accessible within twenty-five miles. The wildflowers will be at their peak in locations such as Snowbird Resort (eight thousand feet), the location of the Thursday tour and buffet dinner during the Summer meetings (see "Social Event" on page xv).



© Kim McHugh/The Stock Broker

Aerial tramway at Snowbird in the winter

Nonmembers who preregister or register at the meeting and pay the nonmember fee will receive mailings from AMS and MAA, after the meeting is over, containing information about a special membership offer.

Registration Dates, Times, and Locations

Joint Mathematics Meetings

[and MAA Minicourses (until filled)]

Center Ballroom, A. Ray Olpin University Union Building

Tuesday, August 4	4:00 p.m. to 8:00 p.m.
Wednesday, August 5,	7:30 a.m. to 4:00 p.m.
Thursday, August 6	7:30 a.m. to 2:00 p.m.
Friday, August 7	7:30 a.m. to 4:00 p.m.
Saturday, August 8	7:30 a.m. to 3:00 p.m.

Registration Desk Services

Assistance, Comments and Complaints

A log for registering participants' comments or complaints about the meeting is kept at the Transparencies section of the registration desk. All participants are encouraged to use this method of helping to improve future meetings. Comments on all phases of the meeting are welcome. If a written reply is desired, participants should furnish their name and address.

Participants with problems of an immediate nature requiring action at the meeting should see the Director of Meetings, who will try to assist them.

Audio-Visual Equipment and Assistance

A member of the AMS/MAA staff will be available to advise or consult with speakers on audio-visual usage.

Most rooms where sessions will be held are equipped with an overhead projector, screen, and blackboard. Speakers are strongly urged to use the overhead projector rather than the blackboard for their presentation in order to obtain maximum visibility by all members of the audience of the material being presented.

Baggage and Coat Check

Provision will be made for participants checking out of the residence halls or motels early to leave baggage in the meeting registration area while it is open.

Check Cashing

The meeting cashier will cash personal or travelers' checks up to \$50, upon presentation of the official meeting registration badge, provided there is enough cash on hand. Canadian checks must be marked for payment in U.S. funds. It is advisable that participants bring travelers' checks with them. When funds are low the meetings cashier will not be able to cash checks, and travelers' checks can be easily cashed at local banks, restaurants, or hotels.

Local Information

This section of the desk will be staffed by members of the Local Arrangements Committee and other volunteers from the Salt Lake City mathematical community.

Information Table

The information table at Joint Meetings of the AMS and MAA is set up in the registration area for the dissemination of information of a nonmathematical nature of possible interest to the members. The administration of the information table is in the hands of the AMS-MAA Joint Meetings Committee, as are all arrangements for such joint meetings. The following rules and procedures apply.

1. Announcements submitted by participants should ordinarily be limited to a single sheet no more than $8\frac{1}{2}'' \times 14''$.

2. A copy of any announcement proposed for the table is to be sent to: H. Hope Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940 to arrive at least one week before the first day of the scientific sessions.

3. The judgment on the suitability of an announcement for display rests with the Joint Meetings Committee. It will make its judgments on a case by case basis to establish precedents.

4. Announcements of events competing in time or place with the scheduled scientific program will not be accepted.

5. Copies of an accepted announcement for the table are to be provided by the proponent. Announcements are not to be distributed in any other way at the meeting (for example, not by posting or personal distribution of handbills).

6. It may be necessary to limit the number of events or the quantity of announcements distributed at a meeting.

7. At the close of registration, the table will be swept clean. A proponent who wishes the return of extra copies should remove them.

Lost and Found

See the meeting cashier during the meeting. After the meeting, all lost articles not claimed will be turned over to the Department of Mathematics.

Mail

All mail and telegrams for persons attending the meetings should be addressed as follows: Name of Participant, c/o Joint Mathematics Meetings, Department of Mathematics, University of Utah, Salt Lake City, Utah 84112. Mail and telegrams so addressed may be picked up at the mailbox in the registration area during the hours the registration desk is open. U.S. mail not picked up will be forwarded after the meeting to the mailing address given on the participant's registration record.

Personal Messages

Participants wishing to exchange messages during the meeting should use the mailbox mentioned above. Message pads and pencils are provided. It is regretted that such messages left in the box cannot be forwarded to participants after the meeting is over.

Telephone Messages

A telephone message center will be located in the registration area to receive incoming calls for participants. The center will be open from August 4 through 8, during the hours that the Joint Mathematics Meetings registration desk is open. Messages will be taken and the name of any individual for whom a message has been received will be posted until the message has been picked up at the message center. The telephone number of the message center will be provided later.

Transparencies

Speakers wishing to prepare transparencies in advance of their talk will find the necessary materials and copying machines at this section of the registration desk. A member of the staff will assist and advise speakers on the best procedures and methods for preparation of their material. There is a modest charge for these materials.

Visual Index

An alphabetical list of registered participants, including local addresses and arrival and departure dates, is maintained in the registration area.

Miscellaneous Information

Athletic Facilities

The university has two large sport complexes: HPER and the E. Nielsen Fieldhouse. The HPER Complex has several basketball, badminton, volleyball, racquetball, and handball courts. There are weightlifting rooms and an olympic size swimming pool. The Fieldhouse has seven indoor tennis courts, racquetball and squash courts, an indoor track, and weightlifting facilities. These facilities will be made available to registered participants who pay a \$3 fee. The fee entitles the participant to a temporary pass, good for one week. The pass can be purchased at HPER East 214 during business hours. Participants should bring their meeting badges when purchasing the pass. The hours that the various facilities will be available to participants is determined quarterly and a schedule will be given to those who purchase a pass. In addition to these facilities, the university also has a golf course and many outdoor tennis courts which are open to the general public.

Book Stores

The University of Utah Bookstore on campus is open from 8:00 a.m. to 5:00 p.m., Monday through Friday. The bookstore will be closed Saturday. The Sam Weller Book Store is located at 254 South Main (downtown).

Camping and RV Facilities

The closest commercial campgrounds, about five miles west of the campus by bus or automobile, are KOA Salt Lake City Campground, 1400 West North Temple, Salt Lake City, UT 84116 (801-355-1192) and Campground VIP, 1350 West North Temple, Salt Lake City, UT 84116 (801-328-0224). It is suggested that people interested in these campgrounds contact them several weeks in advance for information and reservations.

For those who desire locations that are more isolated and primitive, there are four campgrounds (Spruces, Redman, Tanner's Flat, Albion) under the supervision

of the National Forest Service in the nearby Wasatch Mountains, all within about 25 miles of the campus, at altitudes of 7,000–10,000 feet. These do not accept reservations, but spaces are usually available for people arriving on weekdays from Monday through Thursday. The procedure is to select a vacant camp site and then pay a fee at a registration box at the entrance. These campgrounds are in the watershed for the Salt Lake City water supply and no pets are permitted. People interested in these four campgrounds should write for a map and further information from the Department of Mathematics, University of Utah, Salt Lake City, UT 84112.

Child Care

There are several state licensed childcare facilities in the vicinity of the University of Utah. A list of some recommended centers follows. Reservations should be made directly with the center of your choice at least two weeks in advance.

Taylor-Wright Childcare Center

801-363-4332

1063 East 200 South

Salt Lake City, UT 84102

Director: Anne Taylor

Ages: 2–13. Hours: 6:30 a.m.–6:00 p.m.

Rates: Daily—\$11; half-day, up to 5 hours—\$7.50, hourly—\$1.90

Tutor Time Child Care/Learning Centers (2 locations)

801-363-5437

560 East 200 South

Salt Lake City, UT 84102

Assistant Director: Verlene Beck

and

505 Wakara (in Research Park, just south of the university)

Salt Lake City, UT 84113

801-582-3423

Director: Helen Villamor

Ages: 6 weeks to age 12

Hours: 6:30 a.m.–6:30 p.m. (evening hours possible if there is sufficient demand)

Rates: up to age 2, \$2 per hour; age 3 and up \$1.50 per hour

For Children Only (2 locations)

560 East 200 South

Salt Lake City, UT 84102

801-355-5437

Director: Bianca Candelaria

and

1400 South 1100 East

Salt Lake City, UT 84105

801-467-5730

Director: Bianca Candelaria

Ages and rates: 0–24 months—\$3.50 per hour, \$14 per day; 2 year olds—\$2 per hour, \$10 per day; age 3 to 8—\$1.75 per hour, \$9 per day.

If you wish to have an individual babysitter (high school or college age student), call the Arts and Sciences office at Westminster College 801-488-4166, 9:00 a.m.–4:00 p.m., no later than July 28.

Crib Rental

Portacribs and metal cribs (standard size) can be rented from **Progressive Rental** (about four miles south of campus), 2253 East 3300 South, 801-487-4601. Portacribs cost \$17.50 per week. Metal cribs cost \$20 per week. Tax is 5.75%. They will deliver for a charge of \$13 each way. Cribs can be reserved from July 1 on.

Handicapped

Most (not all) university facilities are accessible to the handicapped. People with special requirements for campus housing should have made these clear when submitting preregistration forms. People with special questions regarding handicapped access should contact Deanne Randall, Department of Mathematics, University of Utah, Salt Lake City, UT 84112 (801-581-6851).

Libraries

The Marriott Library is the main library on campus. The Mathematics Research Library is located in Room 121 of the John Widstoe Building. Summer hours for these libraries will be announced later.

The main branch of the Salt Lake City Public Library is located at 200 East 500 South, downtown.

The new Genealogical Library of the Latter Day Saints (LDS Mormon) Church is located at 35 North West Temple. The library is open to the public and there is no fee for using the research facilities for genealogical purposes. The library houses the world's largest collection of genealogical records. The hours are Monday 7:30 a.m. to 6:00 p.m., Tuesday through Friday 7:30 a.m. to 10:00 p.m., and Saturday 7:30 a.m. to 5:00 p.m.

Local Information

Salt Lake City is the main city in a valley populated by nearly a million people. The city is laid out like the (xy)-plane, with the LDS Temple at the origin. Locations are identified with reference to this coordinatization like this: "351 South 700 East" means a building which is between three and four blocks south of the x-axis (South Temple Street), and on the street which is seven blocks east of the negative y-axis (Main Street). While walking around the city, keep in mind that seven blocks make a mile (more or less). There is a free trolley (called the Brigham Street Trolley) which regularly wends its way around the main locations in downtown: this is an easy (but not speedy) way to get around. Bus service between downtown and the university is very good during the daylight hours. There are many routes which originate along Main or State Streets and pass by the university.

The novice homemaker visiting Italy will eat insipid food until he discovers that salt is sold in the tobacco stores. Similarly, in Utah, the visitor goes dry until he becomes familiar with the local customs. First of all, beer is sold in all supermarkets and most drugstores. Wine and liquor are to be found in outlets of the state monopoly called "Utah State Stores." These stores are open from 11:00 a.m. until 7:00 p.m. except on Sundays, and any other day that passes for a holiday. Now, to find the locations of these establishments is easy: just look in the blue pages of your copy of the White Pages under "ALCOHOLIC BEVERAGE CONTROL DEPARTMENT - Liquor Stores." You will discover that

none of these addresses has anything to do with the nice coordinate system described above; why one of these stores is on something called "Kentucky Avenue!" The stores closest to the university are these: 1615 Foothill Boulevard is really "1615 South 2300 East," and 416 6 Avenue is at "416 East 300 North." The university is at 200 South 1500 East, so both of these are more than a mile away. Salt Lake City does have two outlets which have a remarkably good selection of wines, champagnes, and liqueurs; the one closest to the university (and downtown) is at 250 South 300 East.

One of the advantages of our quaint method of liquor distribution is that all restaurants and hotels are required to accept the contents of brown bags (of course they'll get you on the cost of the glass to put it in - but don't fret, the total is still more reasonable than in most cities). Now, if you you've forgotten your brown bag, don't worry; there is almost always a liquor store on the premises which can provide you with minibottles and splits of wine after 4:00 p.m. So you see, once you learn the language, it's just like back home. More about restaurants will appear in the Program.

As a city of moderate size, Salt Lake City has a moderate amount of things going on. Brochures on events taking place during the month of August will be available at the Local Information Section of the Meeting Registration Desk. But the most interesting thing about Salt Lake City is its environment. There are very many good hikes (or climbs) for all abilities within minutes of the campus. In fact, one can walk just to the east of the campus into foothills reaching an elevation of about 7500 feet. Here again, more information will be available at the meeting.

The most famous landmark, the Great Salt Lake, will be a disappointment to all. At its best it is foul and brackish water which allows its occupants to bob around like corks. Alas, this summer it is at flood stage and at its worst: it is not even particularly buoyant.

Following closely behind in national-if not local-interest is the headquarters of the LDS faith. This is located at the center of coordinates-about two miles west of the university. The Visitor's Center is open for almost all the daylight hours (save Sunday). The Mormon Tabernacle is on the grounds, and features an organ, and the Tabernacle choir. There are organ recitals on Monday through Friday at noon, and Saturday and Sunday at 4:00 p.m. The choir has a public rehearsal on Thursday at 8:00 p.m., and a public radio broadcast on Sunday at 9:30 a.m.

There are several attractions which may be of interest to families. There are the Utah Museums of Fine Arts and Natural History on campus. Hogle Zoo is on the very eastern end of the city on Sunnyside Avenue (900 South). North of Hogle Zoo is Pioneer State Park, commemorating the Mormon migration to Utah. Liberty Park, between 500 and 700 East, and 900 and 1300 South, is a pleasant place to walk around or picnic. It contains the Tracy Aviary, as well as a small pond with pedal boats. On State Street just north of 100 South is the Hansen Planetarium.

Salt Lake City lies within one day's drive (an average of 300 miles) of ten national parks (Arches, Bryce Canyon, Canyonlands, Capitol Reef, Grand Canyon, Grand Teton, Great Basin, Mesa Verde, Yellowstone, and Zion's). For

further information, write to the National Park Service, 125 South State, Salt Lake City, UT 84111.

For scenic air tours, contact Interwest Scenic Tours, P. O. Box 22063, Salt Lake City, UT 84122.

Medical Services

The following medical care facilities are located close to the university.

Instacare

Provides quick service walk in care, emergency or otherwise

1355 Foothill Drive

Hours 7 days per week Monday through Sunday

9:00 a.m. to 9:00 p.m.

Telephone: 321-2495

University Medical Center (East of Dormitories)

50 North 18th East

24 Hour a day service

Telephone **Emergency:** 581-2291

Holy Cross Hospital

24 Hour a day service

1045 East 100 South

Telephone **Emergency:** 350-4630

Paramedics

Emergency: 911

LDS Hospital

8th Avenue and C Street

24 Hour a day service

Telephone **Emergency:** 321-1180

Parking

Parking stickers for those participants not residing on campus will be available for purchase at the Meetings Registration Desk for \$1.50 per day or \$4.50 for August 5-8. These stickers will allow parking in all campus lots.

Smoking

Please note that smoking is not allowed in any of the buildings or public areas on the University of Utah campus, except for specially designated areas; for example, certain areas of the cafeterias in the Union building.

Social Event

On Thursday afternoon and evening there will be an outing including buffet dinner and sight-seeing at Snowbird Ski and Summer Resort, at an altitude of 8,100 feet in the Wasatch Mountains about 25 miles from the university campus. This activity is highly recommended for everyone who attends the meeting. Buses, arranged by courtesy of the Department of Mathematics, will leave from Olpin Union Building at 3:30 p.m.-4:00 p.m. and reach the resort in about 45 minutes. (People with automobiles may wish to drive instead. Please check at the Local Information section of the registration desk for driving instructions.) The schedule will enable people to have some time for sight-seeing before the Western Barbecue Buffet is served on the Plaza between 6:00 p.m.-7:00 p.m. (There is a sheltered area in case of rain.) Those who desire may buy tickets on the Plaza to ride the tram to the top of Hidden Peak, at an elevation of 11,000 feet. This is truly a spectacular vantage point from which, on a clear day, forest and mountains can be seen in all directions at distances of at least 50 miles. With time for sight-seeing at the top, about an hour should be planned for this.

People who eat early should have time for the tram ride after dinner. Wildflowers should be in abundance in early August, and there will likely be some lingering snowdrifts. People who do not wish to ride the tram may enjoy the scenery from the Plaza or walk among the nearby mountain streams, trees, and wildflowers. Suitable warm clothing is recommended for this occasion. The first bus will leave the resort at about 7:30 p.m. and the last one at 8:30 p.m. for the return trip to the campus.

The buffet menu includes barbecued chicken and spareribs, five different salads, a relish tray, corn on the cob, baked beans, baked potatoes, chef's selection of vegetables, rolls, butter, two desserts, and soft beverages (Beer can be purchased at the Birdfeeder on the Plaza.) There is no special menu for vegetarians since the above selections suffice; however, one should indicate if a vegetarian meal is wanted to insure that a substantial amount of vegetables will be available. Tickets are \$15 per person for adults and \$9 per person for children (12 years old and younger).

Those planning to attend the outing should purchase their tickets through preregistration, since a guarantee must be given. Interested participants should complete the appropriate section of the preregistration form. In the event of cancellations, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence prior to August 3. After that date, no refund can be given.

Travel (Special Air Fare page XVI)

In August, Salt Lake City is on Mountain Daylight Saving Time. The city is served by most major U.S. airlines; in particular, the hub of Western Airlines (recently merged with Delta). The airport lies about six miles west of downtown Salt Lake. There is regular bus service during daylight hours to downtown at \$1.50. A cab to downtown should cost about \$10, and to the university, it might run about \$14.

For some years now, the AMS-MAA Joint Meetings Committee has engaged a travel agent for the January and August Joint Meetings in an effort to ensure that everyone attending these meetings is able to obtain the best possible airfare. This service is presently being performed by Meetings, Incentives, Conventions of America, Inc. (MICA); their advertisement can be found elsewhere in this meeting announcement. Although any travel agent can obtain Supersaver or other such published promotional fares, only MICA can obtain the special additional 5 percent discount over and above these fares, and the 35-40 percent off regular coach fare. The latter, of course, is financially beneficial only when one does not qualify for one of the promotional fares. Participants should pay particular attention to the cancellation policies stated in the ad. Winners of the two free tickets in San Antonio were David Buchanan and Ramesh Sharma.

If you drive to Salt Lake City you will arrive on I-15 (North or South) or I-80 (East or West). If you are coming from the west, you will intersect I-15 west of the city. Take the 6th South exit and proceed according to the following instructions.

Coming from the north or south on I-15, take the 6th South exit, heading East. If you want to go to

the downtown hotels, turn left on West Temple, and proceed until you see your hotel. If you are heading for the university, proceed along 6th South until you reach 7th East; turn left (north) and proceed to 1st South. Turn right (east) and proceed until you reach University Avenue; then follow the map to your destination.

Coming from the east, you enter the Salt Lake Valley via Parley's Canyon. Take the Foothill Drive exit (old route US 40, now Utah 186) and follow this main artery (which changes name several times) for about seven miles to the university (which will be well marked and lie to the right), or nine miles to the downtown area.

Weather

Salt Lake City lies at an altitude of approximately 4,500 feet at the foot of the Wasatch mountains on the eastern rim of the great basin. The climate is that of a desert: very little humidity, much sunshine, and a large daily variation in temperature. The average high in August is about 88 degrees F, and the low near 60. During the day the sun will be quite warm, but otherwise the weather should be very pleasant. In particular, the evenings could be cool, and some sort of outer wear is advisable. By mid-August the late summer thundershowers begin to come; we could see one during the meeting. This could be a spectacle, but of brief duration. Otherwise, there will be little inclement weather.

SPECIAL AIRFARES 1-800-826-6011

MICA, the official travel management firm for the Joint Mathematics Meeting to be held in Salt Lake City, August 5-8, 1987, has arranged for special discounts aboard American Airlines.

Save 5% off all published promotional fares, meeting all restrictions, or 35-40% off regular roundtrip coach fares, with a 7-day advance purchase.

It is possible to receive an even lower airfare depending on your individual circumstances.

Sample Airfares to Salt Lake City
(Quoted 2/11/87 and subject to change)

Originating City	Coach Fares	Discounted Coach Fares	Discounted Promotional Fares
New York	\$900.00	\$585.00	\$245.00
Chicago	\$740.00	\$444.00	\$207.00
San Francisco	\$518.00	\$310.00	\$188.00

Please Note: The lowest published promotional fares require a Saturday night stay, are subject to an airline change/cancellation penalty, and must be purchased at least 30 days prior to departure.

Make your reservations today! MICA reservationists can obtain the lowest available airfare on any airline, and help you with car rental arrangements.

You may pay by **credit card** or **ask to be invoiced**. We urge you to purchase your airline tickets without delay using your credit card. This will confirm your reservation, the current airfare and protect you against later fare increases.

Remember, these special discounts are available only through MICA's toll-free number.

Call 1-800-826-6011 And Save!
In Connecticut call (203) 678-1040
Monday - Friday, 9:00 am - 5:30 pm E.S.T.

Meetings, Incentives, Conventions of America, Inc./MICA, Inc.
Suite 303, 195 Farmington Avenue
Farmington, CT 06032



Summer List of Applicants

Instructions for Applicant Form on facing page

The form. Forms submitted by job applicants who attend the August meetings in Salt Lake City will be posted. The first impression a prospective employer has of an applicant may be based on the appearance of this form.

The forms should be carefully typed using a fresh black ribbon. The best results are obtained with a carbon-coated polyethylene film ribbon, but satisfactory results may be obtained using a ribbon made of nylon or other woven fabric if suitable care is exercised. It is important that the keys be clean and make a sharp, clear impression. Use a correcting typewriter or correction tape or fluid if necessary. Submit the original typed version only. Hand lettered forms are acceptable if prepared carefully.

The summary strip. Information provided here will be used to prepare a printed list of applicants for distribution to employers. Please supply all information requested, and confine your characters to the boxes provided. Use the codes below. Circled letters identify corresponding items on the form and the strip.

Address forms to the Mathematics Meetings Housing Bureau, P. O. Box 6887, Providence, RI 02940. The deadline for receipt is **June 1, 1987**.

(A) Specialties

AL = Algebra	AN = Analysis
BI = Biomathematics	BS = Biostatistics
CB = Combinatorics	CM = Communication
CN = Control	CS = Computer Science
CT = Circuits	DE = Differential Equations
EC = Economics	ED = Mathematical Education
FA = Functional Analysis	FI = Financial Mathematics
FL = Fluid Mechanics	GE = Geometry
HM = History of Math	LO = Logic
MB = Mathematical Biology	ME = Mechanics
MO = Modelling	MP = Mathematical Physics
MS = Management Science	NA = Numerical Analysis
NT = Number Theory	OR = Operations Research
PR = Probability	SA = Systems Analysis
ST = Statistics	TO = Topology

(B) Career Objectives

AR = Academic Research	AT = Academic Teaching
NR = Nonacademic R&D	NC = Nonacad. Consulting
NS = Nonacademic Supervision	

(H) (I) Duties

T = Teaching	U = Undergraduate
G = Graduate	R = Research
C = Consulting	A = Administration
S = Supervision	IND = Industry
GOV = Government	DP = Data Processing

Location

E = East	S = South
C = Central	M = Mountain
W = West	O = Outside U.S.
	I = Indifferent

(L) U.S. Citizenship Status

C = U.S. Citizen	P = Permanent Resident
T = Temporarily in U.S.	N = Non-U.S. Citizen

Summer List of Applicants
Mathematical Sciences Employment Register
August 1987 Salt Lake City, Utah

(Please see instructions on facing page)

EMPLOYMENT REGISTER FORM FOR MEETING

APPLICANT: Name _____
 Mailing address (include zip code) _____

(A) Specialties _____
 (B) Career objectives and accomplishments
 ACADEMIC: Research, Teaching
 NON-ACADEMIC: Research and Development, Consulting, Supervision
 Near-term career goals _____

 Significant achievements or projects, including role _____

 Honors and offices _____
 Other (e.g., paper to be presented at THIS meeting) _____

 Selected titles of papers, reports, books, patents _____

(C) Degree Year Institution
 _____ _____ _____
 _____ _____ _____
 _____ _____ _____

(D) No. of abstracts, internal reports _____
 (E) No. of papers accepted _____
 (F) No. of books and patents _____

EMPLOYMENT HISTORY:

	Present	Previous	Previous
(G) Employer _____	_____	_____	_____
Position _____	_____	_____	_____
(H) Duties _____	_____	_____	_____
Years _____ to _____	_____ to _____	_____ to _____	_____ to _____

DESIRED POSITION:

(I) Duties _____
 (J) Available mo. ____ /yr. ____ Location _____ Salary _____
 (K) References (Name and Institution) _____

(L) Citizenship _____
 (M) I plan to attend the Summer Meeting yes no

SUMMARY STRIP

Family Name	First Name	Mailing Address
<input type="text"/>	<input type="text"/>	<input type="text"/>
Address (cont'd.)	Address (cont'd.)	State & Zip Code
<input type="text"/>	<input type="text"/>	<input type="text"/>
(B) Career objectives	(C) Highest Degree	(A) Specialties
<input type="text"/>	(C) Yr. (C) Institution	<input type="text"/>
<input type="text"/>	(D) (E) (F) (G) Most recent employer	<input type="text"/>
<input type="text"/>	(J) Available mo./yr.	(L)
(H) Present duties	(I) Desired duties	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

Preregistration and Housing

Preregistration. Preregistration for these meetings **must be completed by June 1, 1987.** All those wishing to preregister must complete the form which appears at the back of this issue and submit it along with the appropriate preregistration payments to the Mathematics Meetings Housing Bureau in Providence by June 1.

Please provide your nickname if you wish this information to be printed on your badge.

Preregistration for the meeting and full payment of room charges is a requirement in order to obtain confirmed residence hall accommodations at the University of Utah through the Mathematics Meetings Housing Bureau.

Checks for preregistration fee, housing payments, and fees for social events should be made payable to the AMS. Canadian checks must be marked for payment "in U.S. funds." The registration fees at the meeting will be 30 percent higher than the preregistration fees listed below:

Joint Mathematics Meetings

Member of AMS, MAA, IIME	\$59
Emeritus Member of AMS, MAA	\$16
Nonmember	\$90
Student/Unemployed	\$16

A \$5 charge will be imposed for all invoices prepared when preregistration forms are submitted without accompanying check(s) for the preregistration fee or are accompanied by an amount insufficient to cover the total payments due. Preregistration forms received well before the deadline of June 1 which are not accompanied by correct payment will be returned to the participant with a request for resubmission with full payment.

A 50 percent refund of the preregistration fee will be made for all cancellations received in Providence no later than August 4, 1987. **No refunds will be granted for cancellations received after that date,** or to persons who do not attend the meetings.

The only exception to this rule is someone who preregisters for the Joint Mathematics Meetings only in order to attend an MAA Minicourse, and is too late to obtain a slot in the MAA Minicourse. In this case, full refund will be made of the Joint Mathematics Meetings preregistration fee, **provided the preregistrant has checked the box** on the MAA Minicourse Preregistration Form that this was his or her intent. Individuals who preregister for both the Joint Meetings and an MAA Minicourse and who intend to attend the Joint Meetings, even if the MAA Minicourse is not available, should, of course, **not** check the box on the MAA Minicourse Preregistration Form. In this case, the Joint Meetings preregistration will be processed and will be subject to the 50 percent refund rule.

Housing. The use of the services offered by the Mathematics Meetings Housing Bureau requires preregistration for the meetings. Persons desiring confirmed residence hall accommodations should complete the Preregistration/Housing Form, or a reasonable facsimile, and send it with payment in full to the Mathematics Meetings Housing Bureau, Post Office Box 6887, Providence, Rhode Island 02940-6887, Telex: 797192, **so that it will arrive no later than June 1, 1987.** (See Housing section of Preregistration/Housing Form.)

Please read carefully the section on **University Housing** before completing the form. Forms sent to the wrong address and thus incurring delay in delivery to the Housing Bureau until after the deadline cannot be accepted. All residence halls reservations with **full prepayment** for room will be confirmed by the Housing Bureau. All reservation requests must be received in writing and be processed through the Housing Bureau in Providence. Please do not contact the university directly. **Telephone requests will not be accepted.**

Housing assignments are made on a first-come, first-served basis, so participants desiring specific types of accommodations are urged to get their housing requests in as early as possible. **Housing requests received after the deadline of June 1 most surely cannot be honored.**

Participants who are able to do so are urged to share a room whenever possible. This procedure can be economically beneficial. The housing form should be fully completed to ensure proper assignment of rooms. Participants planning to share accommodations should provide the name of the person with whom they plan to occupy a room. Each participant should, however, complete a separate Preregistration/Housing Form. Parties planning to share rooms should send their forms together in the same envelope, if possible.

Changes/Cancellations

Please make all changes to or cancellations of residence hall reservations with the Housing Bureau in Providence **before August 4, 1987, in order to receive a 90% refund of housing payment.** After that date, refunds for cancellations or no-shows will equal 90% of the amount paid minus one night's room charge. No cancellations can be made between 5:00 p.m. on Tuesday, August 4, and 4:00 p.m. on Thursday, August 6, after which changes or cancellations may be called in to Penny Pina at the Telephone Message Center number in Salt Lake City. Changes in reservations may be made at any time by notifying the Housing Bureau in Providence.

PREREGISTRATION AND HOUSING FORM, SALT LAKE CITY, UTAH
August 5-8, 1987

MUST BE RECEIVED IN PROVIDENCE NO LATER THAN JUNE 1987
Please complete this form and return it with your payment to
Mathematics Meetings Housing Bureau

P. O. Box 6887, Providence, Rhode Island 02940 - Telephone 401-272-9500, Ext. 290 Telex: 797192

DEADLINES:	Preregistration	June 1
	Residence Hall Room Payments	June 1
	50% Refund on Preregistration	August 4*
	90% Refund on Residence Hall Room	August 4
	50% Refund on MAA Banquet	July 31*
	50% Refund on Snowbird Outing	August 3*

* No refunds after this date.

	REGISTRATION FEES	
	Preregistration (by mail prior to 6/1)	At Meeting
JOINT MATHEMATICS MEETINGS		
Member of AMS, MAA, IIME	\$59	\$ 77
* Student, Unemployed or Emeritus	\$16	\$ 21
Nonmember	\$90	\$117

* All full-time students currently working toward a degree or diploma qualify for the student registration fees, regardless of income. The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include persons who have voluntarily resigned from their latest position. The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more and is retired on account of age from his or her latest position.

1) _____ Nickname for badge: _____
(Please print) Surname First Middle (optional)

2) _____
ADDRESS: Number and street City State Zipcode

3) _____
Address for confirmation of room reservation, if other than above

4) Employing institution _____ Emeritus member () Unemployed ()

5) I am a student at _____ 6) Name of spouse _____ 7) Number of children _____
(List only if accompanying to meeting)

8) Member of AMS () MAA () IIME () Nonmember () (Member discount applies only to members of AMS, MAA, or IIME.) Members of other organizations: AWM () NAM ()

PAYMENT(S) ENCLOSED:

9) Joint Meetings fee \$ _____ 10) MAA 25-year Banquet ticket(s) _____ @ \$17.00 _____

11) Snowbird Outing:
a. Adult ticket(s) _____ @ \$15.00 _____ () Indicate if vegetarian meal is required
b. Children's ticket(s) _____ @ \$ 9.00 _____ () Indicate if vegetarian meal is required

12) FULL PAYMENT for residence hall accommodations enclosed \$ _____

13) TOTAL AMOUNT ENCLOSED FOR 9 through 12 \$ _____ (Make checks payable to AMS; Canadian checks must be marked "In U.S. Funds".) VISA or MasterCard credit cards may also be used for payment.

VISA () MasterCard () Card Number _____ Exp. date _____

Signature (name as it appears on credit card)

- () PLEASE CHECK HERE IF YOU WILL NOT REQUIRE A ROOM
- () PLEASE CHECK HERE IF YOU WILL BE USING A CAR AND WILL REQUIRE A PARKING STICKER
- () PLEASE CHECK HERE IF YOU WILL REQUIRE DAYCARE FACILITIES WHILE IN SALT LAKE CITY
- () PLEASE CHECK HERE IF YOU WILL BE RIDING THE BUS TO SNOWBIRD

Please be sure to complete the section on next page if you will require housing

For office use only:				
Codes:	Options:	Dates:	Residence Hall:	Room Type
Special:		Amount pd:	CC ()	Check ()

PREREGISTRATION/HOUSING FORM

PREREGISTRATION AND HOUSING REQUEST FORM (continued)

(Please read sections on housing and room rates in meeting announcement.)

UNIVERSITY HOUSING SECTION: (Please complete Sections I through IV below.)

NOTE: Full prepayment for room and board is required as noted in Item 12 on the reverse. Please make checks payable to AMS. Canadian checks must be marked "In U.S. Funds". VISA and MasterCard credit cards will also be accepted.

I. Please reserve the following residence hall accommodations and send confirmation to me at address below:

	SINGLE ROOM	DOUBLE ROOM	
		<u>2 persons</u>	<u>1 person</u>
Austin Hall (a/c)	\$ 13.00	\$ 19.00	\$ 9.50
Ballif Hall (no a/c)	\$ 12.00	\$ 17.00	\$ 8.50
Van Cott Hall (no a/c) apartments	\$ 12.00	\$ 17.00	\$ 8.50

Number of nights _____

II. I will arrive on _____ at _____ a.m./p.m. and depart on _____ at _____ a.m./p.m.

I will share a double room with _____ who will arrive on _____

at _____ a.m./p.m. and depart on _____ at _____ a.m./p.m.

Children (5 yrs. and younger using sleeping bag - same rm. as parents) _____ days @ \$5.00 per day = \$ _____

(Children 6 yrs. and older pay adult rate.)

III. ADDRESS FOR CONFIRMATION OF ROOM RESERVATION:

Telephone number: _____
(area code)

IV. TRAVEL INFORMATION:

() I plan to arrive by plane on _____ scheduled to arrive at _____
(airline/flight/number)

airport on _____ at _____ a.m./p.m.

() I plan to drive to the meeting.
(date) (time)

Note: This additional information is being requested in order to assist the university's housing office in planning for heavy arrival times.

FOCUS EMPLOYMENT ADVERTISEMENTS

Rates for FOCUS Employment Ads are:

- 50 words or less: \$25.00
- More than 50 words: \$30.00 per column inch

There is a 15% discount for the same ad in 3 consecutive issues (with contract in advance). An insertion order on institutional letterhead will be considered a contract. Charges will be billed after the **first** occurrence specified in the contract.

Anyone wishing to place an employment ad in FOCUS should write to: FOCUS Employment Ads, Mathematical Association of America, 1529 Eighteenth Street, N.W., Washington, D.C. 20036. Or for more information, call the MAA Washington Office at (202) 387-5200.

The deadline for submission in the September issue is July 27.

Mathematics Faculty Position

Master's Degree or equivalent in mathematics. Applicant must be enthusiastic, versatile and possess the ability to teach a wide range of mathematics courses from the remedial through college level. Previous community college experience preferred. Review of applications will begin on Nov. 10, 1986 and continue until the position is filled. Send letter of application and resume to:

Director of Personnel
**MOHAWK VALLEY
COMMUNITY COLLEGE**
1101 Sherman Drive
Utica, New York 13501

Equal Opportunity Employer M/F.

URSINUS COLLEGE

Anticipated opening, Dept. of Math. and Comp. Sci., Fall 1987. Tenure-track position at the Asst. Prof. level. Ph.D. desired and required for tenure. Salary open. Twelve hours per week teaching load, full range of courses in the mathematical sciences. Good teaching references essential. Standard fringe benefits. Send application and 3 letters of recommendation to John W. Shuck, Chairman, Dept. of Math. and Comp. Sci., Ursinus College, Collegeville, PA. 19426. An Equal Opportunity Employer.

RANDOLPH-MACON COLLEGE Computer Science Department

Randolph-Macon College invites applications for a visiting position beginning in September, 1987. Area of specialization is open, but evidence of strong, general teaching ability in computer science will be necessary. A candidate with a Ph.D. in Computer Science or a closely related discipline is preferred. Candidates with the M.S. in Computer Science will be considered. Salary and rank will be commensurate with credentials and experience. To apply for this position, submit a cover letter, resume, graduate transcripts, and names of three references to John Rabung, Chairman, Department of Computer Science, Randolph-Macon College, Ashland, VA 23005. Randolph-Macon College is an equal opportunity/affirmative action employer.

ALLEGHENY COLLEGE DEPARTMENT OF MATHEMATICS MEADVILLE, PA 16335

Tenure-track positions in an expanding department are available beginning in September 1987. Applicants should have a Ph.D. in mathematics and strong commitments to the teaching of undergraduate students and to continued professional development. Rank and salary are competitive and commensurate with qualifications and experience. Fringe benefits include TIAA-CREF, health and life insurance, full tuition benefits for family, and IBM PC's in faculty offices. There may also be a sabbatic replacement position open to persons with at least a Master's degree and teaching experience.

Screening of applicants will begin December 1, and continue until all positions are filled. Send application, graduate transcripts, and three letters of recommendation to Ronald E. Harrell, Search Committee Chairperson. Early applicants should also indicate whether they plan to attend the Joint Mathematics Meetings in San Antonio. Allegheny College is an Equal Opportunity Employer.

WASHINGTON AND LEE UNIVERSITY LEXINGTON, VIRGINIA 24450

Two tenure-track positions at assistant professor level, at least one in analysis and/or numerical analysis (which will carry the title of Dana Fellow). Ph.D. required. W&L is a private, undergraduate college committed to quality instruction in small classes. Send resume, three letters of reference (one should address teaching experience and potential), and list of graduate courses to Search Committee, Dept. of Mathematics at the address above. Equal Opportunity Employer.

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE BLOOMSBURG UNIVERSITY BLOOMSBURG, PENNSYLVANIA 17815

Two tenure-track positions beginning Fall 1987. Appointment at Assistant or Associate Professor level. Individuals with expertise in computer science or statistics are encouraged to apply. Ph.D. preferred. Salary is competitive, excellent benefits. Normal teaching load is 12 hours per week. Review of applications will begin January 1, 1987 and continue until the positions are filled or May 1, 1987. Participation in Employment Register at annual meeting is planned. Minorities, women and other protected class members are urged to apply. Bloomsburg University is an equal opportunity/affirmative action employer. Send letter, vita, transcripts and three letters of reference to John Riley, Chair, Search Committee.

MATHEMATICS DEPARTMENT ENID, OK 73702

Teach undergraduate courses in a general mathematical sciences program. Must be dedicated to excellence in undergraduate education in a quality church related university. Ph.D. in mathematics or computer science required. Salary dependent upon qualifications and experience. Send resume, transcripts and three letters of reference to Dr. Roy Rakes-traw, Science and Mathematics, Box 2000 University Station, Phillips University, Enid, OK 73702. Applications will be accepted until a suitable candidate is found.

Queens College

1900 Selwyn Avenue
Department of Mathematics and Computer Science
Charlotte, NC 28274

Queens College is seeking candidates for a tenure track position as Assistant or Associate Professor of Mathematics commencing fall, 1987. Qualifications include a Ph.D. in mathematics and superior teaching. Closing date is March 30 or until position is filled. Salary is competitive with generous fringe benefits. Send vita and 3 letters of reference to: Dr. Robert Vogel, Department of Mathematics and Computer Science, Queens College, 1900 Selwyn Avenue, Charlotte, NC 28274. Queens College is an Affirmative Action/EQUAL Opportunity Employer.

MOOREHEAD STATE UNIVERSITY

Mathematics Department
Moorhead, MN 56560

Tenure-track position at rank of assistant or associate professor to begin September 1987. A Ph.D. in mathematics. Preference given to candidates with successful college teaching experience. Duties include teaching undergraduate courses in statistics and mathematics, advising students, and university and departmental committee work. First screening of applications on March 15, 1987—applications accepted until filled. Apply to: Milton Legg, Chair, Mathematics Department. Moorhead State University is an equal opportunity educator and employer.

AUGSBURG COLLEGE
Minneapolis, MN 55454

Dedicated to quality mathematics teaching at exciting liberal arts college in heart of dynamic city? Tenure-track position opens 9/87. Doctorate, general interests preferred. Send letter of intent, resume, and evidence of excellent teaching ability to Larry Copes, Chair, Department of Mathematics. Augsburg is an EOE.

PHILLIPS EXETER ACADEMY
Exeter, NH 03833

Ninth through twelfth coed boarding school anticipates openings in (1) Mathematics through Calculus and (2) Computer Science including Basic and Pascal or (3) some combination of Computer Science and Math or other secondary-school subject.

Elective mathematics courses include probability and statistics, finite mathematics, computer science, linear and abstract algebra, advanced calculus, and differential equations. Computer Science courses include introductory computer, intermediate programming, and Advanced Placement (Pascal).

Applicants should have secondary school or college teaching experience and expect to contribute to other areas of boarding school life. Equal Opportunity Employer. Send resume listing references to John B. Heath, Dean of Faculty, Phillips Exeter Academy, Exeter, NH 03833. (603) 772-4311 Ext. 205.

Mathematics

Tenure-track position(s) for Fall to teach undergraduate Math. Ph.D. in Math or Stat required; prefer background in Computer Math. Open until filled, salary negotiable. Send letter of application, vita, grad transcripts and three recommendation letters to: Personnel, Saginaw Valley State College, University Center, MI 48710. SVSC is EEO/AA.

Mathematics: Tenure track position beginning August 1987. Ph.D. required. Teaching experience preferred. Candidates must be able to teach all standard undergraduate courses. Application deadline: April 20, 1987, or until position filled. Rank and salary dependent upon qualifications. Illinois College is a small, private college in West Central Illinois. Send application, vita and three letters of recommendation to Professor Edgar Franz, Chairman, Department of Mathematics, Illinois College, Jacksonville, Illinois 62650. AA/EOE

Woodberry Forest School
Woodberry Forest, Virginia

Woodberry Forest School has two openings for experienced and enthusiastic mathematics teachers capable of teaching Algebra I through Calculus and possibly computer literacy. Woodberry Forest is a college preparatory boys' boarding school for 360 boys, founded in 1889, located in central Virginia some 35 miles north of Charlottesville. The Mathematics Department is exceptionally strong and offers, in addition to the traditional secondary school curriculum, a full Advanced Placement Program in both calculus and computer science and advanced courses beyond BC Calculus. Salaries and fringe benefits are very competitive. Because Woodberry is a boys' boarding school, part of a teacher's compensation includes housing and meals. All candidates are expected to assist in the supervision of a boys' dormitory (but not necessarily to live in the dorm) and be able to contribute enthusiastically to the athletic program or some other extra-curricular activity. All applicants must be committed to excellence in the classroom and to helping young men grow and develop. Letter and resume to: Mr. Emmett Wright, Jr., Headmaster, Woodberry Forest School, Woodberry Forest, Virginia 22989.

UNIVERSITY OF ILLINOIS AT CHICAGO
MATHEMATICS AND COMPUTER EDUCATION

The Department of Mathematics, Statistics, and Computer Science invites applications for tenure-track, tenured or visiting positions in Mathematics and Computer Science Education.

The Department offers the stimulating environment of a highly rated Mathematics Department along with a strong commitment to the improvement of pre-college education. It currently has a number of successful programs in the area of pre-college mathematics and computer education. These include undergraduate programs for the certification of elementary and secondary teachers; an M.S.T. degree program; a Doctor of Arts program; courses for gifted pre-college students; and extensive teacher in-service and continuing education programs.

The department has received funding to expand and improve these programs and to set up a center for further development of the following activities: research in the teaching and learning of mathematics; study of the impact and applications of new technology such as microcomputers and computer instruction; inservice programs for the enhancement of primary and secondary teachers.

Applicants must have a Ph.D. or a D.A. in Mathematics, Mathematics Education, Computer Science, or related field, an outstanding research and publication record, experience in undergraduate and graduate teaching and previous involvement with teacher education programs. Applications are also invited for visiting positions of 1 or more quarters. Send vita and direct 3 letters of reference to Chairman, Search Committee, Dept. of Mathematics, Statistics, and Computer Science, Univ. of Illinois at Chicago, Box 4348, Chicago, IL 60680. UIC is an affirmative action/equal opportunity employer.

THE UNIVERSITY OF PUGET SOUND

Full-time, tenure-track position; to begin September 1987. Rank/salary open. Teach junior/senior level computer science courses and share in teaching introductory courses. Three courses per semester. Advise students, participate in governance, and continue professional development. Ph.D. in Computer Science/mathematical sciences, and a genuine interest in teaching required. Facilities include VAX-11/780 and several microcomputers. A computer lab with several Apollo workstations is scheduled to open Fall '87. Send interest letter and complete dossier by 4/15/87 to: Computer Science Search, University of Puget Sound, P.O. Box 7297, Tacoma, WA 98407. An Equal Opportunity, Affirmative Action Educator/Employer.

MATHEMATICS POSITIONS UNIVERSITY OF NORTHERN COLORADO

Two full-time, non-tenure track Instructor or Assistant Professor positions. Reemployment may be possible at the discretion of the University. Candidates with a master's degree will be considered for Instructor position while the doctorate is required for Assistant Professor. For either rank, a strong commitment to undergraduate teaching is essential and the qualifying degree in mathematics must be from an accredited institution. Primary responsibility is to teach undergraduate mathematics courses. Some professional activity and service expected.

Deadline for applications and nominations is April 15, 1987 or until filled. Letter of application, resume, transcripts, and three letters of recommendation should be mailed to: Dr. Robert L. Heiny, Department of Mathematics and Applied Statistics, UNC, Greeley, CO 80639.

Positions contingent upon adequate funding from Colorado Legislature and final approval by the Board of Trustees. UNC is an AAEO employer.

Austin Peay State University Clarksville, TN 37044

Two tenure track positions beginning Fall 1987. All specialties will be considered (mathematics or computer science). Doctorate in mathematics, computer science or related field desired. Teaching primarily at undergraduate level with a continuing interest in scholarly activities is expected. Send letter of application, resume, transcripts and three letters of recommendation to: Leon McQueen, Chairman, Dept. of Mathematics & Computer Science. Applications will be considered immediately and will be accepted until the positions are filled. APSU is an AA/EEO Employer.

MATHEMATICS POSITION AVAILABLE Department of Mathematics/Computer Science Eastern Connecticut State University

Department of Mathematics/Computer Science, Eastern Connecticut State University, invites applications for tenure track assistant/associate professor in Mathematics, expertise in applications and/or Computer Science. Ph.D. in Mathematics, verification of success in undergraduate teaching, evidence of scholarly activity required. Duties include undergraduate teaching in mathematics/computer science, advisement of students, departmental committee participation. Send resume, letter of interest, names, addresses and telephone numbers of four references to Dr. J. Sharlow, Chair, Department of Mathematics/Computer Science, E.C.S.U., Willimantic, CT 06226, by May 1, 1987. E.C.S.U. is an Affirmative Action Employer. E.C.S.U. is an institution of moderate size committed to developing programs of the highest quality.

DIVISION OF MATHEMATICS & COMPUTER SCIENCE Northeast Missouri State University Kirksville, MO 63501

Mathematics Several tenure-track and temporary (renewable) positions available August, 1987. Ph.D. required for tenure-track positions. Specialties in applied or computational mathematics, numerical analysis, differential equations or algebra preferred, others considered.

Computer Science At least one tenure-track and one temporary position available August, 1987. Ph.D. or ABD preferred for tenure-track position. Specialties desired are operation systems, programming languages, artificial intelligence and computer graphics but other areas acceptable. Teaching loads average 9-12 hours per semester depending on research activity. Most temporary positions are renewable for two additional appointments. Candidates must have strong commitment to excellence in teaching.

Northeast is a public, statewide university for the liberal arts and sciences with selective admissions and degree programs designed to prepare graduates to enter and compete successfully in strong graduate programs.

Send letter, resume, transcripts of undergraduate and graduate study and three letters of reference to Lanny Morley, Head.

NORTHEAST IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER

Math instructor (tenure track) to teach in a comprehensive community college math program which includes developmental, technical, transfer courses through D.E. and computer programming courses. Master's required. Preference given to those with previous college teaching experience and ability to teach programming languages. Begins August 20, 1987. Contact V.P. Academic Services, Lincoln Land Community College, Springfield, IL 62708 E.O.E.

Computer Science

A tenure track faculty position at an assistant or associate professor level is available at the University of Michigan—Dearborn. Primary responsibilities are in the Computer and Information Science Program. This program is an interdisciplinary program involving mathematics, engineering and business administration faculty. A Ph.D. in computer science is desired. Applicants with master's level training in Computer Science and a Ph.D. in a related discipline are encouraged to apply. The University of Michigan—Dearborn is one of three campuses in the University of Michigan system. It is located in the core of the southeastern Michigan industrial area. Applicants should send a current vita, three letters of recommendation, and official transcripts to: Dr. Roger Verhey, CIS Program Director, Division of Interdisciplinary Studies, The University of Michigan—Dearborn, 4901 Evergreen Road, Dearborn, Michigan 48128-1491. The University of Michigan is an equal opportunity educator and employer and specifically invites and encourages applications from women and minorities.

HAMILTON COLLEGE DEPT. OF MATHEMATICS & COMPUTER SCIENCE CLINTON, NY 13323

Temporary leave replacement position. Rank open, Ph.D. required. Prior teaching experience desirable. Six courses per year at a small, highly selective, 4-year liberal arts college. Excellence in teaching and continued professional activity required. To apply send curriculum vitae and three letters of reference to Larry Knop. Women and members of minorities are encouraged to apply; Hamilton College is an Equal Opportunity Employer.

OLD DOMINION UNIVERSITY

Mathematics and Statistics: One or more tenure track assistant professorships are anticipated beginning August 1, 1987. The department has a strong Ph.D. program and is interested in hiring people who are capable of teaching at both graduate and undergraduate levels. A Ph.D. in mathematics and demonstrated research ability is required. Applications are invited from individuals with research interests in Analysis, Numerical Analysis or Applied Mathematics. Send a vita and three letters of recommendation by April 30, 1987 to: Dr. John Tweed, Department of Mathematics and Statistics, Old Dominion University, Norfolk, VA 23508. Old Dominion University is an affirmative action, equal opportunity institution.

**SOUTHERN ILLINOIS UNIVERSITY
AT EDWARDSVILLE
Chair, Mathematics and Statistics**

Applications and nominations are invited for the position of Chair of the Department of Mathematics and Statistics. Applicants should have a doctorate in Mathematics or Statistics, a record of successful teaching and research in Mathematics or Statistics, strong leadership and communication skills, and a commitment to promoting research, teaching, and other creative activities.

The Department of Mathematics and Statistics is part of the School of Sciences, which includes departments of biology, chemistry, physics, and computer science. At present, the Department has 16 faculty members, 80 undergraduate majors and 40 master's candidates.

The University occupies a beautiful 2600 acre campus in the St. Louis metropolitan area. Current enrollment is approximately 10,000 students, the majority of whom are residents of the area.

Initial screening of candidates will begin May 1, 1987, and continue until the position is filled. The earliest appointment date is September 1, 1987. Rank and salary will be commensurate with qualifications and experience. Send nominations and letters of application to Chair, Search Committee, Department of Mathematics and Statistics, Southern Illinois University at Edwardsville, Edwardsville, IL 62026-1653. SIUE is an Affirmative Action, Equal Opportunity Employer.

CAMERON UNIVERSITY Mathematics Instructor. Temporary position at the rank of instructor or assistant professor for the academic year 1987-88. Teaching assignment will be 13-14 hours in mathematics, computer science, or statistics. This position is contingent upon funding. Minimum qualifications: Master's degree in mathematics, computer science, or statistics. To Apply: Send letter of application, vita, transcripts, and three (3) letters of reference (please include names, addresses and telephone numbers) and any other supporting information. By: May 1, 1987. To: Dr. Loyal Farmer, Chairman, Search Committee, Cameron University, P.O. Box 16356, Lawton, OK 73505. EOE/AA.

COMPUTER SCIENCE: Westminster College invites applications for tenure-track position starting Fall, 1987. Rank and salary open. Ph.D. in Computer Science, or Ph.D. in related area and Masters, or equivalent, in Computer Science. Westminster is a liberal arts college with 4-1-4 program. Dept. of Mathematics and Computer Science seeks individuals who have commitment to excellence in teaching, interest in maintaining modern curriculum in Computer Science and sincere interest in integrating Computer Science program with liberal arts. Send vitae with three letters of reference: Dr. Warren Hickman, Dept. of Mathematics & Computer Science, Westminster College, New Wilmington, PA 16172. Closing date April 15, 1987 or until filled. AA/EEO

WAYNE STATE UNIVERSITY

Several tenure-track positions available for Fall, 1987. Ph.D. required. Higher rank or tenure possible for extremely qualified individuals with established research records and national or international reputation. There is also the possibility of a few lectureships or visiting positions.

Duties for all positions include undergraduate and graduate teaching and research. Demonstrated excellence in both teaching and research is required. Current areas of interest include statistics, algebra, combinatorics, functional analysis, geometry, analysis and topology.

Salary and rank to be negotiated. Applications should include a detailed resume and the names of three academic references. Arranging for letters of reference to be sent directly to the chairman will expedite consideration. Wayne State is an equal opportunity, affirmative action employer and encourages applications from women and minority candidates.

Clarence W. Wilkerson, Jr., Chairman Department of Mathematics Wayne State University Detroit, MI 48202

**MEMORIAL UNIVERSITY OF NEWFOUNDLAND
DEPARTMENT OF MATHEMATICS AND STATISTICS
ASSISTANT PROFESSOR OF PURE MATHEMATICS**

Applications are invited from suitably qualified Algebraists for one tenure track position at the rank of Assistant Professor effective September 1987, subject to the availability of funds. The successful candidate will have primary research interests in classical ring theory, both associative and non-associative, and will have demonstrated ability in teaching and research.

Applicants should submit a complete curriculum vitae and the names of at least three references to:

Dr. Bruce Shawyer, Head
Department of Mathematics and Statistics
Memorial University of Newfoundland
St. John's, Newfoundland, A1C 5S7

In accordance with Canadian Immigration requirements, this advertisement is directed to Canadian citizens and permanent residents.

**MEMORIAL UNIVERSITY OF NEWFOUNDLAND
DEPARTMENT OF MATHEMATICS AND STATISTICS
ASSISTANT PROFESSOR OF APPLIED MATHEMATICS**

Applications are invited from suitably qualified persons for one tenure track position at the rank of Assistant Professor effective September 1987, subject to the availability of funds. The successful candidate will have a doctorate in Applied Mathematics. Preference will be given to persons with research interests compatible with present members of the department. The successful candidate will have demonstrated ability in teaching and research.

Applicants should submit a complete curriculum vitae and the names of at least three references to:

Dr. Bruce Shawyer, Head
Department of Mathematics and Statistics
Memorial University of Newfoundland
St. John's, Newfoundland, A1C 5S7

In accordance with Canadian Immigration requirements, this advertisement is directed to Canadian citizens and permanent residents.

POSITION ANNOUNCEMENT

East Central University
Department of Mathematics
Ada, Oklahoma 74820

Tenure-track position in mathematics beginning in August, 1987. A Ph.D. is preferred. Duties include teaching 27 hours over two semesters of undergraduate mathematics at the freshman through senior levels. Rank and salary will be commensurate with qualifications. Send a copy of graduate and undergraduate transcripts and three letters of recommendation addressed to Dr. Ray Hamlett, at the above address, not later than March 15, 1987. East Central University is an Equal Opportunity, affirmative action employer.

**GRAND VALLEY STATE COLLEGE
ALLENDALE, MICHIGAN**

Tenure-track positions in Mathematics and Computer Science:

MATHEMATICS: Assistant—must have Ph.D. with an emphasis in statistics or mathematics education. Preference given to candidates with strong teaching recommendations.

COMPUTER SCIENCE: Assistant or Associate Professor—must have Ph.D. in C.S. or Information Systems. Preference given to candidates qualified to assist in the development of a graduate program. For each position, duties include teaching, curriculum development, student advising and professional development. GVSC is located just west of Grand Rapids; the second largest metropolitan area in Michigan and offers numerous cultural and recreational opportunities. Cost of living is moderate and quality of life is high. Salary: Commensurate with experience; good fringe benefits. Send complete resume to: Dr. Donald W. VanderJagt, Chairman, Math & C.S. Dept., Grand Valley State College, Allendale, MI 49401. An EO/AA institution.

**ST. MARY'S UNIVERSITY
DEPARTMENT OF MATHEMATICS
SAN ANTONIO, TEXAS 78284**

Tenure-track faculty position in mathematics available. Rank/salary dependent upon qualifications. Ph.D. in mathematics required. Applicants should have the ability/desire to develop a new Bachelor's Degree Program in mathematical sciences incorporating mathematical modeling, statistics, and use of the computer in problem solving. Usual teaching load is 12 hrs/wk. Send application letter, vita and three (3) letters of reference to Bro. D Brisendine, Chairman. Deadline: Feb. 15, 1987; then monthly until May 1987.

UNIVERSITY OF MINNESOTA

Applications invited for up to 3 anticipated mathematics positions at Instructor or Assistant Professor level. One year appointments to begin 16 Sept 1987, possibility of renewal. To teach 7-10 credit hrs/qtr lower division mathematics/elementary statistics. One appointee to teach Methods of Teaching Math in Secondary School. Salary negotiable. Minimum qualifications include M.A. or M.S., strong undergraduate teaching commitment, teaching experience highly desirable. Send application, resume, transcript, 3 recommendation letters by 15 May to: Dr. A. Lopez, Acting Chair, Room 217F, Division of Science and Mathematics, University of Minnesota, Morris, Morris, MN 56267. Late applications will be considered until positions are filled. The University of Minnesota is an equal opportunity educator and employer and specifically invites and encourages applications from women and minorities.

**TENURE TRACK POSITION
ASSISTANT PROFESSOR MATHEMATICS**

NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY, has a tenure track position at the assistant professor level starting no later than January 1, 1988.

Applicants should have an interest in Applied Mathematics (partial differential equations including numerical analysis, preferred) with emphasis on applications. Ph.D. required. The position involves teaching undergraduate and graduate courses, and research. Opportunities for summer research appointments are also available. Interdisciplinary work is strongly encouraged. The Institute is dedicated to excellence in teaching and research. Send application and resume to: Personnel Department, Brown Hall, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801, and have three letters of reference sent to: Dr. Allan Gutjahr, Chairman, Department of Mathematics.

**MANKATO STATE UNIVERSITY
DEPARTMENT OF MATHEMATICS, ASTRONOMY, AND
STATISTICS
MANKATO, MN 56001**

Tenure track faculty position in mathematics available. Rank/salary dependent upon qualifications. Ph.D. in mathematics required. Applications particularly encouraged from areas of algebra, analysis, applied mathematics, mathematics education, and statistics. Applicants must have strong interest in teaching at freshman through graduate levels and show evidence of successful teaching at postsecondary level. Teaching load at most 36 quarter hours per 9 month academic year. Successful candidate will teach courses in mathematics and assist with student advising, serve on various departmental committees, and conduct appropriate research. Open until filled. Send application letter, vita, research and teaching interests, and three (3) letters of reference to F. T. Hannick, Chairperson. AA/EOE

**Department of Mathematical Sciences
Hiram College, Hiram, Ohio**

The department is soliciting candidates for a tenure-track position in mathematics. Some experience in statistics and/or computers is desired, but not required. Candidates should have a Ph.D. in mathematics or statistics and should be committed to undergraduate teaching. The usual fringe benefits are available and the salary will depend upon background and experience. Write: Dr. Oberta Slotterbeck, Department of Mathematical Sciences, Hiram College, Hiram, OH 44234.

**The University of Scranton
Dept. of Mathematics/Computer Science**

The University of Scranton is a Jesuit university with over 3500 undergraduates. At least one tenure-track position is available in Fall 1987 for faculty interested in a teaching environment. Individuals with expertise in any area of mathematics or computer science will be considered. Research is encouraged and supported through a strong faculty development program. Rank and salary are open and competitive. The department currently has 19 full-time faculty and about 400 majors. The University has a campus-wide commitment to computing including a faculty PC purchase program. Submit a vita, transcripts and three references to: Mathematics/Computer Science Search Committee, University of Scranton, Scranton, PA 18510 or phone (717) 961-7774.

An AA/EO Employer and Educator

MATHEMATICAL SCIENCES POSITIONS

The Department of Mathematical Sciences at Salisbury State College expects openings for the Fall of 1987. A strong commitment to the mathematical sciences point of view and good teaching recommendations are essential. A Ph.D. is required for tenure-track positions. Candidates with knowledge of experimental design and survey sampling are encouraged to apply. Those interested in a temporary or visiting position are also invited to apply.

Salisbury is a small city in a rural area, close to ocean beaches and the Chesapeake Bay.

Send letter of application, resume, and three letters of recommendation to:

Search Committee
Department of Mathematical Sciences
Salisbury State College
Salisbury, Maryland 21801

Equal Opportunity/Affirmative Action Employer

SANTA CLARA UNIVERSITY Department of Applied Mathematics Santa Clara, CA 95053

Tenure-track position is available beginning September 1987. The Department of Applied Mathematics is in the Graduate School of Engineering and offers the master's degree in Applied Mathematics and mathematics courses required in the other master programs offered in the Engineering School. The department offers three undergraduate courses: differential equations, probability and statistics, and numerical methods. The candidate will be expected to teach both graduate and undergraduate classes. Qualifications: Ph.D. (preferably in Applied Mathematics), evidence of excellence in teaching and an interest in research. Salary and rank commensurate with qualifications and experience. Send vita and names of three references to: Dr. Gerald E. Markle, Department of Applied Mathematics, School of Engineering, Santa Clara University, Santa Clara, CA 95053. SCU is a Jesuit University and an affirmative action/equal opportunity employer.

LAFAYETTE COLLEGE Easton, Pennsylvania 18042

Possible one-year visiting position. Instructor (near-Ph.D.) or assistant professor (Ph.D.) to teach undergraduate mathematics. Teaching load is 3 courses per semester. Liberal arts and engineering in a small (2000) college close to Philadelphia and New York City. Salary competitive (1986 AAUP salary rating 1* in all ranks). Send resume, 3 reference letters, and telephone numbers (office and home) to Chair, Mathematics Search Committee. An Equal Opportunity Employer.

One year leave replacement, Mathematics. Teach introductory and advanced undergraduate mathematics courses. Master's required; further training preferable. Teaching experience desirable. Salary dependent on training and experience. Send vita and three letters of reference to: Dr. Stanley Caine, Vice President for Academic Affairs, Hanover College, Hanover, Indiana 47243.

Math/Computer Science

Adams State College announces a regular track vacancy in math/computer science starting 8/27/87. Teach intro and advanced math and intro computer science courses. M. A. in mathematics with formal coursework in computer science required. Successful experience in teaching math and computer science courses preferred. Desirable attributes include familiarity with 8088/8086 family of computers, high levels of energy, and teaching enthusiasm. Send letter of application, resume including citizenship status, official copies of all transcripts, and 3 letters of reference to Ron Loser, Adams State College, Alamosa, CO 81102. Complete applications will be considered beginning April 3, 1987, and continue until vacancy is filled.

POSITION OPENING: LECTURER IN COMPUTER SCIENCE

An individual is sought who can teach undergraduate Computer Science courses, aid researchers in Mathematical Modeling in software development and manage an ethernet network of workstations running the UNIX operating systems. MINIMUM QUALIFICATIONS: Bachelor's in EEE, Master's in Computer Science and 1 year experience maintaining computer equipment. Teaching experience preferred. CLOSING DATE for applications—postmarked by May 1, 1987. SALARY range is \$20,000-\$25,000 depending on qualifications. Send applications (including a complete vitae) to: William Perrizo; C.S. Dept.; Box 5075; NDSU; Fargo, ND 58105;(701) 237-7248 NDSU is an equal opportunity-affirmative action employer.

OPENING IN TEACHER PREPARATION PROGRAM DEPARTMENT OF MATHEMATICS UNIVERSITY OF ARIZONA TUCSON, ARIZONA 85721

The Department of Mathematics at the University of Arizona is seeking a person whose major contributions will be to the Department's teacher preparation program and to the enhancement of mathematics teaching at the precollege level. This tenured or tenure-track position will begin in the Fall of 1987. An interested candidate should send a letter and a resume plus a list of at least three references to Head, Department of Mathematics. The resume should include evidence of the candidate's involvement in projects related to the preparation for and nurturing of the teaching of mathematics at the pre-college level. The closing date for applications is April 1, 1987, or whenever the position is filled. The University of Arizona is an Equal Opportunity/Affirmative Action Employer.

Midwestern State University has a tenure-track position for an Assistant or Associate Professor of Computer Science beginning September 1, 1987. Applicants should have a Ph.D. in Computer Science. Applicants holding a Ph.D. in an associated field (Mathematics, Statistics, Operations Research, etc.) and a Master's degree in Computer Science will be considered. Applicants should have a commitment to excellence in teaching. Successful candidate will teach courses in undergraduate and graduate Computer Science, assist with student advising, serve on various departmental committees and participate in curriculum development activities. Compensation is competitive. Applicants should send a resume and three letters of recommendation to Dr. S. B. Carpenter, Computer Science Dept., Midwestern State University, Wichita Falls, Texas 76308.

HAMILTON COLLEGE
Dept. of Mathematics & Computer Science
Clinton, NY 13323

Two-year tenure track position. Ph.D. required; three years prior teaching experience desirable. Six courses per year at a small, highly selective, 4-year liberal arts college. Excellence in teaching and continued scholarly activity required. To apply send curriculum vitae and three letters of reference to Larry Knop, Chair. Women and members of minorities are encouraged to apply; Hamilton College is an Equal Opportunity Employer.

ILLINOIS BENEDICTINE COLLEGE
MATHEMATICAL SCIENCES DEPARTMENT
LISLE, ILLINOIS 60532

Illinois Benedictine College invites applicants for a tenure-track position in mathematics for fall, 1987. Applicants should hold the Ph.D. in mathematics. Interest in research and teaching preferred in areas related to modern algebra, number theory, geometry. Summer teaching available under separate contract.

Illinois Benedictine College is a selective, liberal arts, coeducational college with 40 math majors and five full time faculty. Contact Phyllis M. Kittel, Ph.D. 312-960-1500 extension 561.

CONNECTICUT COLLEGE
NEW LONDON, CONNECTICUT

We invite applications for an Assistant Professorship from individuals committed to scholarship and teaching. Connecticut College is a very selective, coeducational, private, liberal arts institution (1600 students) located on Long Island Sound, midway between New York City and Boston. Two-year renewable appointment. Ph.D. required. Teaching comprises introductory and advanced courses in mathematics and some computer science. Send resume and 3 letters of recommendation to: E. C. Schlesinger, Acting Chairperson, Mathematics Department, Box 1566, Connecticut College, New London, CT 06320. Women and Minorities are encouraged to apply. Equal Opportunity Employer.

THE WESTMINSTER SCHOOLS
ATLANTA, GA

Faculty position, Mathematics Department, September, 1987. Qualifications: at least a Masters Degree in Math/Math Ed., several years of teaching experience, capability of teaching Algebra I through Calculus in a strong department of 20, flexibility to adapt to a rigorous and demanding honors program, outstanding classroom teaching ability, commitment to working in the entire school community. Westminster is a Christian college preparatory school with 1680 students (K-12). Founded in 1951, Westminster gives the above average young person an education of highest quality in all dimensions. Applications available from: Ruthanna Bost, Westminster Schools, 1424 W. Paces Ferry Rd. NW, Atlanta, GA 30327.

UNIVERSITY OF NORTH DAKOTA
Department of Mathematics
Grand Forks, North Dakota 58202

Applications invited for tenure-track position at Assistant Professor level starting 8/16/87. Areas considered are statistics or math education. Ph.D. in Statistics (or Mathematics with stat concentration) or Math Education is required. Must possess strong commitment to teaching and an interest in research. Teaching load is three courses per semester. Salary competitive. Open until filled. Send resume, copy of transcripts and three names of reference to Selection Committee. UND is an AA/EOE.

INSTRUCTOR
WRIGHT STATE UNIVERSITY
DEPARTMENT OF MATHEMATICS AND STATISTICS
DAYTON, OHIO 45435

Several instructorships are anticipated for Fall 1987. These are one year non-tenure track positions which may be renewed annually for up to five years. These positions offer competitive salaries and excellent benefits. The teaching load is 12-15 contact hours per quarter, mainly in service courses. Masters degree in mathematics or statistics required. Previous full-time teaching experience preferred. Please send resume, graduate transcript(s) and three letters of reference to: Faculty Search Committee. Closing date: April 1, 1987, then every two weeks until selection or August 1, 1987. WSU is an AA/EOE.

MEMBERSHIP OFFER ON NEXT PAGE

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THE MATHEMATICAL ASSOCIATION OF AMERICA

January 23, 1987

BYLAWS OF THE MATHEMATICAL ASSOCIATION OF AMERICA (INCORPORATED)

Article I—Name, Purpose and Corporate Seal

1. This organization shall be known as
**THE MATHEMATICAL ASSOCIATION OF AMERICA
(INCORPORATED)**
2. Its object shall be to assist in promoting the interests of the mathematical sciences in America, especially in the collegiate field, by holding meetings in any part of the United States or Canada for the presentation and discussion of mathematical papers, by the publication of mathematical papers, journals, books, monographs, and reports, by conducting investigations for the purpose of improving the teaching of mathematics, and by cooperating with other organizations whenever this may be desirable for attaining these or similar objects.
3. The Corporate Seal of the Association shall have inscribed thereon the name of the Association and the words "Corporate Seal—Illinois."

Article II—Membership

1. There shall be two classes of members: individual and institutional.
2. Any person interested in the field of collegiate mathematics shall be eligible for election to individual membership in the Association.
3. Any institution, academic or corporate, interested in the support of collegiate mathematics shall be eligible for election to institutional membership in the Association.
4. Election to membership shall be by vote of the Board upon written application from the individual or institution seeking admission. In the case of individuals qualifying for student dues, the application shall be endorsed by two individual members of the Association.

Article III—Board Of Governors and Officers

1. The Officers of the Association shall be a President, a President-Elect (only during a year immediately prior to the expiration of a President's term), a Past-President (only during a year immediately following the expiration of a President's term), a First Vice-President, a Second Vice-President, a Secretary, and a Treasurer.
2. There shall be a Board of Governors (herein called "the Board") to consist of the officers, the ex-presidents for terms of six years after the expiration of their respective presidential terms, the Editor of each of its three publications entitled THE AMERICAN MATHEMATICAL MONTHLY, THE COLLEGE MATHEMATICS JOURNAL, and MATHEMATICS MAGAZINE, the members of the Finance Committee, and additional elected members (herein called "Governors"). It shall be the function of the Board to supervise all scholarly and scientific activities of the Association, to administer and control these activities, and to authorize expenditures of funds of the Association.
3. There shall be an Executive Committee of the Board consisting of the Officers of the Association and a current journal editor. It shall be the function of this Committee to review continually the policies and activities of the Association, to plan and organize new activities, to formulate in broad outline the programs of meetings and of publications, and in general to consider all matters of importance or interest to the Association. This Committee shall prepare the agenda for meetings of the Board and shall analyze the implications and aspects of all matters which are to come before the Board for decision. It shall

present to the Board the viewpoints suggested by such analyses, as well as all such facts as may seem pertinent or as may in any way facilitate the Board's work.

4. At all meetings of the Board of Governors a quorum shall consist of not less than 25 percent of the membership of the Board, and no business may be validly transacted at a meeting at which less than a quorum is present.

5. There shall be a Finance Committee responsible to the Board; at the direction of the Board it shall receive and administer the funds of the Association, control its properties and investments, make its contracts, and exercise such powers as may be delegated to it by the Board. This Committee shall consist of six members including the President, the Secretary, the Treasurer, the President-Elect or the Past-President, and two members-at-large.

6. The Board shall hold a meeting each year immediately preceding the annual business meeting of the Association. Other meetings of the Board may be held from time to time at the call of the President or of any six (6) members of the Board.

7. Notice of all meetings of the Board shall be given by the Secretary to each member of the Board at least fifteen (15) days prior to the date set therefor.

8. A member of the Board may waive notice with the same effect as if due notice had been given.

9. The Board may refer a matter to a referendum mail vote of the entire membership and shall make such reference if a referendum is requested, prior to final action by the Board, by three hundred or more members. The taking of a referendum shall act as a stay upon Board action until the votes have been canvassed, and thereafter no action may be taken by the Board except in accordance with a plurality of the votes cast in the referendum.

Article IV—Elections, Appointments, Terms of Officers and Members of the Board

1. (a) The membership at large shall elect biennially a President-Elect for a term of one year, a First Vice-President for a term of two years, and a Second Vice-President for a term of two years. The President-Elect shall become President for a two-year term at the expiration of the one-year term as President-Elect and shall become Past-President for a one-year term at the expiration of the term as President.

(b) The membership in each Section shall elect triennially a Governor for a term of three years beginning July 1. For these elections at least two nominations shall be submitted to the members by a committee appointed for that purpose by the Chairman of the Section. A Governor who has moved his or her place of employment from the Section by which he or she was elected shall be considered to have ended his or her term of office on the Board.

(c) The Board shall elect annually two Governors for terms of three years and at appropriate times by ballot and for terms stated: an Editor of THE AMERICAN MATHEMATICAL MONTHLY, an Editor of THE COLLEGE MATHEMATICS JOURNAL, an Editor of MATHEMATICS MAGAZINE, a Secretary, and a Treasurer each for five years, and two members-at-large of the Finance Committee for four years. In even-numbered years the Board shall elect one of the current editors to be a member of the Executive Committee for a two-year term beginning on January 1 of the next year.

(d) The beginning and end of the term of every officer and member of the Board (except as provided in Section (b) of this Article) shall occur at the adjournment of the annual business meeting. All officers and members of the Board shall hold over until their respective successors have been duly elected or appointed and qualified.

(e) The President shall be ineligible for reelection as President-Elect or as President. The Vice-Presidents, the Editors, and the Governors shall be eligible for reelection only after an interim

equal to their respective terms of office except that Governors having served less than a year and a half shall be eligible for reelection for a term of three years.

(f) The Board shall have authority to fill vacancies *ad interim* in any office, including vacancies in the Board, and to make any other appointments necessary for the transaction of business of the Association.

(g) Elections by the Board shall be made from nominations by the Executive Committee. At least two nominations shall be made for each office to be filled in the case of Governors (except Sectional Governors) and members of the Finance Committee. The Board may make additional nominations.

2. (a) For each odd-numbered year there shall be a Nominating Committee appointed by the President with the approval of the Board. Its duties shall include preparation of slates and ballots for general elections by the membership of the Association. The Nominating Committee shall consist of five members appointed for one-year terms. Where possible, exactly two of its members shall be selected from those who served on the preceding Nominating Committee.

(b) For the general election the Nominating Committee shall prepare printed ballots with five or more nominees for President-Elect and three or more for each other office to be filled by the members. Blank spaces on the ballot shall be provided for write-in votes. Each voting member of the Association may vote for as many candidates for each office as he or she desires. This ballot shall be mailed to the membership approximately eight months before the annual meeting and the voting shall close four months prior to the annual business meeting. For each office, the Nominating Committee shall declare elected the person having received the most votes and been determined by the Nominating Committee to be willing and able to serve. In the case of ties, the Nominating Committee shall make the selection from among those tied.

3. The President shall be the Executive Officer of the Association, shall preside at all meetings of the Board of Governors and at the annual business meeting of the Association, shall be Chairman of the Executive Committee and of the Finance Committee; and shall have the usual duties pertaining to the office and such other duties as may from time to time be assigned by the Board of Governors.

4. In the absence of the President, the First Vice-President (or in his or her absence the Second Vice-President) shall have and exercise the powers of the President, except that the Past-President shall preside at meetings of the Finance Committee (or in his or her absence the senior member, in terms of service on the Committee, of the two elected members of the Finance Committee). The Board of Governors may assign to the Vice-Presidents such duties as may from time to time be determined.

5. The Secretary shall have the usual duties pertaining to the office, including the custody of the records of the Association and of its Corporate Seal, the keeping of minutes of the meetings of the Board of Governors and of the annual business meeting and special meetings, and the giving of due notice of all regular and special meetings of the Association and of the Board of Governors. The Secretary shall also have the duty of seeing that whenever Governors are elected, including the election of Governors to fill vacancies, a Certificate, under the Seal of the Association, giving the names of those elected and the terms of their office, shall be recorded in the Office of the Recorder of Deeds for Cook County, Illinois. Such Certificates shall be signed by the Secretary and verified by oath of the President.

6. The Treasurer shall have the usual duties pertaining to the office including the collection of dues and the supervision and safekeeping of the funds of the Association.

7. (a) There shall be an Executive Director who shall be a paid employee of the Association. The Executive Director shall have

charge of the central office of the Association and shall carry out such other duties as may be assigned to him or her by the Board. The Executive Director shall be responsible to the Board and shall attend meetings of the Board, the Executive Committee, and the Finance Committee, except when they meet in executive session, but shall not be *ex officio* a member of these bodies. The Executive Director shall be especially responsible for implementing and coordinating Section activities.

(b) The Executive Director shall be elected by the Board under terms and conditions of employment fixed by the Finance Committee.

8. The Association shall, to the extent allowed by law, indemnify any member or former member of the Board of Governors or any other committee of the Association against expenses (including attorneys' fees), judgments, fines and amounts paid in settlement actually and reasonably incurred by such member in connection with the defense of any action, suit, or proceeding in which he or she is made a party by reason of having been made a member and having acted in good faith as a member of the Board of Governors or other committee. The Association may purchase and maintain insurance on behalf of such member to provide for indemnifying him or her against such liabilities.

Article V—Business Meetings of the Association

1. A business meeting of the Association shall be held annually, at such time and place as the Board may direct. Other business meetings of the Association may be called from time to time by the Board or by the President of the Association to be held at such time and place as may appear from the call.

2. Notice of any business meeting of the Association shall be given by the Secretary to each member of the Association at least thirty (30) days prior to the date set for each meeting.

3. Any member of the Association may waive notice with the same effect as if due notice had been given.

4. At all business meetings of the Association a quorum shall consist of not less than fifty (50) members and no business may be validly transacted at a meeting at which fewer than a quorum are present.

Article VI—Sections

1. In the interest of more effective promotion of the objectives of the Association on a local level, the United States, Canada and their possessions shall be subdivided by the Board of Governors into non-overlapping geographical areas, and a Section of the Association shall be established in each of these areas. The subdivision into non-overlapping areas may be changed by the Board, upon recommendation by the Committee on Sections (see paragraph 7).

2. Each member of the Association residing in the United States, Canada or their possessions shall belong to one and only one Section.

3. Each Section shall adopt a set of Bylaws which, along with any subsequent changes, must be approved by the Board. The geographic area covered by a Section shall be described in the Bylaws for the Section.

4. If there are members of the Association residing in a geographic area in which no Section has been organized, any ten or more members of this Association residing or employed in this area may petition the Board for authority to organize a Section covering that area.

5. A group of not less than twenty-five members of an existing Section may petition the Board to partition the area and the Section into two or more Sections. The Board shall have the authority to approve or deny this petition. The Board may specify conditions under which such action may be accomplished. It may conduct a poll of some or all members of the Association in the Section to determine the advisability of allowing the pro-

posed partition of the Section. If separate Sections are approved then each new Section must prepare its own set of Bylaws to be approved by the Board.

6. A group of not less than twenty-five members residing or employed in that part of the area of an existing Section which they desire to become part of another existing Section may petition the Board to redefine the geographic boundaries of the Sections affected. The Board shall have the authority to approve or deny this petition. It may conduct a poll of some or all members of the Sections involved to determine the advisability of permitting such action.

7. There shall be a standing Committee on Sections through which the Board shall maintain general supervision over the activities of all Sections. This Committee, in particular, shall study all matters involving creation of Sections or modification of boundaries of Sections and make appropriate recommendations to the Board.

8. The Association shall not be obligated to pay from its treasury any of the expenses of a Section except as the Board may provide.

Article VII—Publications

1. The Association shall publish one or more journals.
2. The Board shall have full control of the publication and sale of each journal, and of all other publications.
3. There shall be appointed by the Board a body of Associate Editors for each journal.
4. The Board shall from time to time, as the need arises, make special provisions for the management of any other publications.
5. The Board shall fix the price of each journal. The prices for other publications of the Association shall be determined by the Finance Committee.

Article VIII—Dues

1. The Board shall establish the annual dues and privileges of membership for individual and institutional members. The dues of individual members shall include a subscription to one or more of the Association's journals.

2. All dues shall be payable on the first of January of each year. Should the annual dues of any member remain unpaid beyond a reasonable time, that member shall be dropped from the list after due notice.

3. New members entering the Association after April 1 of any year may have their dues prorated for the balance of the year, except when they desire to receive the full current volume of a journal.

4. Any individual member who because of age is no longer in active service, who is in good standing at the time of retirement, and who has been a member of the Association for twenty years, may upon notifying the central office of said retirement, be exempt from the payment of dues, while retaining all of the privileges of membership except receipt of journals. Such a member may elect to receive one or more journals at an annual cost of one half of the dues paid by a regular individual member receiving the same journals.

Article IX—Financial Administration

1. The deposit, investment, and disbursement of all funds shall be subject to the direction of the Board. The Executive Director shall be custodian of the current operating funds. The Treasurer shall be responsible for the control and administration of all investment funds; endowment, trust, and gift funds; and such other funds as the Board may designate.

2. All incoming funds shall be received by the Executive Director, entered in the Association's books, and deposited or invested as shall have been prescribed by the Finance Committee. The Executive Director shall keep proper accounts of all financial

transactions of the Association. The accounts of the Association shall be audited annually by a certified public accountant.

3. The Board shall annually adopt a budget allocating funds of the Association for the purpose of carrying out the objectives of the Association.

4. The Executive Director, the President, and the Treasurer are empowered and authorized to enter into contracts for the Association that have been approved by the Board or the Finance Committee acting between meetings of the Board, or that are required for the conduct of the Association's activities specifically provided for in the approved annual budget.

5. Checks drawn on the accounts of the Association shall bear the signature of any one of several individuals whom the Finance Committee shall have authorized to sign checks on behalf of the Association.

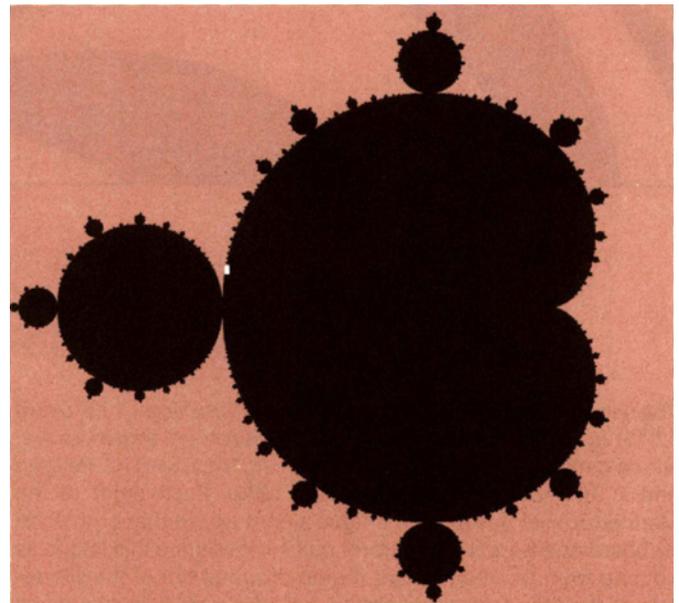
6. The fiscal year of the Association shall be from January 1 through December 31.

7. There shall be an Investment Committee, a subcommittee of the Finance Committee. The Investment Committee shall make recommendations to the Finance Committee on the investment of the Association's funds and on financial questions. The securities of the Association may be bought, sold, or exchanged upon the oral orders of members of the Investment Committee who have been given this authority by the Investment Committee.

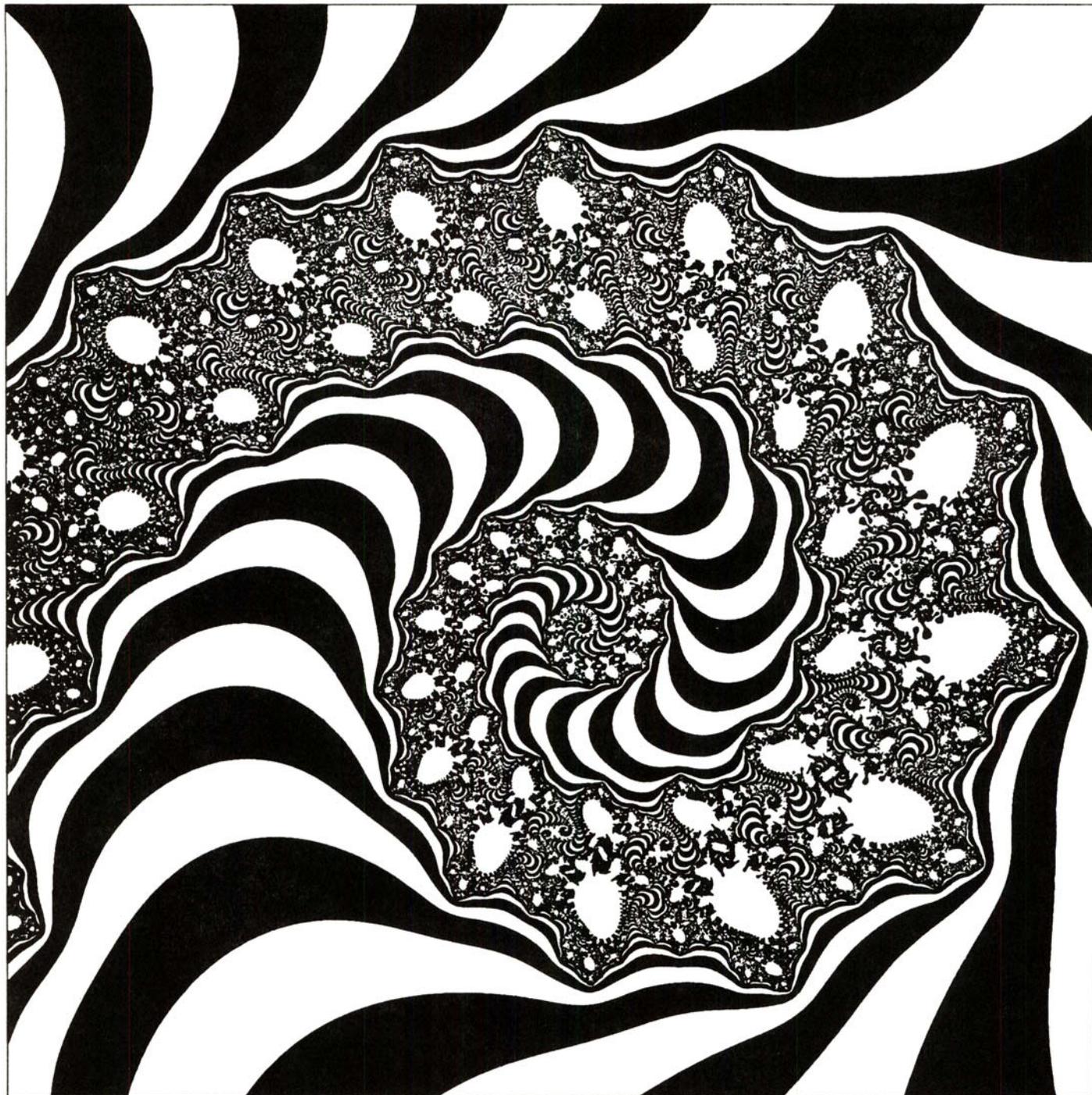
Article X—Amendments to the Articles of Association and Bylaws

1. Changes in the Articles of Association or amendments to the Bylaws may be made at any annual business meeting of the Association, or at any adjourned session thereof, or at any special meeting of the Association called for such purpose, by a two-third (2/3) vote of those present and entitled to vote; *provided* that due notice concerning such amendment shall have been mailed to each member at least one (1) month before the date of such meeting. The Secretary shall give such due notice when so instructed by a vote of the Board of Governors or when so petitioned by at least one hundred members of the Association.

2. No changes in the Articles of Association or amendments to these Bylaws shall have legal effect until a certificate thereof, verified by oath of the President and under Seal of the Association, attested by the Secretary, shall be recorded in the office of the Recorder of Deeds for Cook County, Illinois.



Silhouette of the Mandelbrot set. Dropped out rectangle shows the general location of the spiral detail. See page xxxii for detail.



**MATHEMATICS AWARENESS WEEK: APRIL 12-18, 1987
THEME: THE BEAUTY AND CHALLENGE OF MATHEMATICS**

The second image for Mathematics Awareness Week 1987 (April 12-18) is the spiral detail of the Mandelbrot set shown above, which comes from *THE BEAUTY OF FRACTALS* by H.-O. Peitgen and P. H. Richter (Springer-Verlag, 1986). Each point of the Mandelbrot set has its own unique signature, so that both John Hubbard and Benoit Mandelbrot quickly identified this image as coming from the rectangular region dropped out of the silhouette of the Mandelbrot set shown on page xxxi (see also maps 41, 42, 43, 100, and 101 in the Peitgen and Richter book).

The complement of the Mandelbrot set consists of parameter points μ for which iterates of a certain quadratic polynomial carry the point zero off to infinity (see *FOCUS*, Volume 6, Number 4, page 4). The zebra stripes are contour lines indicating how rapidly zero is carried away to infinity by these iterations.

Approval Voting (continued from page 2)

son acceptable (a fact that would certainly have benefited his political career had it become widely known). In our own organization, this kind of information would be useful to the next nominating committee.

The mathematical problem in deciding how to vote is to maximize some numerical function. A reasonable procedure is to assign "utility" ratings to the outcomes. The difference between any two ratings represents the value of electing the better candidate instead of the worse one. Given these ratings, you vote to maximize your expected utility (with respect to some simple probability assumptions). A standard device for assigning values is a scale of 0 to 10.

Remember: you assign these ratings *in your mind only*—to decide whom to vote for. In the actual balloting, you just say *yes* for some of the candidates and *no* for the rest.

Say there are three candidates, *A*, *B*, and *C* and that you rate *A* 8 and *C* 3. If you rate *B* 4, then presumably you will vote only for *A*. On the other hand, if you rate *B* 7 you are likely to vote for both *A* and *B*. These intuitive conclusions suggest the general procedure: *To maximize your expected utility, vote for those and only those candidates whose ratings exceed the arithmetic mean.* (See [1, pp. 84-85] and [2].)

The idea of voting for more than one candidate as in the second example may take some getting used to, since you run the risk of contributing to the defeat of your favorite at the hands of a lesser choice. Nonetheless, this lesser choice is an acceptable candidate, so you will still be gratified, even if not maximally happy; moreover, you increase the likelihood of defeating the knave, and in that event you end up pleased rather than miserable.

Because only the *relative* ratings count, the results are not always that intuitive. If your ratings of *A*, *B*, *C* are 5, 1, 0, then you vote only for *A*. But if they are 5, 4, 0, you vote for both *A* and *B*, despite your poor opinion of *B*. Note that these examples are a translation of earlier ones.

SENSITIVITY OF APPROVAL VOTING Voters should be aware of the consequences of making their choices by whim. Consider the 1980 race, under approval voting. Conceivably, some Reagan or Carter supporters who thought little of Anderson would include a vote for him anyhow, with the idea that a few extra votes his way might be a good thing, and that this is safe since of course he couldn't possibly be elected; if enough voters were to reason that way, he *would* be elected.

Similarly, suppose there are three candidates of whom two are outstanding. Suppose the third is a person you believe is not yet ready for the office but whom you decide to vote for as a means of encouragement (in addition to voting for your favorite). If enough voters reason that way, you will elect that person *now*.

MORE ABOUT SENSITIVITY The sensitivity to cut-off choices has been portrayed by Saari and Van Newenhizen [4] in the following dramatic fashion: A modest set of voters can rank the *n* candidates so as to produce *any one* of the *n!* possible rankings in the election, depending on how the voters select their cut-off points. (Of course, only the winner of the election will be known, not the ranking of the candidates.) Thus, if the voters are impulsive in making these choices, even when they hold fast to their rankings, the results of the election will be random.

Here is a simple construction, employing only $n(n - 1)$ voters. They represent all combinations of 1st and 2nd choices and do not vote beyond the 2nd choice. The case $n = 4$ is sufficiently illustrative. The accompanying table lists the rankings of candidates *A*, *B*, *C*, *D*, with the irrelevant 3rd and 4th choices represented by dashes. The table also shows a particular voting pattern, votes received being shown in color; for example, candidate *A* receives three first-choice votes and three second-choice votes. The outcome of this election is the ranking

(A B --)	(B A --)	(C A --)	(D A --)
(A C --)	(B C --)	(C B --)	(D B --)
(A D --)	(B D --)	(C D --)	(D C --)

A-B-C-D, by a vote of 6-5-4-3. By symmetry, we get any of the other 4! rankings. (To get the reverse ranking, reverse all the decisions on the 2nd-choice vote.) If the voters decide at random whether or not to include their second choices (because their feelings are not strong one way or the other), then a random outcome truly reflects these feelings. If the voters vote that way out of carelessness, then I suppose they deserve what they get.

REMARKS No voting system can be entirely free of anomalies (Arrow's impossibility theorem). Social scientists are therefore limited to balancing one set of criteria against another. In recent years, voting systems have been subjected to intensive mathematical analysis, and the deficiencies of the usual plurality system of voting have been well documented. While opinion differs about what should replace it, the case for approval voting in choosing one winner from several candidates is very strong. Other organizations that have adopted approval voting include the United Nations Security Council, for electing the Secretary-General; the Econometric Society, to elect its Fellows; sections of the National Academy of Sciences, in their final balloting; and a number of universities, for choosing their presidents. The North Dakota Senate has just passed a bill 2-to-1 to adopt approval voting in certain state elections. Part of the attractiveness of the method lies in its simplicity: the rankings are not weighted; no votes are transferred, as in proportional representation schemes; and there are no runoffs to contend with.

The definitive work on approval voting is Brams and Fishburn [1]; it is highly technical except for the first chapter, which is a low-key, expository overview. Straffin [5] is an engaging introduction to voting questions in general. Your liberal arts students will enjoy Rolf [3, Chapter 11].

Bibliography

- [1] Brams, Steven J., and Peter C. Fishburn, APPROVAL VOTING, Birkhauser, 1983
- [2] Merrill, Samuel, III, Approval Voting: A "Best Buy" Method for Multicandidate Elections?, MATH. MAG. 52 (1979), 98-102
- [3] Rolf, Howard L., MATHEMATICS, Allyn and Bacon, 1982
- [4] Saari, Donald G., and Jill Van Newenhizen, THE CASE AGAINST BULLET, APPROVAL AND PLURALITY VOTING, International Institute for Applied Systems Analysis, February 1985
- [5] Straffin, Philip D., Jr., TOPICS IN THE THEORY OF VOTING, UMAP Expository Monograph, Birkhauser, 1980

EDITORIAL QUERY Can one get all possible orderings of *n* candidates by varying the threshold for approval voting with fewer than the $n(n - 1)$ voters of Gillman's example or is his the best result? What is the answer to this question if one requires the cutoff for voting to be at the voter's first or second choice?

Science Advisor (continued from page 1)

Mathematics must maintain and strengthen public support, and Dr. Graham urged the community not to neglect this area. He noted that few parts of mathematics are more esoteric than parts of physics that have won strong support. He gave the example of a project to test the general-relativistic effects generated by rotating masses. Dr. Graham noted that Bill Fairbank and Francis Everitt of Stanford, with others, had successfully conveyed the importance of the issues to be resolved and the excitement of this project to nontechnical people—including lawmakers and accountants. He challenged mathematicians to do as well with their subject.

The other challenges that Dr. Graham spoke about were those of mathematics education. Here he mentioned the picture emerging from international comparisons (see Lynn Steen's article in this FOCUS), but he went beyond mere endorsement of the various initiatives now in motion at the national and regional levels (the MSEB and so on) to urge that community members become directly involved with school programs on a state and local level.

This outline of the challenges that Dr. Graham put before the community and the selected passages from his speech that follow give a clear view of his concern with mathematics and his support of the subject. With the exception of the bracketed material and indicated ellipses, what follows is taken directly from the written version of Dr. Graham's speech to the Joint Meetings in San Antonio.

[WHY MATHEMATICS SHOULD BE SUPPORTED] One of the lessons of the '80s has been that the most persuasive arguments for Federal support for research are those that characterize the benefits that will ultimately be returned to the taxpayer, even when those benefits are somewhat diffuse and certainly long-term. That approach has been difficult for many scientists, as they've been conditioned by a kind of academic isolationism which has led to the view that any claims to the utility of their work are a potential threat to its integrity or its other scholarly characteristics. That's not true, and happily . . . [this attitude has] been changing as many of you found it healthy to think about your own work and its reason for deserving public support. It is possible to develop sound, persuasive arguments that are entirely consistent with the rationale for why we do research.

Federal Government support for science itself is changing. In fact, there's an interesting analogy. Mathematics is commonly accepted not only as a discipline in itself but as the universal language of science—a key enabling discipline. I think a professor of mine, Richard Feynman, said it best. He said, "I'm sorry some people find it difficult to learn math, but if you want to understand nature you must be conversant with the language in which nature speaks to us."

In a similar vein, the nation increasingly sees science, particularly basic research, as the enabling element for our national economic competitiveness and for our security as a free and leading nation. That fundamental point has influenced Federal policy in science for much of the '80s, and I can't emphasize that too strongly. It's been the dominant reason for the rapid growth and support for science and technology, especially for science and technology at the universities, where our greatest talent in basic research lies today. And, likewise, persuasive arguments for support for mathematics are both the manifest intrinsic value of the field and its links to the rest of science. . . .

[THE EXTENT AND NATURE OF FEDERAL SUPPORT FOR RESEARCH] For 1988, we're requesting more than \$9 billion for basic research. That represents more than a 50 percent increase in Federal support for basic research since 1982. And when we consider that inflation has been held relatively low during that time, we get a sense of the impact that support has been having. Without a doubt, basic research remains one of the highest priorities of this Administration.

I would call particular attention to the National Science Foundation, which not only embodies Federal support for basic research, but which has also been a primary focus for mathematics. For 1988, the President has proposed an increase of nearly 18 percent for the National Science Foundation—the latest in a series of consistently large annual increases during the 1980s. Moreover, the President stated his intention to request support for NSF that would, by 1992, only five years from now, triple the 1980 level of our annual investment for basic research. . . .

Support for mathematics will continue to grow as well, although the detailed numbers for 1988 haven't been released yet, it looks as if we're seeing more than a doubling of NSF support for math since 1982. That far exceeds the growth rate even for basic research in general.

In addition, this is an important point, the Defense Department is finally coming up to speed in providing its own independent support for university research. I would point in particular to DARPA, the Defense Advanced Research Project Agency's new mathematics program, as an example of renewed DOD commitment to basic science. And I'd add that this is a healthy sign—recognition by the DOD that national security depends to a large extent on the quality of U.S. science and technology and on the quality of people who are trained in science and technology, and that certainly includes mathematics. . . .

[MATHEMATICS: PURE AND APPLIED] There are two kinds of mathematics—they're coupled certainly—but one is the science of mathematics, the kind of research effort that many of you here are engaged in. The other is mathematics as the sophisticated instrument whose applications are nearly universal. I would argue that the health of your science is going to be dependent, to a larger extent than we might think, on how successful you are in bringing the tools of mathematics to other people—other than professional mathematicians and professional mathematics educators. . . .

[MATHEMATICS EDUCATION] Something important has happened in the past year and I'm delighted to say that the impetus for that action has come from your community. I viewed the establishment a year ago of a Mathematical Sciences Education Board, under the auspices of the National Research Council, as a potentially far-reaching step. To understand its importance, we have to consider what it's going to take to rework education in math in this country. . . .

First, we can devise an effective partnership between national education leadership and the Federal Government—it can be done. The government won't write curricula and won't suggest how they should be written, but the government can, as NSF did in the 1960s, encourage our national leaders in education and research to provide the kind of vision that will give the weight we need to have a coherent, intellectually unified approach to education. . . .

Second, we should use broadly based leadership to hammer home to everyone the importance of quality in education—the importance of reflecting the changes in science and mathematics that make them dynamic fields. The importance of demanding more from our students and by extension from our schools and our parents and the importance of putting our money where our mouths are. . . .

Third, this time we shouldn't allow ourselves to think of educational reform as a crisis to be solved, because the solutions then are seen as one-time fixes. Maybe we're better off than in 1957, because we've had a decade-long sensitization in this country to our faltering schools. . . .

And that brings me back to the subject of national leadership in the Mathematical Sciences Education Board. I see that as exactly the right kind of mechanism to work on this problem. First of all, it provides a focus for those in the mathematics community who need a channel for working on the problem of mathematics education. Second, it establishes at the outset a similar avenue for school leaders to focus efforts on reform where they're likely to be successful. Composition of the Board—which includes professors of mathematics, superintendents of education, school teachers, education school professors, and community leaders—is not, like too many such groups in the past, designed to be cosmetically representational but basically ineffective. Instead, the Board can build on the strength of that group to develop a consensus that's essential for reform.

[A CALL FOR MORE DIRECT INVOLVEMENT] I can't help but remember a description by the teacher of mine whom I mentioned earlier, Richard Feynman. In his book *SURELY YOU'RE JOKING, MR. FEYNMAN*, which I recommend to all of you over the age of 12 at least, he relates his experiences as a reviewer of proposed mathematics textbooks for the State of California. He found reviewing all these math books to be not only a time-consuming activity, but frustrating as well. Nevertheless, he took it seriously. He tells how he showed up at one committee meeting with his ratings in hand of a big set of books that he had reviewed. When one particular text was discussed, I believe it was a 6th or 7th grade math text, he was amazed to find that it received ratings that more or less set [it] in the middle of the pack. How, he wondered, did that square with the fact that the copies of the book that had been sent out to the reviewers contained only pages that were completely blank—nothing in the book. Not having enough time to run off the proofs, the publishers sent a handsomely bound version of nothing with the explanation that the text would be available soon. To Feynman's astonishment, he was the only one of the reviewers who had bothered to open the book. In fact, as it turned out, most of the reviewers didn't read the books at all. They simply rounded up other people to review them and pass along their comments.

Surely if Feynman could find the time to review these books, the others could have done so too. Just think of the impact if every textbook reviewing group had someone with his kind of dedication, experience, knowledge, and insight—or your kind of dedication, experience, knowledge, and insight.

That's one place where you come in. My point is that you, as members of the scholarly community, can and should become active in this emerging push to turn around school math, in primary and secondary schools and all the way up—certainly undergraduate education as well.

[THE CHALLENGE TO MAKE WISE USE OF TECHNOLOGY] If any single trend has characterized science and technology in this century, it has been the remarkable increase in productivity brought about by the incorporation of new tools—both physical and mental. You can't meet a scientist who doesn't have his favorite story about how some task that took him three months when he was in graduate school can now be done in thirty minutes by some combination of sensors, computers, and undergraduate capabilities. . . .

I challenge you to create a range of mathematics curricula that are up-to-date in content, innovative in approach, well integrated, and highly sophisticated—but above all interesting. Let me challenge you to provide opportunities for classroom teachers to continue their own mathematics education; to become role models for our students. And most fundamentally, I challenge you to become a part of our local, state, and national policy-making process. In short, I ask you to give some of that sacred fourth dimension—time—to a cause from which we'll all benefit. . . .



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Calendar

National MAA Meetings

- 64th Summer Meeting**, Salt Lake City, Utah, August 5-8, 1987.
71st Annual Meeting, Atlanta, Georgia, January 6-9, 1988.
72nd Annual Meeting, Phoenix, Arizona, January 11-14, 1989.
73rd Annual Meeting, Louisville, Kentucky, January 24-27, 1990.

Sectional MAA Meetings

- Allegheny Mountain**, Gannon University, Erie, Pennsylvania, May 1-2, 1987.
Eastern Pennsylvania & Delaware, Franklin & Marshall University, Lancaster, Pennsylvania, November 21, 1987.
Illinois, Northern Illinois University, DeKalb, Illinois, April 24-25, 1987.
Indiana, Tri-State University, Angola, Indiana, October 17-18, 1987.
Intermountain, Idaho State University, Pocatello, Idaho, April 24-25, 1987.
Iowa, University of Northern Iowa, Cedar Falls, Iowa, April 24-25, 1987.
Louisiana-Mississippi, Mississippi University for Women, Columbus, Mississippi, February 27-28, 1988.
Maryland-D.C.-Virginia, Salisbury State University, Salisbury, Maryland, June 13, 1987.
Metropolitan New York, CUNY, Borough of Manhattan Community College, New York, New York, May 2, 1987.
Michigan, Michigan State University, East Lansing, Michigan, May 1-2, 1987.
North Central, University of Minnesota, Minneapolis, Minnesota, April 24-25, 1987.
Northeastern, Connecticut College, New London, Connecticut, June 12-13, 1987; Bentley College, Waltham, Massachusetts, November 20-21, 1987.
Pacific Northwest, Pacific Lutheran University, Tacoma, Washington, June 18-20, 1987.
Rocky Mountain, University of Southern Colorado, Pueblo, Colorado, April 24-25, 1987.
Seaway, Hobart and William Smith College, Geneva, New York, April 24-25, 1987.
Wisconsin, University of Wisconsin, Central, Sheboygan City, Sheboygan, Wisconsin, April 25-26, 1987.

Other Meetings

April 1987

24-26. **New York State Mathematics Association of Two-Year Colleges, 1987 Annual Conference**, Syracuse, New York. This conference will celebrate the twentieth anniversary of NYSMATYC and be held at the Sheraton University Inn and Conference Center. For information, contact Joseph Browne, Mathematics Department, Onondaga Community College, Syracuse, NY 13215.

May 1987

21-23. **Geometry and Topology Conference**, Lehigh University, Bethlehem, Pennsylvania. Speakers: S. Bloch, M. Hopkins, B. Lawson, F. Quinn, R. Schoen, W. Thurston. For information contact D. Davis, C. C. Hsiung, or D. Johnson at Department of Mathematics, Lehigh University, Bethlehem, PA 18015. Telephone (215) 758-3730.
27-30. **Canadian Mathematical Society Summer Meeting**, Queen's University, Kingston, Ontario. Contact: Grace Orzech, Department of Mathematics and Statistics, Queen's University, Kingston, Ontario, Canada K7L 3N6.

June 1987

8-12. **Maryland-D.C.-Virginia Section Workshops** respectively titled "AI, Mathematics & the Microcomputer" and "OR, Mathematics & the Microcomputer". See FOCUS, Volume 7, Number 1, page 3 for details.

8-12. **Mathematical Modeling Workshop**, Messiah College, Grantham, Pennsylvania. Speakers will be Frank Giordano of U.S. Military Academy, West Point, New York, and Maurice D. Weir, Naval Postgraduate School, Monterey, California. For information call or write Marvin L. Brubaker at 717-766-2511 Ext 379—Mathematical Sciences Department, Messiah College, Grantham, PA 17027. Limited to 30 participants.

15-19. **1987 Mathematical Science Lecture Series**, Johns Hopkins University, Baltimore, Maryland. Ten lectures by Richard Karp on probabilistic analysis of algorithms. For information, contact Edward Scheinerman (301) 338-7210 or Robert Serfling (301) 338-7200, Department of Mathematical Sciences, Johns Hopkins University, Baltimore, MD 21218.

15-19. **MAA North Central Section Summer Seminar on Graph Theory and Linear Algebra**, University of Minnesota, Duluth, Minnesota. This will consist of eight lectures by Allen Schwenk on the relationship between graph theory and linear algebra; talks by invited speakers and contributed papers (talks) by participants. No prior knowledge of graph theory required but undergraduate-level linear algebra assumed. For information write: J. Gallian, Dept. of Mathematics and Statistics, University of Minnesota, Duluth, MN 55812. Deadline for housing: May 15, 1987.

24-26. **1987 National Educational Computing Conference**, Temple University, Philadelphia, Pennsylvania. Conference information and registration forms: Frank L. Friedman, General Chair, NECC'87, Computer Activities Bldg., Box JA1, Dept. of Computer and Information Sciences, Temple University, Philadelphia, PA 19122 (215) 787-8450; specifications for submission of original papers: Laurie Scheir.

29-July 3. **ICIAM87**, First International Conference on Industrial and Applied Mathematics, LaVillette, Paris, France. Sponsored by: GAMM, IMA, SIAM, and SMAI. For information write: SIAM, 14th Floor, 117 South 17th Street, Philadelphia, PA 19103-5052, USA.

July 1987

20-24. **SIAM Conference on Applied Geometry**, cosponsored by the Rensselaer Polytechnic Institute, Albany, New York. For information, write: SIAM Conference Coordinator, 117 South 17th Street, 14th Floor, Philadelphia, PA 19103-5052. Telephone (215) 564-2929.

31-Aug. 3. **Boston Workshop for Mathematics Faculty**, M.I.T., Cambridge, Massachusetts. Contact Gilbert Strang, Room 2-240, M.I.T., Cambridge, MA 02139.

August 1987

4-7. **Sixth International Conference on Mathematical Modeling** to be held at Washington University. For information, write: Professor Ervin Y. Rodin, Department of Systems Science and Mathematics, Washington University, Saint Louis, MO 63130. Telephone (314) 889-5806.

October 1987

9-10. **Ohio Delta Chapter of Pi Mu Epsilon**, Miami University, Oxford, Ohio. Abstracts of student contributed papers in mathematics and statistics should be sent to Professor Milton Cox, Department of Mathematics and Statistics, Miami University, Oxford, OH 45056.

December 1987

13-15. **Canadian Mathematical Society Winter Meeting**, University of British Columbia, Vancouver, British Columbia. Contact: Denis Sjerne, Department of Mathematics, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Y4.

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