

FOCUS

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Conferences Propose Changes in Mathematics Curricula

Increased Role of Discrete Mathematics in College Curriculum Urged

Anthony Ralston

Twenty-eight people met for four days last summer on the Williams College campus, at a conference sponsored by the Alfred P. Sloan Foundation, to discuss the curriculum for the first two years of college mathematics. The question before the conference was whether discrete mathematics deserves some, perhaps even a co-equal, place in the lower-division mathematics curriculum along with the traditional subjects of calculus and linear algebra. Twenty-three of the attendees were mathematicians; the other represented disciplines served by the first two years of college mathematics. Gail Young of the University of Wyoming and I served as co-chairs of the conference.

During the first two days of the conference there was discussion of nineteen papers, all of which had been prepared specifically for the conference. Topics covered by these papers include:

- The importance of algorithms, problem-solving, and modeling in the curriculum.
- The effect on the curriculum of symbolic manipulation systems for computers.
- The mathematical needs of the physical sciences, engineering, the social sciences, business and management, and computer science.
- Possible new curricula.
- The importance of statistics in the curriculum.
- Problems of implementing a new curriculum.
- The effects of a new curriculum on the high school curriculum, on teacher training, and on remedial mathematics.

The third day of the conference was devoted to workshops on the design of an integrated two-year curriculum in calculus and discrete mathematics, the design of two separate one-year curricula (one in calculus-linear algebra and one in discrete mathematics), and implementation problems and next steps. On the fourth day there were reports from the workshops and a final general discussion.

(continued on page 2)

Conference Claims Fundamentals in K-12 Mathematics Have Changed

The Conference Board of the Mathematical Sciences (CBMS) held a day-and-a-half meeting at MAA Headquarters in Washington, D.C. last September to address the question of what is still fundamental, and what is not, in K-12 mathematics. (See "CBMS Advises NSB Commission on Precollege Mathematics Curriculum," *FOCUS*, November-December 1982.)

The idea for this conference arose during a lively exchange between Henry O. Pollak of Bell Laboratories, former MAA President, and William T. Coleman, Co-chair of the National Science Board (NSB) Commission on Precollege Education in Mathematics, Science, and Technology, at the July meeting of the Commission. Dr. Pollak presented testimony to the Commission on the role of technology in mathematics education in which he stated that the fundamentals of K-12 mathematics are due for a major overhaul. Mr. Coleman questioned whether, indeed, the mathematical knowledge and skills that have long been regarded as essential for the educated citizen might no longer be needed. Dr. Pollak, in his role as Chairman of CBMS, volunteered the services of CBMS in organizing and conducting a conference of educators and mathematical scientists to assess opinions within the wider mathematical community with regard to this question.

During August and September, CBMS issued invitations to presidents and other representatives of the thirteen mathematical sciences organizations which belong to CBMS. The thirty-three individuals who accepted the invitation and participated in the conference included secondary and collegiate mathematics educators, statisticians, computer scientists, and various other mathematical scientists with extensive knowledge of, and interest in, K-12 mathematics. Among the participants were the presidents of the Mathematical Association of America, American Mathematical Society, Society for Industrial and Applied Mathematics, National Council of Teachers of Mathematics, and the American Mathematical Association of Two-Year Colleges.

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Discrete Mathematics (continued from page 1)

The proceedings of the conference, *The Future of College Mathematics: Proceedings of a Conference/Workshop on the First Two Years of College Mathematics*, were published by Springer-Verlag in December 1982. This publication contains revised versions of all of the papers prepared for the conference, highlights of the discussions, the reports of the workshops, and the text of a dinner address given at the conference by John Kemeny, President Emeritus of Dartmouth College.

Summarizing four days of discussion in a couple hundred words is a risky business. But I think it is fair to say that there was, if not unanimity, at least general consensus on these points:

- The present calculus-linear algebra sequence could use an overhaul, quite aside from the impact of computers and computer science. At the freshmen level at least, it has become a rather poor course, mechanical instead of mathematical, due in part to the poor high school preparation of many freshmen.
- On the other hand, computers and computer science *should* be having a major impact on the first two years of college mathematics. They have raised the importance of discrete mathematics relative to continuous mathematics and, through the effect of symbolic mathematical systems on computers, they imply a de-emphasis of various topics in the current syllabus.



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- The time is ripe for change. The American mathematical community senses the need for it and will generally support or, at least, not oppose substantial change.
- The most difficult aspect of obtaining acceptance of a new curriculum may be opposition by those who depend on service courses in mathematics, particularly physical scientists and engineers. While it seems likely that a new two-year curriculum with substantially less calculus *can* satisfy the needs of these disciplines, it will require careful argumentation and considerable tact to persuade these disciplines that this is the case.
- No single model of a new curriculum should be proposed as a panacea. Rather, a number of models involving different approaches to integrating or separating discrete mathematics and calculus need to be tried. It will be necessary to try these models at various colleges and universities to test their efficacy. This will require dedicated faculty as well as outside support for the development of texts and other course materials.
- At most smaller colleges, because resources are not sufficient to support two tracks, it will only be possible to switch to a new curriculum "cold turkey." At larger institutions, two separate curricula may be possible; however, this carries with it the danger of requiring students to make choices of majors too early.
- The algorithmic approach needs to be widely used in whatever mathematics is taught during the first two years of college as well as in high school courses. Included in this should be a more constructive, less existential, approach to mathematical proofs.

What's next? Well, if there is to be a movement toward including more discrete mathematics in the curriculum in the first two years, we should be developing courses and writing textbooks, starting pilot programs at a number of colleges and universities, and involving as much of the mathematical community as possible in the process of change through the auspices of the MAA and, in particular, CUPM (Committee on the Undergraduate Program in Mathematics).

The attendees at the Sloan Conference all, I think, look forward over the next few years to discussion of the issues raised at the conference, to some ferment, and also to change, both in the curriculum for the first two years of college mathematics and of their own views on it.

Niven Testifies Before NSB Commission

On November 16, MAA President-Elect Ivan Niven presented testimony before members of the National Science Board (NSB) Commission on Precollege Education in Mathematics, Science, and Technology at one of a series of meetings with representatives of colleges and universities. Professor Niven spoke about how colleges and universities are contributing to strengthening mathematics education at the secondary and lower levels through teacher education programs and a variety of cooperative efforts such as high school competitions. He emphasized ways in which the federal government could assist with this work by support of inservice and summer programs. The meeting was held at the National Academy of Sciences in Washington, D.C.

The Commission was established last spring by the National Science Board and was charged with the responsibility of producing a national consensus on the nature and solution to the national problems in science and mathematics edu-

cation. It has until the end of 1983 to make recommendations which will be part of the consensus-building process.

Two meetings of the full Commission have been held, one in July and one in October. At the October meeting, the Commission heard from Henry O. Pollak, Chairman of the Conference Board of the Mathematical Sciences (CBMS), concerning the meeting and report described on page 1 of this issue. (See "Conference Claims Fundamentals in K-12 Mathematics Have Changed.") Robert Yager, President of the National Science Teachers Association (NSTA), reported on the results of an NSTA search for exemplary science and mathematics school programs.

The Commission has issued a report, *Today's Problems Tomorrow's Crises*, based on conclusions reached at its July meeting. Copies of this report may be obtained without charge from: NSB Commission, National Science Foundation, 1800 G Street, N.W., Washington, D.C. 20550.

Information Service for Mathematical Visitors to New Zealand Established

The New Zealand Mathematical Society has established an information service for those who wish to plan a professional mathematical visit to New Zealand. This service provides general information about mathematical activities in research and educational institutions for prospective visitors and, for those who do not already have contacts in New Zealand, helps locate a principal contact at one of these institutions. It is expected that the detailed planning for the visit will then be made through the principal contact.

For more information, write to: Dr. W. D. Halford, Department of Mathematics and Statistics, Massey University, Palmerston North, New Zealand.

Editorial Manager

The Mathematical Association of America has an opening for an Editorial Manager (EM) at its headquarters in Washington, D.C. beginning July 1, 1983 or as soon as possible thereafter. The EM will supervise an editorial department responsible for copy editing and layout for three journals and several books per year. In addition to supervising 2-3 editorial assistants, the EM will be expected to participate in the editorial process and work closely with journal editors and authors. Qualifications for this position include mathematical training to the master's degree level or beyond, demonstrated writing skills, and professional experience, or its equivalent, in editing mathematical manuscripts. Salary will be commensurate with the experience and training of the candidate.

Applicants should send a curriculum vitae and should arrange to have three letters of recommendation sent to:

Dr. Marcia P. Sward, Associate Director
Mathematical Association of America
1529 Eighteenth Street, N.W.
Washington, D.C. 20036.

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Some Natural Undecidable Statements Found

James R. C. Leitzel

The impact of Kurt Gödel's work of the 1930's is being felt again in mathematics. Gödel established that in every logical system that is axiomatizable, consistent, and strong enough to contain the theory of the natural numbers, there are statements the truth or falsehood of which cannot be determined within that system. If those undecidable statements are subsequently taken as axioms to extend the original logical system, new undecidable statements will inevitably occur in the extended system.

Gödel's result has frequently been dismissed as being artificial and of no use in dealing with problems that really matter. The result was seen as being of interest only to logicians and the examples as dependent upon linguistic tricks.

Recently, however, two examples of "natural" statements involving finite quantities have been discovered. Both of these can be phrased in language from the field of combinatorics and involve functions definable in Peano arithmetic which grow at incredible rates.

The first example was discovered by Jeff Paris of Manchester University and Leo Harrington of the University of California at Berkeley. They define a "large" set of integers to be one that has at least as many elements in it as its smallest member. Hence, the set 2, 7, 8, 9, 10 is "large," but the set 100, 102, 110, 120 is not. The Paris-Harrington example treats the question of the size of finite set A with the property that if you select two integers r and k and assign r colors to the k -element subsets of A , you can always find a "large" subset all of whose k -tuples are the same color. The lower bound on the size of A , which is clearly dependent on the choices of r and k , grows at an astounding rate. It is this that yields an undecidable statement in Peano arithmetic.

The second example, discovered by Harvey Friedman of the Ohio State University, involves a function that makes the Paris-Harrington function seem like a dwarf. It has been termed the fastest-growing computable function ever described. The example comes out of a finite version of Kruskal's theorem on trees. Friedman demonstrated that if you take a large enough sequence of finite trees, with fixed initial size and modest growth rate, then one element of the sequence is embeddable, in a particular way, in a later element of the same sequence. For each fixed initial size, the result is provable in Peano arithmetic, but the number of steps in the proof is enormous. The theorem is formally undecidable, however, when one attempts to verify it for arbitrary initial size of tree.

For more information, the reader is referred to Gina Kolata's article "Does Gödel's Theorem Matter to Mathematics?," which appeared in *Science*, Volume 218, 19 November 1982. Also, in an article in the *Mathematical Intelligencer* 2 (1980), "Some Rapidly Growing Functions," Craig Smornyski discusses the Paris-Harrington example. In a forthcoming article in the *Intelligencer*, Smornyski discusses Friedman's example in a paper titled "The Varieties of Arboreal Experience."



from the Editor's mailbox . . .

I am deeply concerned about the increasing fragmentation of the mathematics community and the resulting long-range impact on the Association.

The MAA has consistently tried to position itself in the center of mathematical interests. Historically, it has been "surrounded" by three other major mathematical organizations: the research-oriented AMS (American Mathematical Society), the applications-oriented SIAM (Society for Industrial and Applied Mathematics), and the precollegiate education group NCTM (National Council of Teachers of Mathematics). In recent years, however, a variety of other organizations have arisen which cater to special interests in the mathematical community. These include ACM (Association for Computing Machinery) and a number of other organizations such as AMATYC (American Mathematical Association of Two-Year Colleges), AWM (Association for Women in Mathematics), and CIMSE (National Consortium on Computer Uses in Mathematical Sciences Education).

In principle, all of these groups can co-exist with the MAA. Unfortunately, in practice, I feel that each of these organizations must have an increasing effect on the MAA. If nothing else, there is the loss of time and energy on the part of those individuals who will now devote themselves to another group. Worse, what with constantly escalating increases in membership and subscription rates on all sides, many will be forced to curtail some of their memberships on purely economic grounds. I fear that the loser in this will be the MAA. It may turn out to be the organization at the very center of the mathematical community and yet have one of the smallest constituencies.

I suggest that what is needed is a more aggressive policy to broaden the base of Association interests and activities to match the divergent interests and activities of the membership before the other alternatives become too attractive. The special sessions on computer usage which were organized by CIMSE and held at recent national and regional MAA meetings and the introduction of contributed paper sessions at national meetings represent positive steps in the right direction.

However, much more must be done. For example, I notice that there is no standing committee of the Association involved in the area of computers. It seems incredible, considering the revolutionary impact that these devices are having on the delivery and even the content of mathematics education, that the MAA has not moved in this direction.

Many other interests will also be common to large numbers of members: remediation, personalized instruction, AV usage, statistics, etc. Perhaps the Association should organize a special survey of the entire membership to determine what major directions the members would like to see developed. Once such areas are identified, I would urge the creation of standing committees to coordinate Association-wide activities in each such area.

My intent in writing this letter is to stimulate MAA members to come forth with their own suggestions and ideas. I definitely feel that such responses will serve to strengthen and invigorate the Association for all of us.

Sheldon P. Gordon
Suffolk County Community College

New MAA Awards Established

The MAA recognizes outstanding service and achievement by the presentation of various awards. In August the number of these awards was increased by two. After an extensive review of the Association's awards program, the Board of Governors voted, at its meeting on August 22 in Toronto, to approve two new MAA awards, the **MAA Book Prize** and the **Certificate for Meritorious Service**.

The MAA Book Prize of \$500 will be awarded for distinguished, innovative books published by the MAA. The award will be made irregularly by the Board, on the recommendation of a standing committee, the only restriction being that not more than one award will be made in any two consecutive years.

The Certificate for Meritorious Service will be awarded by the Board for service of high quality to the Association at the national level or for service of high quality to a Section of the MAA. No more than two awards will be made annually for national service. Each Section will be entitled to nominate one person each five years, on a rotational basis, to receive the award for service to the Section. Recipients for the Award for Distinguished Service to Mathematics will not be eligible for this award.

These new awards increase the number of awards made by the Association to nine. The seven current awards are: the Award for Distinguished Service to Mathematics, Honorary Life Membership, and the Certificate of Merit, made for distinguished service; and the Chauvenet Prize, the Lester R. Ford Award, the Carl B. Allendoerfer Award, and the George Pólya Award, made for outstanding expository writing.

Ohio Section Offers Short Course on Factoring and Primality Testing

The MAA Ohio Section has announced that it will conduct a short course, "An Introduction to Factoring and Primality Testing," at Kent State University in Kent, Ohio, on June 16-18, 1983. The principal lecturers are Carl Pomerance and Samuel S. Wagstaff, Jr.

The course will be an introduction to modern factoring and primality testing algorithms, culminating with the new Adleman-Rundy-Cohen-Lenstra tests. Mornings will be devoted to lectures and afternoons to workshops in applications. The lectures will assume a general understanding of undergraduate modern algebra. The workshops will assume the basic fundamentals of Fortran or WATFIV programming. The registration fee is \$30. For further information, write or call: Jacqueline Parsons, Conference Bureau, 211A Kent Student Center, Kent State University, Kent, OH 44242, (216-672-3161).

The Ohio Section is also offering a three-week short course on data structures, June 13-July 1, at Denison University. (See "New Programs in Retraining for Computer Science Offered" in the November-December 1982 issue of *FOCUS*.)

K-12 Mathematics (continued from page 1)

A report on the findings of this conference was delivered to the NSB Commission on December 1. Copies of the report may be obtained without charge from: NSB Commission, National Science Foundation, 1800 G Street, N.W., Washington, D.C. 20550.

The "Executive Summary" of the report is quoted here in its entirety:

Our charge from the NSB Commission was to identify what parts of mathematics must be considered fundamental for education in the primary and secondary schools. We concluded that the widespread availability of calculators and computers and the increasing reliance of our economy on information processing and transfer are significantly changing the ways in which mathematics is used in our society. To meet these changes we must alter the K-12 curriculum by increasing emphasis on topics which are fundamental for these new modes of thought.

This report contains our recommendations on needed changes—additions, deletions, and increased or decreased emphases—in the elementary and middle school mathematics curricula and a statement of more general concerns about the secondary school mathematics curriculum.

With regard to elementary and middle school mathematics, in summary, we recommend:

- That calculators and computers be introduced into the mathematics classroom at the earliest grade practicable. Calculators and computers should be utilized to enhance the understanding of arithmetic and geometry as well as the learning of problem-solving.
- That substantially *more* emphasis be placed on the development of skills in mental arithmetic, estimation, and approximation and that substantially *less* be placed on paper and pencil execution of the arithmetic operations.
- That direct experience with the collection and analysis of data be provided for in the curriculum to insure that every student becomes familiar with these important processes.

We urge widespread public discussion of the implications of the changing roles of mathematics in society, support of efforts to develop new materials for students and teachers which reflect these changes, and continued and expanded experimentation within the schools.

With regard to the secondary school curriculum, in summary, we recommend:

- That the traditional component of the secondary school curriculum be streamlined to make room for important new topics. The content, emphasis, and approaches of courses in algebra, geometry, precalculus, and trigonometry need to be re-examined in light of new computer technologies.
- That discrete mathematics, statistics and probability, and computer science now be regarded as "fundamental" and that appropriate topics and techniques from these subjects be introduced into the curriculum. Computer programming should be included at least for college-bound students.

Modern computer technology clearly has vast potential for enriching and enlivening the secondary school curriculum. However, we are not now in a position to make firm recommendations. There is need for research on the effects of incorporating technology into the traditional secondary school curriculum. We urge federal support for investigations into this question, including development of experimental materials and prototypes of actual school curricula.

Although we are generally optimistic about the future role of computers, we feel we must highlight one point that worries us even though it is not directly within our charge. The disparity of access between children who have a computer at home and children who do not threatens to widen the educational gap that already exists between different economic strata. It is urgent that programs be designed to address this problem.

We clearly recognize that the most immediate problem is not the mathematics *curriculum*, but the need for more, and better qualified, mathematics *teachers*. One section of this report is devoted to recommendations on attracting and training prospective teachers, better utilizing the talents of in-service teachers, and retraining teachers who are inadequately prepared for teaching mathematics. We feel that the coming changes in subject matter and emphasis not only will bring a new sense of vitality to

K-12 mathematics, but also will encourage teachers actively to seek and participate in programs of professional development.

The Conference Board of the Mathematical Sciences stands ready to assist efforts to develop immediate strategies for addressing the teacher shortage and to develop long-term strategies for bringing about the curricular changes envisioned in this report.

England: A Mathematical Journey

The Department of Mathematical and Computer Sciences of Kean College of New Jersey has announced that its international studies program for teachers and supervisors of mathematics, "England: A Mathematical Journey," will be held this year from June 30 to July 25.

Up to six graduate credits are available for twenty-six days of experiencing the culture of Great Britain in a mathematical context. Through lectures, tours and visits to museums, churches, universities and other tourist highlights, the mathematical view of British history and culture, mathematics education in English schools, and the history of mathematics will be emphasized.

For complete information, contact Dr. Susan G. Marchand, Department of Mathematical and Computer Sciences, Kean College of New Jersey, Union, NJ 07083.

In Memoriam

The MAA has been informed of the deaths of these individuals: **Sam K. Bright** of Austin, Texas, an MAA member for 34 years; **Haskell B. Curry** of State College, Pennsylvania, an MAA member for 53 years; **J. Dwight Daugherty** of Clearwater, Florida, an MAA member for 44 years; **David DeVol** of Caldwell, New Jersey, an MAA member for 34 years; **P. J. Federico** of Washington, D.C., an MAA member for 59 years; **Howard F. Fehr** of New York, New York, an MAA member for 49 years; **Evelyn Frank** of Evanston, Illinois, an MAA member for 36 years; **Sidney Gross** of Long Beach, New York, an MAA member for 29 years; **C. Morris Horowitz** of Brooklyn, New York, an MAA member for 7 years; **Herman R. Hyatt** of Woodland Hills, California, an MAA member for 16 years; **Wyatt H. Ingram** of Fire Island, New York, an MAA member for 32 years; **Orlando C. Kreider** of Ames, Iowa, an MAA member for 51 years; **Dorothy E. Matson** of Little Rock, Arkansas, an MAA member for 22 years; **Eugene S. Mayer** of Annapolis, Maryland, one of the 1045 charter members who organized the MAA in 1915; **Douglas T. McClay** of Montpelier, Vermont, an MAA member for 17 years; **William A. Miller** of Miller Place, New York, an MAA member for 22 years; **Richard H. Sady** of Knoxville, Tennessee, an MAA member for 9 years; **Franklin C. Smith** of St. Paul, Minnesota, an MAA member for 46 years; **Fred W. Sparks** of Claremont, California, an MAA member for 59 years; **Helen M. Titus** of Derby, Kansas, an MAA member for 4 years; **G. C. Webber** of Newark, Delaware, an MAA member for 36 years; **Russell A. Welker** of Raleigh, North Carolina, an MAA member for 23 years; **George K. Williams** of Durham, North Carolina, an MAA member for 19 years; **Joanne B. Wunch** of Pacific Palisades, California, an MAA member for 19 years.

People in the News



John D. Bradburn of Elgin Community College was recently named the first winner of the "Outstanding Faculty Award" granted by the Association of Community College Trustees (ACCT). This award was established to recognize both "excellence of instruction" and the "tremendous contributions" made by community college faculties, according

to William Meardy, ACCT Executive Director. Professor Bradburn was cited for his leadership in state and national mathematics education associations and for his work towards establishing doctoral mathematics education programs. He was one of the founders of the American Mathematical Association of Two-Year Colleges. Currently, he chairs the MAA's Committee on Two-Year Colleges.



Victor Klee, Professor of Mathematics at the University of Washington, has been selected to receive Reed College's Howard Vollum Award for Distinguished Accomplishment in Science and Technology. Professor Klee was selected for this award because of his excellence as a mathematician and communicator and his extensive contributions to the appli-

cations of mathematics in technology and industry. The Vollum Award recognizes exceptional achievement of a member of the scientific and technical community of the Northwest. The Vollum laureate receives a silver medal and an award of \$2000. Professor Klee served as MAA President in 1971-72 and received the MAA's Award for Distinguished Service to Mathematics in 1977.



Anthony Ralston, State University of New York at Buffalo, is the recipient of the 1982 ACM (Association for Computing Machinery) Distinguished Service Award. In presenting the award, which is given each year by the ACM in recognition of long-term service to the computing community, the ACM cited Dr. Ralston's wide range of accomplishments as

author, educator, human rights advocate, and his service as President of the ACM in 1972 and of the American Federation of Information Societies in 1975.

Visiting Lecturers and Consultants Programs Mailed

The *MAA Program of Visiting Lecturers and Consultants* was mailed last September to all mathematics and mathematical sciences department heads in the United States and Canada. Additional copies may be obtained by writing to: Mathematical Association of America, 1529 Eighteenth Street, N.W., Washington, D.C. 20036.

The following change of affiliation was too late for inclusion in the program: Professor T. D. Parsons is on leave from Pennsylvania State University and, during 1982-83, will be at the Department of Mathematics, California State University, Chico, CA 95929-0525.

CBMS Reports on Bachelor's and Master's Graduates

Published last June, *Employment of Recent Bachelor's and Master's Graduates in the Mathematical and Computer Sciences* is the 34-page report of a study conducted by the Conference Board of the Mathematical Sciences (CBMS) with National Science Foundation support. Salary data from the report and their implications for mathematics majors have already been discussed in *FOCUS's* September-October 1982 lead article by MAA President Richard D. Anderson, who was a member of the informal advisory committee for the study. The other members of the committee were Lida K. Barrett, Wendell H. Fleming, Brockway McMillan, and Jack Minker. The project was under the direction of recently-retired CBMS Executive Director Truman Botts.

The data organized and analyzed in the CBMS project were derived from sample surveys conducted by NSF in the years 1976, 1978, 1979, and 1980. The surveys focused on employment, as of the survey year, of science and engineering bachelor's and master's graduates who were one, two, or six years beyond their degrees. The CBMS report is addressed primarily to demographic profiles, employment status, fields of employment, types of employers, and mean salaries of the graduates whose degrees were in mathematics, statistics, operations research, or computer science. It also considers more briefly fields of degrees and salary ranges for science and engineering graduates whose employment as of the survey year was in one of the above four fields or in mathematics education.

A selection of results typical of those in the report follows.

- Of the 1978 graduates (bachelor's and master's), only about half of those whose degrees were in mathematics were employed full-time in science/engineering (S/E) positions in 1980 (with graduate study and teaching being counted in the other half). In contrast, nearly 90% of those with degrees in computer science, and about two-thirds of those with master's degrees in statistics or operations research, held full-time S/E employment in 1980. Over the period 1974-1978 there has, however, been a gradual increase in the fraction of mathematics graduates employed in S/E fields two years after the degree.
- For mathematics bachelor's graduates of the year 1978 employed in 1980, the most common field of employment was computer science (nearly 40% of the totals). Another quarter were employed in mathematics or mathematics education, with the rest in statistics, engineering, business, or other work. In contrast, 88% of the computer science bachelor's graduates of 1978 were employed in the computing field in 1980.
- For the 1978 mathematical and computer science bachelor's and master's graduates employed in 1980, the largest employer category was business and industry, as compared with the three other categories—colleges and universities, schools, and government-and-other. This was overwhelmingly the case for graduates at the bachelor's level and for computer science and operations research graduates at the master's level. At that level, a bare majority of mathematics graduates were employed in academia and a quite substantial fraction of the statistics graduates, about 36%, were employed in the government-and-other category.

- Of the 1978 and 1979 bachelor's graduates in science and engineering who were employed in 1980 in the mathematical or computer sciences, roughly one-third received their degrees in mathematics, statistics, or operations research. Another third received their degrees in computer science, and the remaining third received their degrees in other science or engineering fields. Of the corresponding graduates at the master's level, roughly 40% received their degrees in mathematics, statistics, or operations research, 35% in computer science, and the remaining 25% in other science or engineering fields.

Copies of the full report are available at \$2 prepaid from CBMS, 1529 Eighteenth Street, N.W., Washington, D.C. 20036.

Computer Science Retraining Programs Offered at Evansville and Memphis State

The University of Evansville and Memphis State University have recently introduced retraining programs for faculty members from other disciplines who wish to learn to teach computer courses in the undergraduate curriculum. Both programs require two summers of full-time study and additional work in the intervening year.

Information about the University of Evansville program may be obtained by writing to: Dr. William Mitchell, Director, Graduate Program in Computer Education, University of Evansville, P.O. Box 329, Evansville, IN 47702-0329. For information about the Memphis State program, write to: Chairman, Department of Mathematical Science, Memphis State University, Memphis, TN 38152.

Information about other retraining programs in computer science is being sought by the Joint ACM-MAA Committee on Retraining for Computer Science. Such information should be sent to the chairman of the committee: Professor Donald L. Kreider, Department of Mathematics, Bradley Hall, Dartmouth College, Hanover, NH 03755.

VisUMAP to Produce TV Programs on Applications of Mathematics

The Visual Mathematics and its Applications Project (VisUMAP) will produce 30 half-hour television programs, plus text and test materials, that demonstrate contemporary, real-world applications of mathematics. This is one of four projects recently approved by the Corporation for Public Broadcasting/Annenberg School of Communications Project. VisUMAP is a project of the Consortium for Mathematics and its Applications (COMAP).

The programs will be targeted at an audience of entry-level undergraduates and adults in continuing education courses, such as "Introduction to Mathematics" or "Mathematics for Liberal Arts," or in non-academic settings. The objectives are to increase awareness and understanding of exciting and relevant uses of mathematics, to motivate the study of quantitative skills, and to present skills necessary to put mathematics to use.

The programs will deal with mathematics applications in six areas: Management Science, Politics, Growth, Computers, Choice and Chance, and the Physical Universe. Each area will be introduced by an overview program and then explored in further detail by three or four classroom-styled programs.

For further information contact: Solomon A. Garfunkel, Project Director, or Donald S. Berman, Executive Producer, VisUMAP/COMAP, 55 Chapel Street, Newton, MA 02160.

Sabbatical Exchange Directory Ready

MAA members may obtain a free copy of the 1983-84 Sabbatical Exchange Information Service (SEIS) Directory by writing to SEIS, Mathematical Association of America, 1529 Eighteenth Street, N.W., Washington, D.C. 20036. Non-members may purchase the SEIS Directory for \$5.

Mathematical sciences faculty members who are interested in exploring the possibility of no-cost faculty exchanges during the academic year 1983-84 are invited to write to any of the SEIS participants listed in the directory.



NEW FROM THE MAA . . .

New Mathematical Library - Volume #29 THE CONTEST PROBLEM BOOK IV

Annual High School Mathematics Examinations 1973-1982

Compiled and with solutions by Ralph A. Artino,
Anthony M. Gaglione, and Niel Shell

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Calendar

National MAA Meetings

66th Annual Meeting, Denver, CO, January 6-9, 1983
63rd Summer Meeting, SUNY at Albany, NY, August 8-10, 1983

67th Annual Meeting, Louisville, KY, January 27-29, 1984
68th Annual Meeting, Anaheim, CA, January 11-13, 1985

Sectional MAA Meetings

Florida Florida State University, Tallahassee, Florida, March 4-5, 1983.
Illinois Rockford College, Rockford, Illinois, April 29-30, 1983.
Indiana Indiana University, Bloomington, Indiana, April 16, 1983.
Intermountain University of Utah, Salt Lake City, Utah, April 29-30, 1983.
Iowa Iowa State University, Ames, Iowa, April 22-23, 1983.
Kansas University of Kansas, Lawrence, Kansas, April 8-9, 1983.
Kentucky Bellarmine College, Louisville, Kentucky, April 8-9, 1983.
Louisiana-Mississippi Delta State University, Cleveland, Mississippi, February 18-19, 1983.
Metropolitan New York St. John's University, Jamaica, New York, May 7, 1983.
Michigan Oakland Community College, Auburn Heights, Michigan, May 6-7, 1983.
Nebraska University of Nebraska, Omaha, Nebraska, March 25-26, 1983.
New Jersey Glassboro State College, Glassboro, New Jersey, April 23, 1983.
North Central Carleton College, Northfield, Minnesota, April 22-23, 1983.
Ohio Marietta College, Marietta, Ohio, April 22-23, 1983.

Oklahoma-Arkansas University of Oklahoma, Norman, Oklahoma, March 18-19, 1983.
Pacific Northwest University of Idaho, Moscow, Idaho, June 16-18, 1983.
Rocky Mountain Colorado State University, Ft. Collins, Colorado, April 29-30, 1983.
Seaway, joint meeting with the New York State Mathematics Association of Two-Year Colleges, Sheraton Inn and Conference Center, Utica, New York, April 22-23, 1983.
Southeastern The Citadel, Charleston, South Carolina, April 15-16, 1983.
Southern California University of California-San Diego, La Jolla, California, March 5, 1983.
Southwestern New Mexico Institute of Mining and Technology, Socorro, New Mexico, March 25-26, 1983.
Texas North Texas State University, Denton, Texas, April 8-9, 1983.
Wisconsin University of Wisconsin, West Bend, Wisconsin, April 15-16, 1983.

Other Meetings

JANUARY 1983

5-9. **American Mathematical Society Annual Meeting**, Denver, Colorado. Contact: AMS, P.O. Box 6248, Providence, RI 02940.

5-9. **Meeting of the Association for Women in Mathematics**, Denver, Colorado. Contact: AWM, Women's Research Center, Wellesley College, 828 Washington Street, Wellesley, MA 02181.

8-9. **Association for Symbolic Logic Annual Meeting**, Denver, Colorado. Contact: J. Donald Monk, Mathematics Department, University of Colorado, Boulder, CO 80309.

FEBRUARY 1983

14-17. **Fourteenth Southeastern Conference on Combinatorics, Graph Theory, and Computing**, Florida Atlantic University. Instructional lecture series by Paul Erdős, Victor Klee, Carl Pomerance, Jacobus H. van Lint. Fifteen-minute presentations on contributed papers. Abstract deadline: February 1, 1983. Contact: Professor Frederick Hoffman, Department of Mathematics, Florida Atlantic University, Boca Raton, FL 33431. (305-393-3345 or 305-393-3340).

MARCH 1983

25-26. **16th Annual Small College Computing Symposium**, St. Olaf College. The theme will be computer applications in the college curriculum and computer networking for small colleges. Contact: Ms. Doris Wagner, Assistant to the Director, Academic Computing Center, St. Olaf College, Northfield, MN 55057. (507-663-3097).

28-31. **1983 Mathematics and Computation Topical Meetings, American Nuclear Society**, Salt Lake City, Utah. The theme is "Advances in Reactor Computations." Contact: Elmer E. Lewis, Department of Mechanical and Nuclear Engineering, Northwestern University, Evanston, IL 60201. (312-492-7025).

APRIL 1983

15-16. **Conference on Undergraduate Mathematics**. Oklahoma State University. Invited speakers: George Piranian, C. H. Edwards, Jr., Lynn O. Wilson, Reuben Hersh. Contributed papers from undergraduate students are welcome. Contact: J. R. Choike, Department of Mathematics, Oklahoma State University, Stillwater, OK 74078.

21-22. **Fourteenth Annual Pittsburgh Conference on Modeling and Simulation**, Pittsburgh, PA. Contact: William G. Vogt or Marling H. Mickle, Modeling and Simulation Conference, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, PA 15261.

25-27. **The Institute of Management Science/Operations Research Society of America Joint Meeting**, Chicago, Illinois. Contact: ORSA, 428 East Preston Street, Baltimore, MD 21202.

29. **Symposium on Statistical Graphics**, Delaware Chapter of the American Statistical Association, University of Delaware. The purpose of the symposium is to expose statisticians and other interested persons to state-of-the-art methods and software for the graphical display of data. Speakers include W. S. Cleveland, R. McGill, J. Filliben, J. Gentleman, R. H. Moore, P.A. Tukey, H. Wainer. Contact: W. O. Williford, CSPCC (151E), VAMC, Perry Point, MD 21902 (301-642-2411, Ext. 572).

JUNE 1983

6-8. **National Educational Computing Conference (NECC 83)**, Baltimore, Maryland. Host: Towson State University. Contact: Doris K. Lidtke, General Chairman, NECC 83, Department of Mathematics and Computer Science, Towson State University, Baltimore, MD 21204.

13-July 1. **MAA Ohio Section Short Course on Data Structures**, Denison University, Granville, Ohio (See *FOCUS*, November-December 1982.)

16-18. **MAA Ohio Section Short Course—An Introduction to Factoring and Primality Testing**, Kent State University, Kent, Ohio. (See "Ohio Section Offers Short Course on Factoring and Primality Testing," on page 4 of this issue.)

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