FOCUS

THE NEWSLETTER OF THE MATHEMATICAL ASSOCIATION OF AMERICA

February 1995

Volume 15, Number 1

In this Issue

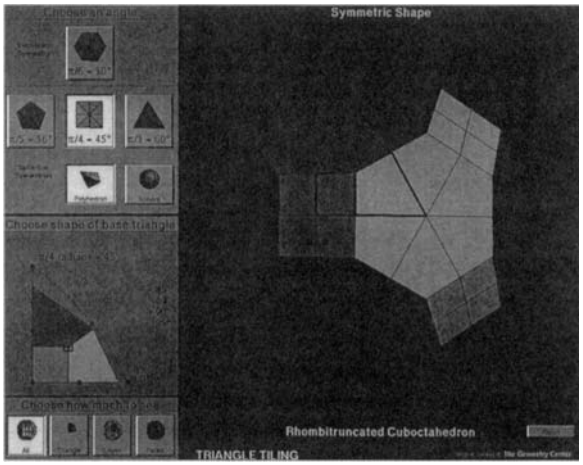
The Mathematical Association of America
1529 Eighteenth Street, NW
Washington, DC 20036

The Geometry Center Reaches Out

A major mission of the NSF-sponsored University of Minnesota Geometry Center is to support, develop, and promote the communication of mathematics at all levels. Last year, the center increased its efforts to reach and to educate different and diverse groups of people about the beauty and utility of mathematics. Center members ***Harvey Keynes*** *and* ***Frederick J. Wicklin*** *describe some recent efforts to reach the general public, professional mathematicians, high school teachers, talented youth, and underrepresented groups in mathematics.*

Museum Mathematics

Just a few years ago, a trip to the local science museum resembled a visit to a taxidermy shop. The halls of the science museum displayed birds of prey, bears, cougars, and moose—all stiff, stuffed, mounted on pedestals, and accompanied by "Don't Touch" signs. The exhibits conveyed to all visitors that science was rigid, boring, and hardly accessible to the general public.



The graphical interface to a museum exhibit that allows visitors to explore regular polyhedra and symmetries.

Fortunately times have changed. Today even small science museums literally snap, crackle, and pop with interactive demonstrations of the physics of electricity, light, and sound. Visitors are encouraged to pedal, pump, and push their way through the exhibit hall. The message conveyed to today's museum visitor is equally clear: science is vibrantly alive, is fun, requires participation, and can be rewarding.

But where are the mathematics exhibits? One could argue that math is behind the scenes in almost every exhibit; but if math is behind the scenes, then it is not in the public's eye. In an effort to make mathematics more visible in science museums, the Geometry Center teamed up with the Science Museum of Minnesota to develop an interactive mathematics exhibit for the general public that uses computer graphics to illustrate geometric ideas such as symmetry groups, tilings, regular polyhedra, and spherical geometry.

The exhibit was designed for the science museum environment with visitors ranging from very young children to adults, so it is accessible to the casual browser yet has deep mathematical content for the more serious investigator. Computer graphics allow users to continuously deform a Platonic solid (that is, a regular polyhedron) into related polyhedra that are invariant under the same symmetry group as the original Platonic solid. In particular, given a Platonic solid (e.g., the cube) the museum visitors can investigate which Archimedean solids have the same symmetries. They can also discover that within the family of polyhedra, there is another Platonic solid (e.g., the octahedron) that is "dual" to the first Platonic solid, meaning that the faces and vertices of the first are transformed into the vertices and faces of the second. Users may also change the symmetry group in order to explore a different family of polyhedra, or to explore planar tilings.

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FOCUS

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

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

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

ISSN: 0731-2040
Printed in the United States of America.
Printed on recycled paper.

Editorial

Proof Beyond Reasonable Doubt

Three events in the news during 1994 brought the issue of proof into the spotlight. One was the O. J. Simpson trial taking place in Los Angeles. The second was the news that Andrew Wiles had corrected the proof of Fermat's Last Theorem he had announced in June 1993, but which was subsequently found to be flawed. The third was the discovery that the computer chip that is the computational heart of millions of widely used personal computers (Intel's *Pentium* chip) has a significant mathematical flaw.

The standard of proof required by law is well known: *proof beyond reasonable doubt* is the all-important phrase. Of course, like most concepts in everyday life, once you start to examine it, it is not at all clear just what this definition amounts to. What is reasonable to one person can seem quite unreasonable to the next. I have heard it said—though I do not know if it is true—that prosecution lawyers have been known to object to the presence of mathematicians on juries, on the grounds that such persons will be able to see 'reasonable doubt' in any legal argument, and are thus very reluctant to convict.

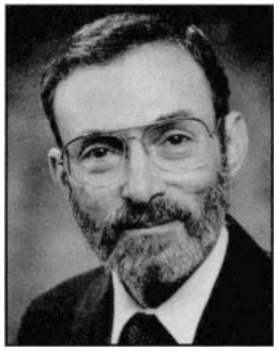
In the O.J. Simpson case, whatever the final outcome, neither the prosecution nor the defense are likely to produce a proof that meets the totally precise standards of mathematics. From the time of its introduction in ancient Greece by Thales in the sixth century B.C., the formal proof has been the bedrock of mathematics, what Cambridge (England) mathematician Michael Atiyah has referred to as "the glue that binds mathematics together." It is the absolute certainty provided by rigorous proofs that sets mathematical knowledge apart from all other kinds of knowledge, including all other sciences. Undoubtedly, it is a lack of a proper appreciation of the nature of mathematical proof that results in continued attempts of amateur mathematicians to square the circle or to trisect the angle, long after mathematicians have *proved*, conclusively, that such feats are impossible.

The proof that no ruler and compass construction can trisect a general angle is very different from any kind of proof O. J. Simpson's defense team might offer to prove that it was impossible for their client to have commited the crime of which he stands accused. Even if the defense produces an eye witness who claims that O. J. was not at the murder scene, that will still not amount to *mathematical* proof; there always remains the possibility, however remote, of mistaken identity, hallucination, or plain dishonesty. In legal cases, the judge and the jury must decide whether such doubts are 'reasonable' or not. In mathematics, the standard of proof is far higher. The mathematician demands complete, 100% certainty.

At least that is what our propaganda says. But does the product live up to the image? Has Andrew Wiles proved Fermat's Last Theorem or hasn't he? What will it take to convince you? What will it take to convince Mazur or Ribet or Faltings, or any of the other handful of number theorists who are best able to understand Wiles' long and difficult reasoning? Would you be convinced if these experts agreed that the proof was correct? Won't there remain a 'reasonable doubt' in your mind that these experts could be wrong? After all, Wiles himself is surely the greatest expert on his argument, and he was wrong initially. It took him well over a year to come up with a second version of the argument that corrects (he believes) his earlier error.

With textbook examples such as the infinitude of the primes or the irrationality of the square root of 2, the issue seems fairly clear. At least it seems clear to mathematicians. Whether or not a typical trial jury made up of twelve ordinary citizens would be able to rule on the correctness or otherwise of Euclid's proof that there are infinitely many prime numbers is a question to which I do not know the answer. But, for the sake or argument, since these comments are written by a mathematician for consumption 'in the mathematical family,' let's assume the absolute correctness of these classical proofs. After all, they are all sufficiently short and of a sufficiently simple nature that anyone with a basic mathematical education can follow them.

President's Column



It is a unique privilege and challenge to serve as President of the MAA. I am lucky to have extremely able predecessors who serve as models, though I must confess that my immediate predecessor, Don Kreider, is an especially hard act to follow. On balance, though, I regard myself as very fortunate to be surrounded by many amiable and helpful colleagues.

Several people have asked me, "What does the MAA President do?" An outside observer would say that he or she reads reams of journals, documents, reports, and proposals, engages in lots of correspondence (especially via e-mail), and collects lots of free airline mileage. A more serious answer is that the President presides, represents, manages, and leads the MAA. These are listed in approximate reverse order of their importance. The President presides over meetings of the Board of Governors and the subcommittees that do much of the week-to-week work, namely the Executive Committee and the Finance Committee. The President represents the MAA in its relations with other mathematics and science organizations through various bodies with acronyms like JPBM, CBAMN, and CSSP. In addition, the President plays a major role in the Mathematical Olympiad ceremonies and represents the national MAA at as many section meetings as possible.

The President is the elected leader of the MAA. Fortunately, the MAA is run by an extremely able and professional staff in Washington headed by Marcia P. Sward, and we have an excellent working relationship. Among other things, her staff supports the extensive volunteer work in the organization. Moreover, there's a great

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But what about proofs that stretch over hundreds of pages, proofs that depend on other hundred-page-proof theorems obtained by other mathematicians, and which use mathematical concepts and techniques that perhaps no single person fully understands? Wiles' proof definitely falls into this category.

Or what about proofs such as Appel and Haken's 1976 proof of the Four Color Theorem, which involved an extensive computer calculation that no human can check by hand? The recent discovery of the flaw in the *Pentium* chip reminds us in a graphic fashion that computers are fallible—they too can make mistakes. Given the complexity of any modern computer system, it is surely reasonable to assume that the computer system used in the proof of the Four Color Theorem had faults; indeed, it would be *un*reasonable to assume otherwise. This leaves the proof of the Four Color Theorem dependent on our assumption that the errors in the system, whatever they were, did not adversely affect the calculations on which the proof depended. Given that Appel and Haken's proof was checked by others, using different computer systems running different programs, such an assumption is surely reasonable. But in acknowledging that fact, we pass from the idealistic world of 'absolute mathematical certainty' to the less secure world of 'beyond reasonable doubt'—admittedly not the very messy version of the legal world, rather the far more certain 'beyond reasonable mathematical doubt.' This latter notion is pretty darned convincing, but it is not quite the comforting picture (for mathematicians, at least) provided by the notion of formal proof that was so nicely captured by the mathematical logicians of the late nineteenth century.

The fact is, when you forget the rhetoric and look instead at actual mathematical praxis, when you look at what mathematicians actually do, not what they often say they do, then what passes for 'proof' is far closer to the lawyers' notion than we care to admit. A definition of *proof* that most accurately reflects real, live mathematical proofs, is to be found not in mathematical logic but in the sociology of science. In terms of the arguments that determine what mathematical statements we believe and what we do not, a *proof* is often just an argument that (i) has been accepted by a number of mathematicians whom the community at large feels it can trust on such matters, and (ii) has not yet been shown to be false.

If that is too uncertain for you, then you will probably never know whether or not Fermat's Last Theorem has been proved or not. Or whether the classification of finite simple groups has been completed. Or any of hundreds of other 'facts' of modern mathematics.

If the definition of a proof offered above looks familiar, it should. It is more or less the same thing that the late philosopher Karl Popper said about science praxis. In his highly influential 1963 book *Conjectures and Refutations: The Growth of Scientific Knowledge*, Popper argued that scientific theories are never proved; they are at best accepted until shot down.

This is not to say that mathematics is the same as the natural sciences. There are important differences. Mathematical knowledge has a certainty far greater than the knowledge offered by any scientific theory (let alone the 'facts' established in a court of law). But at the same time, there are similarities that those of us in the mathematics profession often overlook. This state of affairs is undoubtedly less comforting than the secure picture offered by formal logic. (Though when was the last time you saw a proof of a real theorem that followed the strict rules of logic? Remember, it took Whitehead and Russell 362 pages of formal deduction in their mammoth work *Principia Mathematica* before they were able to prove 1+1 = 2.) But, like it or not, for all its lack of comfort, such is the world of mathematics that we actually inhabit.

Personally, though I am attracted to the precision of cold logic, I find the sociological aspect—the element of 'uncertainty'—a pleasingly human aspect of the subject. How about you?

—Keith Devlin

The above are the opinions of the FOCUS editor, and do not necessarily reflect the official views of the MAA. The FOCUS editor says he accepts the proof of the Four Color Theorem, and will accept the proof of Fermat's Last Theorem, once it has been certified by the appropriate experts.

President's Column from page 3

deal of wisdom and talent on the Executive and Finance Committees, so the President never has to make uninformed decisions. The sorts of issues that come up include decisions concerning appropriate computer support, electronic services for the membership, and various financial issues.

My first rule of leadership is "Do no harm!" This is especially appropriate when so many people are already doing so many things well. For example, the MAA publications program and its numerous education initiatives are in extremely able hands. Let me say right off that I feel that the reforms taking place in science and mathematics education are fundamentally sound even though there are potential pitfalls. It is, of course, essential that we continue to motivate and fully prepare the most academic students in serious solid mathematics and science. I urge all members of our community to work with the reform movement, make the improvements necessary, and make sure that all of our students get the best education possible, rather than try to kill the reform movement with anecdotes.

People have also asked me what I hope to accomplish as MAA President. In addition to causing no harm, I have the following high priorities. I am very concerned about the job situation, though I have no solutions. However, communication between established mathematicians and "young" mathematicians has been substantially improved over the past year thanks to the creation of YMN, the Young Mathematicians' Network. Its weekly e-mail newsletter has provided an invaluable forum for sharing frustration and information. At section meetings, I have been trying to increase sensitivity among those who do the hiring. The MAA has already taken an important step in providing professional development for new faculty through the NExT program. More needs to be done by the MAA for professional development at all levels.

A second major concern of mine is to improve Board effectiveness. In the modern age, instant communication and the flood of information have increased the pace of MAA business. The challenge is to keep everyone involved and maintain good communication. A new task force has been created by the Board to look into exactly these issues.

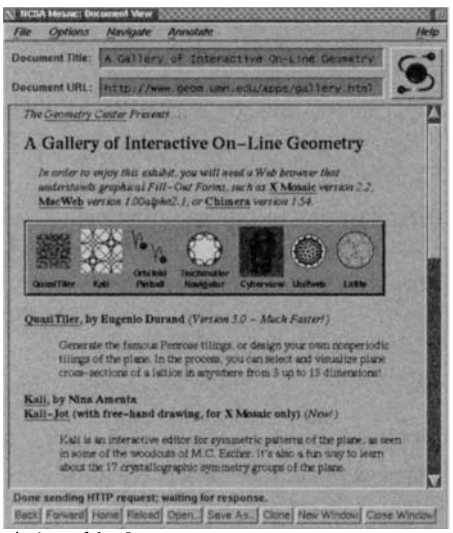
Finally, as mentioned above, I support the reform in mathematics and science education in this incredibly fast-moving world where quality education for all is essential. We need to reverse the widening gap between the haves and have-nots, while recognizing that this societal problem extends far beyond the education establishment.

In future columns, I will report on what is currently going on in the MAA. Also, as I am wading through those reams of paper, I will be on the lookout for references and quotes that I believe readers will find interesting. Comments on these columns and other aspects of the MAA are welcome. My e-mail address is ross@math.uoregon.edu.

Ken Ross

Geometry Center from page 1

The Science Museum of Minnesota estimates that about three thousand people use the exhibit during a typical week. Geometry Center staff member Tamara Munzner, one of the authors of the current museum exhibit, is currently talking to other science museums who may be interested in this exhibit, and is also looking into developing future exhibits with the Science Museum of Minnesota. We hope that in the near future, people visiting science museums will also have the impression that mathematics, like the sciences, is alive, accessible, and fun!



A view of the Geometry Center's interactive Gallery of On-Line Geometry, as it appears using the NCSA Mosaic WWW browser. Each picture and underlined word is actually a "hyperlink" that brings up additional information.

Mathematics on the Internet

Every year, millions of people go to science museums. We are rapidly approaching an age in which a comparable number of people have access to the Internet. The past year has seen a tremendous surge in the number of Internet users; a partial explanation for this is the popularity of so-called WorldWide Web (WWW) browsers such as NCSA Mosaic. (See the August 1994 FOCUS for more information on using NCSA Mosaic as a tool for Internet access.) You might say that the Internet has become a "Web of Dreams" that operates under the philosophy "Build it, they will come." Using a WWW browser, it is relatively painless (in fact, it's a lot of fun!) to electronically obtain information from all over the world. The WWW browsers use "hyperlinks" to allow the user to pass from one site of information to another without having to worry (or even know!) about where the information is coming from.

We at the Geometry Center are using the Web as part of our effort to make mathematics more accessible and understandable to non-mathematicians. Documents are written in hypertext, which allows users to "click" on certain words, phrases, and pictures in order to obtain additional information. Our hypertext documents are designed to present mathematics to the masses, using a combination of expository prose, computer-generated graphics, and animations. Furthermore, we have used the unique capabilities of the Web to produce interactive documents that allow users to explore and discover mathematics for themselves. We have a very popular Gallery of Interactive On-Line Geometry in which Internet explorers investigate and visualize the mathematics of quasiperiodic tilings of the plane, wallpaper groups, geodesics on manifolds, Riemann surfaces, and symmetries of the hyperbolic plane. The Geometry Center's WWW documents are accessible from our so-called "home page." Readers who have

access to the WorldWide Web may view our home page using the Uniform Resource Locator (URL) given by

http://www.geom.umn.edu

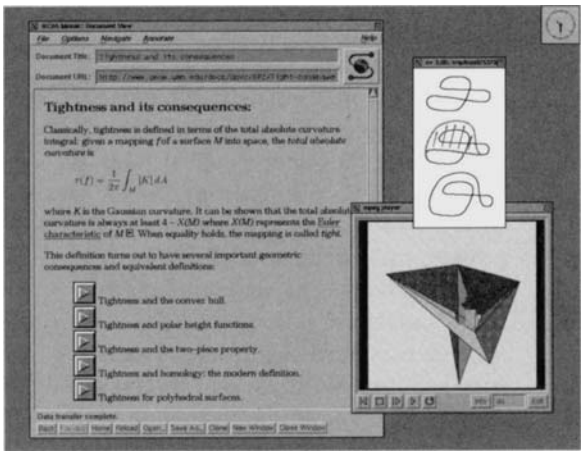
In fact, this article is available on-line as well as part of the Geometry Center's Online Multimedia Document Library!

The Geometry Center is also looking at how to use the WorldWide Web in order to disseminate research-level mathematics to professional mathematicians. Already we live in an age in which a large portion of research mathematics is distributed in preprint form, thanks to TEX, for formatting equations, electronic drawing programs for producing figures, and laser printers for putting it all on paper. Color printers and copiers now allow mathematicians to include color figures in preprints, thus increasing our ability to convey information about geometric structures. Yet our preprints and journal articles are fundamentally limited to static images. No paper-based preprint or journal allows authors to publish an animation showing a rotating surface. None allow the reader to alter parameters interactively in a model and subsequently generate a *new* figure that perhaps even the author has never seen. However, these abilities are available in hypertext documents, and the Geometry Center has begun to experiment with these possibilities through its Web documents.

As an example, we highlight a recent mathematical result by Center postdoc Davide Cervone. Cervone discovered a certain immersion of the real projective plane with one handle into three-space that settles a long-standing conjecture in simplicial geometry. The result is being submitted to a traditional journal, but because the fundamental result concerns exhibiting a surface with special properties, Cervone chose to write a preprint using hypertext as his medium. Cervone's document, obtainable by using the URL

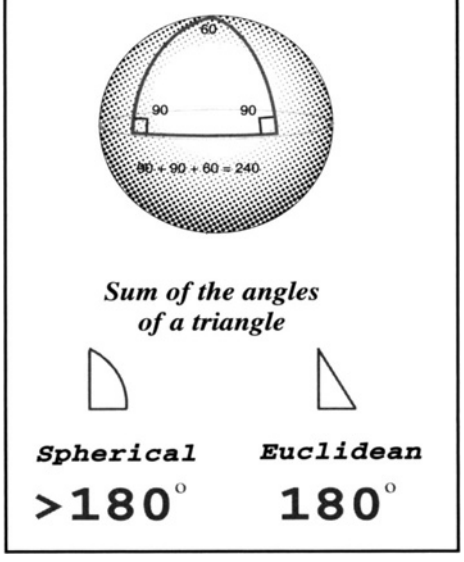
http://www.geom.umn.edu/docs/dpvc/RP2.html

begins with a highly accessible introduction to the problem (complete with hyperlinks to basic definitions!), and then proceeds to present and prove his new result. He then provides the reader with multiple ways of visualizing and interacting with this new immersion; there are movies of the rotating surface and of a family of level sets, and there are interactive pictures that the reader may manipulate in order to see the surface from a desired viewpoint. We are currently considering how to use this powerful medium to communicate mathematics in curricular material for undergraduates in mathematics, science, and engineering.



A document from Davide Cervone's multimedia preprint. The document not only presents a new mathematical result, but also illustrates one way to present mathematics using current technologies.

We believe that our presentation of mathematics on the Web is successfully reaching thousands of people from all walks of life, but it is very difficult to assess the impact of our efforts quantitatively. We have records of hundreds of thousands of connections to the Geometry Center WWW documents, but we cannot evaluate who these people are, nor determine their backgrounds. Are we reaching teachers from high schools and community colleges? Are we reaching populations that are underrepresented in mathematics? Are we making a difference in the way that ordinary people think about mathematics? Are we affecting the way that mathematicians think about presenting mathematics? We have some (very positive) comments sent to us by users, but it is difficult to extrapolate from this data. We need to understand how to assess our outreach through the Internet better.



A sample frame from Lori Holthus' video that introduces high school teachers and students to non-Euclidean geometry.

Summer Enrichment

Through the WorldWide Web, the Geometry Center distributes information to anyone who wants it. But the Geometry Center also runs hands-on, in-house, summer enrichment programs in which we target certain populations. This past summer our target populations were sixth through eighth grade females and underrepresented minorities, talented undergraduates, and high school math teachers.

The four-week summer program for sixth through eighth graders was a joint venture with the Office of Special Projects in the University of Minnesota School of Mathematics. The program was the culmination of a year-long effort to provide exciting and enriching mathematics to students who are in the process of making decisions about whether (or how much) mathematics will play a part in their future. The curriculum for the summer course was developed by postdocs at the Geometry Center and in the School of Mathematics, and featured units on planar isometries, symmetry groups, and the Platonic and Archimedean solids. The last two weeks of the summer institute focused on geometry and visualization, and made extensive use of the Geometry Center. The students met at the Geometry Center to use the Center's facilities and Center-produced software. As a closing group project of the solids unit, the students constructed what we believe to be the world's largest paper model of the MAA symbol—a six-foot-high icosahedron.

This construction was motivated by a FOCUS article (February 1994) that

showed a group of elementary school students who had built the world's largest rhombicosidodecahedron. In that polyhedron, each side had a length of thirteen inches. Rather than try to better that record, we chose to construct an icosahedron of roughly the same size; this resulted in our icosahedron having edges that measure thirty-seven inches. The event attracted the attention of the local television stations and newspapers who not only covered the event but also interviewed the beaming students. Weeks later, the icosahedron was prominently displayed at the MAA booth at MathFest, the joint summer meeting of the MAA and the AMS. We hope to encourage more students to explore symmetry and solid geometry by building models; a teacher's guide to creating a large icosahedron as a class project is available on-line from the Geometry Center's WWW server

http://www.geom.umn.edu/docs/fjw/Icosahedron.html

A much longer and more intensive summer program is the Geometry Center's research experience for undergraduates. We invite twenty undergraduates to spend ten weeks at the Geometry Center conducting research in topics chosen from mathematics, computer science, and math education. They work under the supervision of their "coach" Tony Phillips from SUNY Stony Brook, and collaborate on projects with Center postdocs, University math professors, and representatives from industry. This year many of the students presented their results at a poster session during MathFest, and several will also be traveling to an upcoming AMS meeting to present their work. The students tackled difficult problems in celestial mechanics, dynamical systems, Riemannian manifolds, and mathematical biology. The products of their labors include software and videos to illustrate the problems and solutions. One student, who began teaching high school mathematics this fall, even produced a computer-animated video designed to introduce high school students and teachers to non-Euclidean geometry! She completed this sophisticated video in just ten weeks (thanks to the support of the Geometry Center staff) and the result was so impressive that a publisher wants to market her video.

The summer enrichment class poses with their creation: an icosahedron of staggering proportions!

In addition to our summer program for undergraduates, the Geometry Center also annually runs an intensive two-week residential summer course for high school teachers of mathematics. The programs introduce new mathematics to the teachers and encourages them to develop activities suitable to use in their classrooms. This year the program on probability and statistics was called CHANCE and analyzed current events as reported in newspapers and journals. For example, the teachers discussed and debated applications of statistics to DNA fingerprinting and questioned whether vitamin supplements have any significant impact on health. The course participants learned that seemingly significant events (such as winning and losing streaks in sports) may actually be the natural outcomes of random events. Information about the CHANCE project, including a complete set of handouts from the summer course, is available from the Geometry Center's WWW server at the URL

http://www.geom.umn.edu/docs/snell/chance/welcome.html

Conclusions

In all of these varied activities among diverse populations, there is one common thread: the Geometry Center strives to present mathematics visually and interactively. We use tools such as computer graphics, animations, hypertext, videos, and world-record icosahedra to achieve our goals. And although we do not charge admission to visitors, we are like a modern science museum: we are trying to convey to students, teachers, and the general public that mathematics is alive, requires participation, and can be extremely rewarding. We continue to seek new opportunities and vehicles to spread this important message.

Calculus: A Student Centered Approach

Ithaca College will host a National Science Foundation funded five-day workshop, June 25th–30th, on the use of classroom activities and group projects to teach calculus. The workshop will provide an overview of the calculus reform movement and the experience of working with the materials developed at Ithaca College. A principal aim is to enable a wide range of participants from colleges and universities, two-year colleges, and secondary schools to become involved in these new pedagogical approaches.

Grant funds will provide for room and board. Faculty who teach significant numbers of students from underrepresented groups are particularly encouraged to apply. Applicants will be expected to demonstrate a commitment to use some of the materials in a calculus classroom during the following academic year. There will be a variety of follow-up activities for participants.

For additional information and an application form, contact Diane Driscoll Schwartz, Department of Mathematics and Computer Science, Ithaca College, 1212 Williams Hall, Ithaca NY 14850-7284; e-mail: nsfcalc@ithaca.edu.

Preliminary Call for Student Papers

Eighth Annual MAA Undergraduate Student Paper Sessions The eighth MAA Undergraduate Student Paper Sessions will take place at the Joint MAA-AMS summer meeting in Burlington, Vermont, August 6-8, 1995. For further information and/or to submit nominations for fifteen-minute papers along with brief abstracts, contact Ron Barnes, Computer/Math Sciences, University of Houston-Downtown, 1 Main St., Houston, TX 77002; e-mail: barnes@dt.uh.edu. A limited number of awards to support student travel have been made available through a grant from the Exxon Education Foundation. Deadline for submission of abstracts is June 26th.

Mathematics Awareness Week–April 23–29, 1995

Mathematics and Symmetry

Mathematics Awareness Week is held each year to increase public understanding of and appreciation for mathematics. This year's theme is "Mathematics and Symmetry." More information can be obtained from the Joint Policy Board for Mathematics((202)234-9570) and on the MAA Gopher gopher gopher.maa.org or on the WorldWide Web at: URL"http://www.maa.org". Plans are underway to make MAW visuals available via the WorldWideWeb at the University of Minnesota's Geometry Center; information will be posted on the MAA Gopher.

Activities for Mathematics Awareness Week are generally organized by college and university departments, institutional public information offices, student groups, and related associations and interest groups. They include a wide variety of workshops, competitions, exhibits, festivals, lectures, and symposia.

The number and breadth of activities increases annually. For example, one college has now sponsored a high school mathematics day for several years to encourage women to continue their studies in mathematics. At one university, two departments–mathematics and architecture–cooperated to plan and produce an interactive traveling exhibit that provides hands-on experience for such topics as codes, tilings, chaos, geometry, graphs, and computer science.

Coordination and support for Mathematics Awareness Week is provided by the Joint Policy Board for Mathematics, which includes the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics. Additional financial support comes from the United States Army Research Office, Oxford University Press, and Springer-Verlag.

Mathematics Awareness Week Visuals Order Form

Name _____

Address _____

City/State/Zip _____

Phone _____

1995 MAW "Mathematics & Symmetry" Poster (color) _____ @ $7.00 = $_____

1995 MAW "Mathematics & Symmetry" Postcards (color) _____ @ $5.00 = $_____
(set of 10, 5 each of 2 designs)

Order both the poster and postcards for only $10.00 _____ @ $10.00 = $ _____

****Reduced Prices on Past Visuals****

1 Each of 4 Posters from Past MAWS*
1994 MAW "Mathematics & Medicine" Poster (color)
1993 MAW "Mathematics & Manufacturing" Poster (color)
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A $20 value for only $14.00 _____ @$14.00 = $ _____

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1994 MAW "Mathematics & Medicine" Postcards (set of 10, 5 each of 2 designs)
1993 MAW "Mathematics & Manufacturing" Postcards (set of 3, 1 each of 3 designs)
1992 MAW "Mathematics & the Environment" Postcards (set of 4, 1 design)
1991 MAW "Mathematics Applications" Postcards (set of 4, 1 each of 4 designs)
A $10.50 value for only $6.50 _____ @$6.50 = $ _____

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All orders must be prepaid. All posters are rolled and mailed in a tube. Prices include third-class postage.
Please make check payable to AMS and send this firm to: JPBM Visuals, 1529 Eighteenth Street, NW, Washington, DC 20036.
* The JPBM may substitute another set of posters if supplies are depleted.

Joint Mathematics Meetings
January 4-7, 1995
San Francisco

Prizes Awarded in San Francisco

Prize winning members of the MAA, AMS, and AWM were honored at a joint prize session held at the January meetings in San Francisco.

The Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics was presented to Dr. Anneli Lax of the Courant Institute of New York University. The award is the most prestigious one given by the Association, and consists of a cash prize of $4000, a citation, and recognition by the American mathematics community. Dr. Lax has been editor of and indeed the entire driving force behind the MAA's New Mathematical Library, one of the most distinguished and successful series since its founding in 1961. The complete citation for Dr. Lax's award, written by Ivan Niven, will appear in the February issue of the *American Mathematical Monthly*.

In receiving the award, Dr. Lax observed that she was being rewarded for an activity that had been its own reward, and ended her remarks with some advice to all future mathematical writers: "Let us practice what we preach, read and write carefully, avoid trendy slogans, and go beyond mathematical correctness, syntactic correctness, and political correctness in serving our discipline in our individual ways."

The Chauvenet Prize for expository writing on mathematics by a member of the MAA was presented to Professor Donald G. Saari of Northwestern University, for his paper "A Visit to the Newtonian *N*-body problem via elementary complex variables," published in the *American Mathematical Monthly*, vol. 97 (February 1990). The award consists of a cash prize of $1000, a certificate, and the recognition of the mathematical community.

Anneli Lax

Donald Saari

Barbara T. Faires

Left to right: David Moore, Lisa Mantini, Robert Devaney

Responding to the award, Professor Saari dedicated his acceptance to the two mathematicians who most influenced his early career, Harry Pollard and Ralph Boas.

Three MAA members received the **Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching**, consisting of a cash prize of $1000, a certificate, and the recognition of the mathematical community. The recipients were Professor Robert Devaney of Boston University, Professor Lisa Mantini of Oklahoma State University, and Professor David Moore of Purdue University.

Who Invented Newton's Method?

"Children, don't try this at home," warned Dr. William Dunham, referring to the task of solving the pair of simultaneous equations

$$x^x + y^y = 1000$$

$$x^y + y^x = 100$$

This particular pair of equations was in fact solved in the eighteenth century by Simpson, using a new method he had invented, the method known nowadays as Newton's Method.

Professor Dunham of Muhlenberg College was the MAA Student Lecturer at the Joint Annual Meetings. 'Who invented Newton's Method?' was the main theme of his talk.

After describing Newton's life, and that of his great rival Leibniz, Dunham traced the now-familiar approximation method from Newton's own work, through a later development of Raphson, and on to Simpson. It is only with Simpson, declared Dunham, that we first see the method nowadays called Newton's Method.

Displaying the original writings of all three mathematicians to support his claim, Dunham showed how the method Newton himself used to find approximate roots was entirely algebraic, involving no reference to calculus or fluxions, and how it was only implicitly that Raphson used differentiation in his later version of Newton's approach.

(In his solution to the equations above, Simpson started with initial approximations $x = 4.5$ and $y = 2.5$, and after two iterations obtained the solution $x = 4.5519$, $y = 2.4495$.)

Students enjoy the annual Make-Your-Own Sundae party after the student lecture.

Left to right: Bonnie L. Thomas (Sonoma State University), Joan Chan (Sonoma State University), MAA President Ken Ross (University of Oregon), and his wife, Ruth.

Barbara Beechler

Theresa Michnowicz

Robert Eslinger

Donald W. Robinson

Howard Lewis Penn

Certificates of Meritorious Service to the MAA were presented to Professors Barbara Beechler (Southern California Section), Robert Eslinger (Oklahoma-Arkansas Section), Barbara Faires (Allegheny Mountain Section), Theresa Michnowicz (New Jersey Section), Howard Lewis Penn (Maryland–District of Columbia–Virginia Section), and Donald W. Robinson (Intermountain Section).

At the same ceremony, the AMS awarded the **Ruth Lyttle Satter Prize in Mathematics** to Sun-Yung Alice Chang (UCLA), the **Frank Nelson Cole Prize in Algebra** to Professors David Harbater (University of Pennsylvania) and Michael Raynaud (University of Paris Sud Orsay), and the **Award for Distinguished Public Service to Mathematics** to Professor Donald J. Lewis (University of Michigan).

The **Norbert Wiener Prize in Applied Mathematics**, awarded jointly by the AMS and SIAM, went to Professors Hermann Flaschka (co-coordinating editor of *Physica D: Nonlinear Phenomena*) and Ciprian Foias (Indiana University).

The AWM's **Louise Hay Award for Contributions to Mathematics Education** was made to Professor Etta Z. Falconer of Spelman College.

Board of Governors Meeting

The following are just a few of the many items of business that occupied the Association's Board of Governors for their seven-and-a-half-hour meeting in San Francisco on January 3rd.

- Former MAA President Len Gillman, who retired from the Board at the meeting, observed that he had served on the Board for twenty-two consecutive years, a figure he believed to be a record.
- Treasurer Jerry Porter announced that the cost of moving the meeting from its original venue, Denver, Colorado, which the MAA and the AMS had decided to do in the interest of protecting its members from a voter climate hostile to gays and lesbians, was $22,000. He remarked that this loss may be more than made up by the greater attendance at the San Francisco meeting than would have been in Denver, following the controversial Colorado ballot measure passed in November 1992 (see FOCUS, vol. 13, no. 1, p.4).
- The governors unanimously endorsed the nomination of Andrew Granville of the University of Georgia for the Hasse Prize, in recognition of his article "Zaphod Beeblebrox's Brain and the Fifty-ninth Row of Pascal's Triangle," published in the April 1992 issue of *American Mathematical Monthly* (vol. 99, no. 4, pp. 318-331).
- The governors gave unanimous support to a resolution expressing appreciation to the Exxon Education Foundation for forty years of corporate support of education reform in U.S. schools and colleges, including generous and critical support for a number of MAA programs, projects, and publications.

How to Get Mathematics Stories into the Newspapers

So you think you have just the right mathematical news item to catch the attention of the local newspaper. What does it take to make that desire a reality? This was the main question addressed at a public information session organized by the Joint Policy Board for Mathematics at the San Francisco meetings.

Former *Los Angeles Times* science writer Lee Dembart suggested that the secret was to ask the big, five o'clock question. Not *your* big question, which is probably, "What can this journalist do for me?" but the journalist's big question, the question that, according to Dembart, all journalists ask as their days' work is coming to an end: "Did I make the front page?"

"Try to see your story through the journalist's eye," advised Dembart. "Ask yourself why the journalist should want to spend time working on your story."

One way to increase your chances of success with a mathematics story is to talk about the psychological aspects, according to Keay Davidson, the science writer at the *San Francisco Examiner*, another panelist at the session. "People are fascinated by what motivates the mathematicians to do what they do," Davidson observed, a point echoed by comments from K. C. Cole of the *Los Angeles Times*.

For those mathematicians who want to write their own news stories or expository articles, make sure you have your tenure first, warned Paul W. Davis, an applied mathematician at Worcester Polytechnic Institute who writes articles for *SIAM News*. For, as Davis reminded the audience, the mathematics profession tends to view with considerable disdain anyone who dares to venture into the world of expository writing. The remark brought laughter, but it was laughter in agreement. The mathematical community clearly has a long way to go in the public relations arena. On the other hand, a positive sign that things might be changing was the large attendance at the session, which was chaired by Hugo Rossi, the new editor of the *AMS Notices*, and also included Andy Evangelista, who writes science articles in the publicity office of the University of California, San Francisco.

Schattschneider Demonstrates New Packing Result

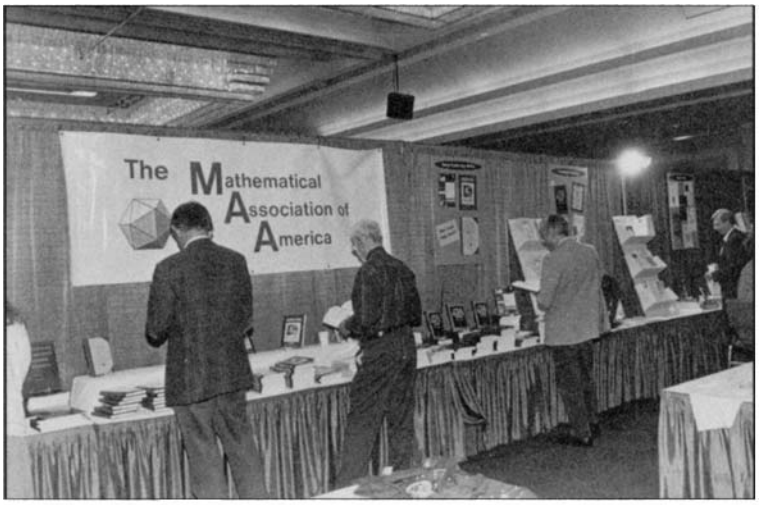
Dr. Doris Schattschneider, professor of mathematics at Moravian College and a vice-president of the MAA, demonstrated that it was possible to pack some 1100 randomly shaped mathematicians into the large ballroom of the San Francisco Hilton on January 6th, when she drew a more than capacity audience for her AMS–MAA invited address "Ingenious Mathematical Amateurs: M. C. Escher (artist) and Marjorie Rice (homemaker)." With all 970 seats occupied and about a hundred people sitting or standing around the edges, many had to be turned away at the doors.

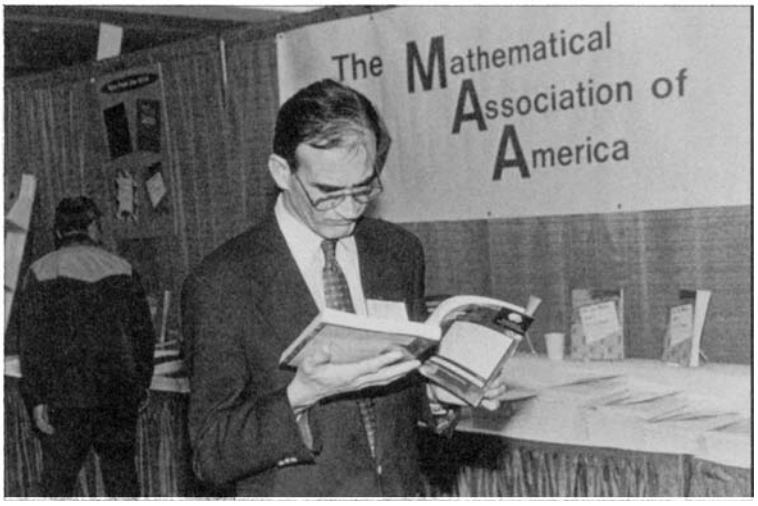
In one of the most successful talks of the meeting, Dr. Schattschneider described how both Escher and Rice, in the absence of any formal mathematical training, developed their own diagrammatic notations to study symmetry and tilings. For Escher, the key to the mathematical ideas he used was provided by a paper of George Pólya's, Schattschneider observed; for Rice it came from an article by Martin Gardner in *Scientific American*, followed later by correspondence with Schattschneider herself.

The work of both demonstrated the power and the importance of visual information in mathematical reasoning, Schattschneider concluded, adding that their status as mathematical "amateurs" proved the importance of good, popular exposition to draw in others whose special talents can further the development of mathematics and the influence of mathematics on human culture.

MAA Book Exhibit a Big Success

As in previous years, the Books Exhibit was a major attraction at the Joint Annual Meetings, with most of the 3500 meeting attendants passing through the display at least once. Sales of MAA books were particularly strong. Among the most popular MAA titles this year were **Linear Algebra Problem Book**, by Paul Halmos; **Lion Hunting and other Mathematical Pursuits**, edited by Gerald L. Alexanderson and Dale Mugler; and **All the Math that's Fit to Print**, by FOCUS editor Keith Devlin.





Expert Advice

"In God we trust, all others bring data!" advised MAA Teaching Award winner David Moore in his address at the award winners special session at the San Francisco meetings. His statistician's caution was directed toward all who seek to improve the teaching of collegiate mathematics. Moore advised that some of the crucial data we need in order to evaluate what we do is to be found in the hands of the educational psychologists.

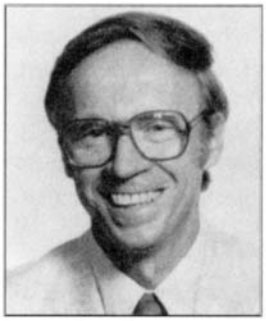
"We should regard teaching as a craft," he said, "and that means that anyone can learn it, and all who are employed to teach mathematics have an obligation to learn it."

Provide each of the students in your class with a list of names and phone numbers of the entire class to encourage them to feel part of a group and perhaps to help each other, was part of the advice offered by award winner Lisa Mantini, who entitled her presentation "To Challenge with Compassion." Insist that each student comes to see you in your office at least once so they see you out of the classroom and realize you are approachable, was another piece of advice she offered.

With the aid of interactive computer technology, some very simple ideas can very quickly lead to deep and interesting mathematical questions that can be investigated both computationally and analytically. This was the principal message conveyed by the presentation of awardee Robert Devaney, who demonstrated some dramatic experiments on randomly generated iterative systems.

Want to know more? During the course of the coming year, FOCUS plans to publish written versions of each of the presentations given by the three Teaching Award winners for 1994.

Award Winners from the MathFest, Minneapolis, MN, August 1994



Bruce Berndt
The Lester R. Ford Award
"Ramanujan—For Lowbrows," *American Mathematical Monthly,* Vol. 100, pp. 644-656. (Coauthored with S. Bhargava.)

Leonard Gillman
The Lester R. Ford Award
"An Axiomatic Approach to the Integral," *American Mathematical Monthly,* Vol. 100, pp. 16-25.

Charles W. Groetsch
The George Pólya Award
"Inverse Problems and Torricelli's Law," *College Mathematics Journal*, Vol. 24, pp. 210-217.

Joan P. Hutchinson
The Carl B. Allendoerfer Award
"Coloring Ordinary Maps, Maps of Empires, and Maps of the Moon," *Mathematics Magazine*, Vol. 66, pp. 211-226.

Dan Kalman
The George Pólya Award
"Six Ways to Sum a Series," *College Mathematics Journal*, Vol. 24, pp. 402-421.

Edgar Lorch
The Lester R. Ford Award
"Szeged in 1934," *American Mathematical Monthly,* Vol. 100, pp. 219-230.

Joseph H. Silverman
The Lester R. Ford Award
"Taxicabs and Sums of Two Cubes," *American Mathematical Monthly,* Vol. 100, pp. 331-340.

Dan Velleman
The Lester R. Ford Award
"Versatile Coins," *American Mathematical Monthly*, Vol. 100, pp. 26-33. (Coauthored with István Szalkai.)

Photographs of Lester R. Ford Awardees, S. Bhargava and István Szalkai were unavailable at press time.

Governors Express Concern Over Mathematics Job Market

At the suggestion of incoming MAA President Ken Ross, the Association's Board of Governors hosted a visit to its meeting in San Francisco by two members of the Young Mathematicians' Network, Steve Kennedy of Carleton College and Frank Sottile from the University of Toronto. The two explained the problems and frustrations of young mathematicians unable to find suitable employment.

In a separate but related agenda item, the Board unanimously passed the following three recommendations to departments and institutions.

- **It is incumbent on mathematics departments to make all their potential Ph.D.s aware of the realities of the job market and to encourage them to prepare for a broad range of jobs in the mathematical sciences.**
- **Colleges and universities should strenuously seek means to offer new Ph.D.s positions of at least two years' duration in order to allow for the crucial career development in teaching, research, and service that our profession expects at this stage.**
- **Colleges and universities should recognize that part-time appointments and the practice of hiring unemployed Ph.D.s by the course, without integrating them into the scholarly life of the department, are detrimental to the individuals and the profession.**

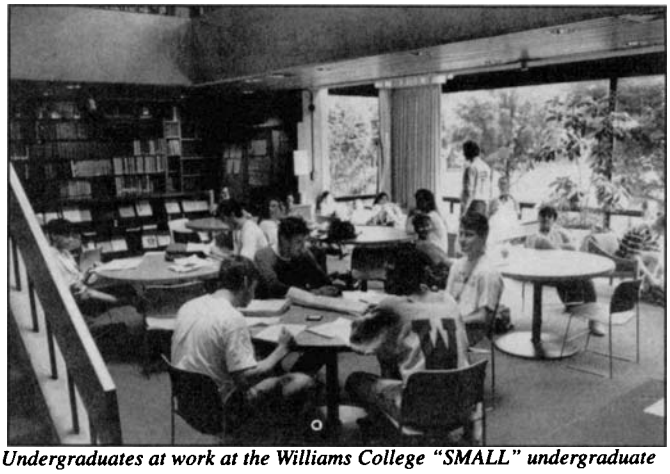
New Undergraduate Research Prize

Frank Morgan

The new prize for undergraduate research announced in December's FOCUS stands to recognize and encourage the excellent mathematical research that undergraduates are already doing. Undergraduates are working on problems of current research interest, proving theorems, writing up results for publication, and giving talks on their work. They are making significant contributions to mathematics. At the same time, they find out what real mathematics is like. They gain a new perspective and a new appreciation for their courses and for their teachers. They can make more intelligent decisions about whether to go on to graduate school. And when they do not go on in mathematics, they become a new breed of politicians, business persons, magazine editors, or other members of the general populace who have an appreciation of mathematics.

Undergraduate research in mathematics is no longer an oddity. Dozens of colleges and universities sponsor summer undergraduate mathematics research programs, many supported by the National Science Foundation. The National Security Agency, the Institute for Defense Analysis, AT&T, Bellcore, and NSF Centers and Institutes have expanded or created undergraduate research programs. Many national and regional meetings now include sessions on undergraduate research. Pi Mu Epsilon and the Mathematical Association of America award prizes and support to undergraduate speakers. The Council on Undergraduate Research, which sponsors research conferences for undergraduates from all fields, now has a Mathematical and Computer Sciences Division. At the first annual Hudson River regional undergraduate mathematics conference at Siena College near Albany last year, faculty and students ranging from introductory calculus to senior mathematics majors participated as equals in giving talks, chairing sessions, and discussing mathematics (see the article on page 946 of the October 1994 *Notices* by Douglas Briggs, one of the undergraduate participants).

It seems that undergraduate research can thrive in diverse locations and in diverse areas of mathematics. Good work and accessible questions are proliferating. Students cite theorems of previous students and pose conjectures for their successors. The 1994 AMS *What's Happening in the Mathematical Sciences* features some work by undergraduates in an article titled "Soap Solution."



Undergraduates at work at the Williams College "SMALL" undergraduate research project. Photograph by Cheryl LeClaire, Williams Alumni Review.

History In 1990 the Association for Women in Mathematics established the Alice T. Schafer Prize for excellence in mathematics by an undergraduate woman. The Schafer prize inspired Joe Gallian, who for seventeen years has run the granddaddy of modern undergraduate mathematics research programs at the University of Minnesota in Duluth, and Stan Wagon to propose an undergraduate research prize to the MAA. Joe took the idea to the CUPM Subcommittee on Undergraduate Research in Mathematics, chaired by John Greever. Stan Wagon took the idea to the MAA Coordinating Council on Awards, chaired by Henry Alder. In an astonishing tribute to our mathematical organizations and committees, the idea developed rapidly to fruition, with the help of Aparna Higgins (chair of the MAA Committee on Student Chapters), Beth Ruskai (chair of the Joint Committee on Women in the Mathematical Sciences), Ron Graham (AMS President), Gil Strang (SIAM Vice-President for Education), and many others throughout the mathematics community.

The Prize The prize has some interesting features. To proclaim the existence of excellent undergraduate research, there is a single prize of $1000. To recognize the keenness of the competition, there is provision for a few honorable mentions. To recognize the important role collaboration often plays, the prize may be shared by a group of students working together.

Nominations For the first award, research papers (submitted by the student or a nominator) and a supporting letter must be submitted by June 30, 1995. Undergraduates in the United States, Canada, or Mexico as of December 1994, are eligible.

Faculty or students interested in organizing or participating in undergraduate research might contact Jack Ryff at the NSF (jryff@nsf.gov) for advice and a list of the current NSF Research Experiences for Undergraduates.

Frank Morgan is chair of the Mathematics Department at Williams College and codirector with Colin Adams of "the SMALL" NSF undergraduate research project. He is also a member-at-large of the AMS Council.

This article also appeared in the January issue of AMS Notices.

Summer Mathematics Camp

The third annual camp for mathematically talented high school students will be held this year in Canada: July 3rd–28th in Vancouver (University of British Columbia) and July 31st–August 25th in Toronto (University of Toronto). The four-week camp, known as MathCamp, is a reeducation of mathematically precocious teenagers by university mathematicians who are also experts in communicating concepts to these teenagers and in helping them do mathematics. The fee is $550 (Can$690). Meals and supervised university dorm rooms are U.S.$30 extra per day. Enrollment is limited to forty. The application deadline is May 15th. For a brochure which also contains the application form, call (519) 672-7990.

New GRE Mathematical Reasoning Test

Alan Tucker

This article is being published simultaneously in Notices of the American Mathematical Society, *and an earlier version appeared in the September 1994 issue of* UME Trends.

The General Test portion of the Graduate Record Examination will be reorganized in fall 1997 to consist of the following five parts:

1. A revised version of the current quantitative test
2. A revised verbal test
3. A revised analytical reasoning test
4. A new mathematical reasoning test
5. A new writing sample test.

These five General Test measures will be offered in two packages: (1) verbal, analytical, writing, and revised quantitative; and (2) verbal, analytical, writing, and mathematical reasoning. Graduate departments will select the package of measures most appropriate for graduate study in their disciplines. Fall 1994 freshmen will be the first graduating class to take this new GRE exam. The new mathematical reasoning test will include problems of the type associated with "reform calculus."

The new GRE mathematical reasoning test is expected to replace the current quantitative test for students planning graduate study in engineering, the physical sciences, the mathematical sciences, computer science, economics, and some areas of biology. Unlike most widely used tests for post-baccalaureate study, such as the LSAT, MCAT, GMAT, and current GRE exams, the new GRE mathematical reasoning test will draw on knowledge acquired in a first-year course in calculus. This writer was a member of the advisory committee that recently set the specifications for this new mathematical reasoning test.

It is important for mathematics departments to be aware of this direct link between learning in calculus and performance on the new GRE mathematical reasoning test. The new test has drawn high praise from faculty in the sciences and engineering, and they expect the test to carry considerable weight in graduate admission decisions in their disciplines. Thus mathematics departments should become familiar with the general types of mathematical problem-solving on this new test. In particular, the new test will include problems of the sort found in calculus reform texts such as the Harvard Consortium text.

Readers might be interested to know that the GRE testing program is likely to be fully computerized in 1997; that is, examinees will be required to take the test on computers. Currently the GRE General Test is available on computer only at selected locations. The current computerized General Test is an adaptive test, as each of the new General Test measures will be (with the exception of writing). In an adaptive test, each question an examinee receives will depend to some extent on the answers to previous questions. Examinees receive fewer questions, since an adaptive test allows the test to estimate the examinee's approximate ability level and focus questions around this level. There is one serious drawback, in the minds of many faculty, to the adaptive testing scheme—examinees may not skip a question and return to it later (or change an answer after it has been confirmed).

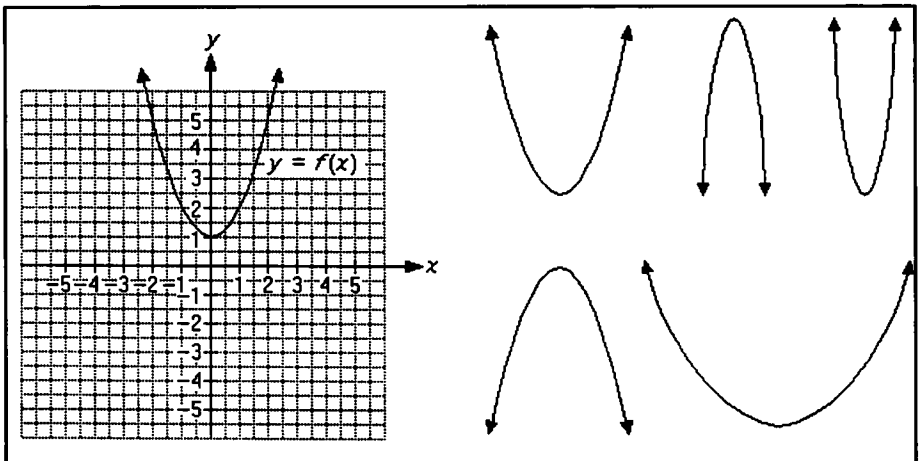
The current GRE quantitative test assumes only two years of high school algebra so as to accommodate humanities students who have had no mathematics since high school, and produces uniformly high scores among college seniors in mathematically oriented disciplines. These high scores limit the value of the test for admission decisions in mathematically oriented graduate programs. At the same time, nonmathematical graduate programs are also concerned because they feel these high quantitative scores bias the GRE General Test to favor mathematically oriented disciplines. Such a bias may influence decisions about university-wide fellowships at the many institutions that use the GRE General Test in selecting fellowship recipients.

Following is the proposed content of the new text in terms of both reasoning skills tested and the mathematical background assumed. Many questions may involve more than one category of reasoning skill and also possibly more than one content category.

Mathematical Reasoning

Mathematical Modeling

- Recognize whether a mathematical model applies to a given situation (e.g., linear function)
- Develop a mathematical model (e.g., graph, equation, schematic, geometric figure) from a description of a system
- Recognize what assumptions underlie a particular mathematical model and how those assumptions can affect the validity of the model (e.g., employing a continuous model for a discrete situation,



Given the graph of $y = f(x)$, produce the graph of

$y = f(2x) - 3$

by selecting one of the 5 curves and positioning it in the coordinate system.

neglecting aspects of a physical situation in developing a mathematical model of it)

- Reason with symbols rather than numbers (e.g., determine the influence of a parameter on a mathematical system)
- Express in everyday language relationships that are given mathematically

Logical Reasoning

- Formulate a conjecture or draw conclusions from a given set of results or observations
- Construct a valid argument to support or refute a conjecture or hypothesis
- Determine the validity of an argument or identify the flaw in an invalid argument

Patterns and Similarities

- Recognize patterns, trends, or symmetries; continue a pattern
- Investigate relationships between various mathematical ideas and processes (e.g., relationship between slope and rate of change)

Problem-Solving Strategies

- Reduce a problem to a simpler case
- Determine when a certain procedure is appropriate for solving a problem (e.g., differentiation, integration, averaging)

Estimation and Approximation

- Determine when estimation techniques are appropriate and determine the degree of accuracy needed in an estimate
- Recognize the reasonableness of results (e.g., orders of magnitude, signs of physical quantities)

Mathematical Content

Arithmetic and Algebra

- Basic properties of integers (e.g., divisors and multiples, prime and composite numbers)
- Solving equations and inequalities; factoring
- Laws of exponents
- Ratio, proportion, and percent

Geometry and Analytic Geometry

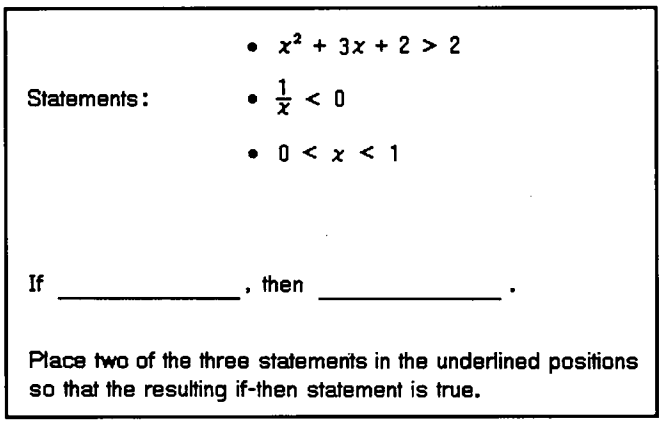
- Properties of geometric figures (e.g., perimeter, area, volume, Pythagorean theorem, similarity)
- Coordinate geometry (e.g., equations of lines, planes, and conic sections, distance between points, relationship between rectangular and polar coordinates)

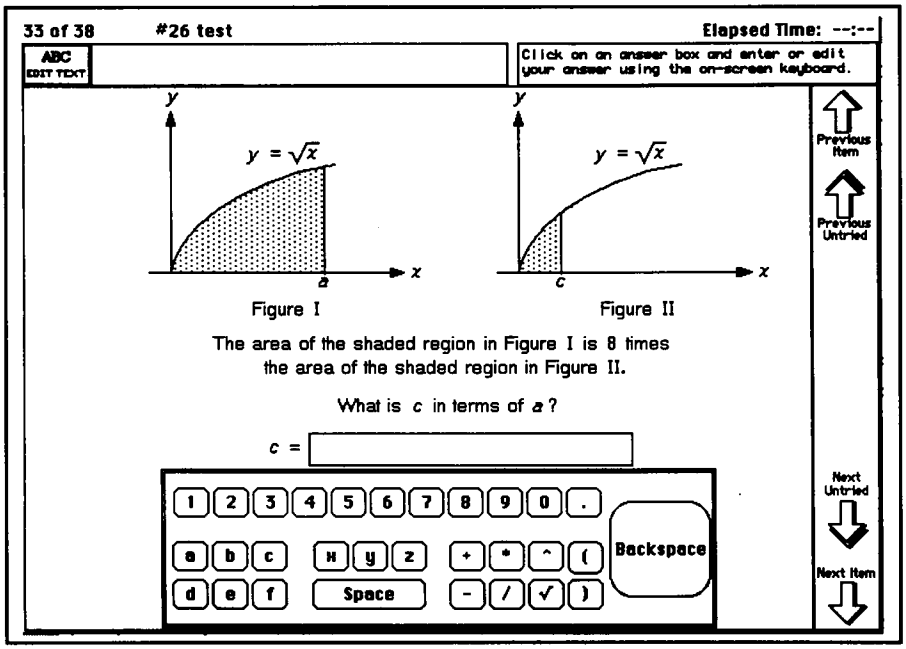
Functions and Their Graphs

- Relationship between algebraic and graphic representations of functional relations (continuous or discrete)
- Properties of functions and their graphs (e.g., domain, range, continuity, symmetry, composites, inverses, intercepts, asymptotes)
- Elementary functions, their properties, and their graphs (e.g., polynomials, rational functions, trigonometric functions, exponential functions, logarithmic functions)

Calculus

- The limit concept, properties of limits, computation of limits
- Rates of change (e.g., speed, average rate of change)
- The derivative of a function and its relationship to the behavior of the function and to the slope of its graph
- The definite integral and its relationship to the area of a region in the plane
- Relationship between integration and differentiation
- Differentiation and integration of elementary functions (e.g., polynomial, trigonometric, exponential, and logarithmic functions)
- Standard applications of the differential and integral calculus (e.g., velocity and acceleration, exponential growth, work,





compound interest, optimization problems)

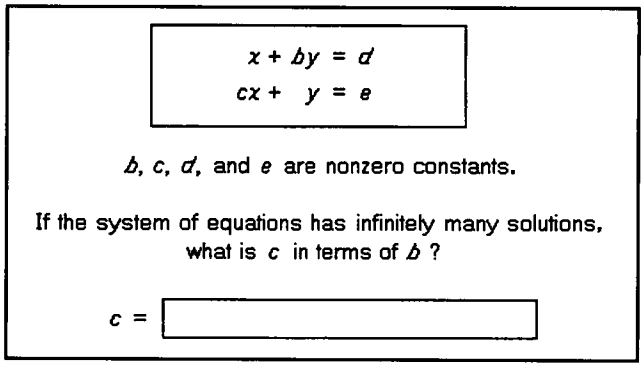
Probability and Statistics

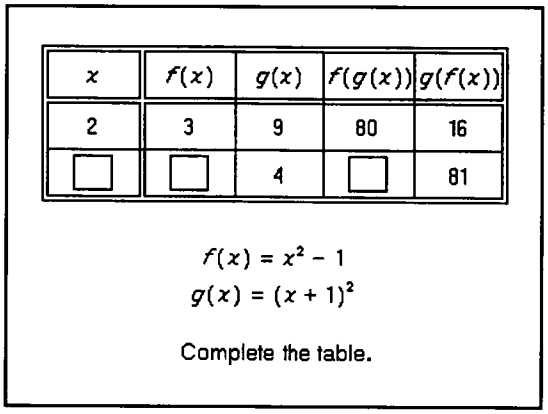
- Measures of central tendency (mean, median, mode) and dispersion (range, standard deviation, variance)
- Interpretation of tables, graphs, histograms, etc.

The new mathematical reasoning test is designed to test mathematical reasoning skills and not mathematical content knowledge, and so its calculus prerequisite will not result in questions directed at knowledge of calculus techniques. The types of questions to appear on this test were developed somewhat independently of the calculus reform movement but reflect the same concern for an understanding of concepts and their interpretation in graphical and applications settings.

Shown are sample test items generated by ETS staff.

For further information about the new GRE mathematical reasoning test, contact Jacqueline Briel, GRE Testing Program, Educational Testing Service, Princeton NJ 08541.





Alan Tucker is the associate chairman of the Department of Applied Mathematics at the State University of New York at Stony Brook.

1996 NSF–CBMS Regional Research Conferences in the Mathematical Sciences

Request for Proposals

Closing Date: April 3, 1995

The National Science Foundation intends to support from five to seven NSF–CBMS regional research conferences in 1996. A panel chosen by the Conference Board of the Mathematical Sciences will make the selections from among the submitted proposals. In the twenty-six-year history of this NSF–CBMS Regional Research Conference Series, a total of 247 such conferences have been supported.

Each five-day conference features a distinguished lecturer who delivers ten lectures on a topic of important current research in one sharply focused area of the mathematical sciences. The lecturer subsequently prepares an expository monograph based upon these lectures, which is normally published as a part of a regional conference series. Depending on the conference topic, the monograph is published by the American Mathematical Society, the Society for Industrial and Applied Mathematics, or jointly by the American Statistical Association and the Institute of Mathematical Statistics.

Support is provided for about thirty participants at each conference and the conference organizer invites both established researchers and interested newcomers, including postdoctoral fellows, graduate students, and underrepresented groups, to attend.

Inquiries concerning this conference series or the preparation of proposals for conferences should be directed to Conference Board of the Mathematical Sciences, 1529 18th St. NW, Washington, DC 20036; (202) 293-1170.

Support Your AAAS Stamp

Preparations are underway to mark a historic event in 1998: the 150th anniversary of the American Association for the Advancement of Science (AAAS). Recently launched was a campaign for a 1998 U.S. postage stamp commemorating not only AAAS but the last 150 years of scientific achievement. A proposal will be submitted to the Citizen's Stamp Advisory Committee (which screens new stamp proposals for the U.S. Postal Service) soon after the AAAS February 1995 annual meeting. It takes about three years to go from a stamp's approval to its design and production, and in order for the proposal to be successful, we must show significant and widespread public support for the new stamp. Letters of support would help a great deal. Send them, as well as any suggestions for the stamp's theme and design, to:

AAAS Commemorative Stamp Committee; Office of Communications, Rm 801; 1333 H St. NW; Washington, DC 20005.

Search Committee Diary

Edward F. Aboufadel

As we bid farewell again to our diarist, we cannot help but wonder, will he be back to clue us in when he goes up for tenure? As for now, read on and find that intrepidity has paid off. The final months of the committee's search slowly wind down until Dr. M arrives on the scene and says, "Yes."

> Some books also may be read by deputy, and extracts made of them by others.
>
> Francis Bacon
> "Of Studies," *Essays*

January 31, 1994: The pace of the search has slowed to a crawl these past two weeks, for a number of reasons. First has been the dangerous weather of the past few weeks. Southern was closed two different mornings last week, and the Search Committee meeting we had scheduled has been postponed until next week. The second reason has been the beginning of spring semester, which has distracted all of us with on-the-spot advising and roster juggling.

The third reason is that we now have over 450 applications, 250 of which haven't been read yet. In order to speed up our decision making, we have decided to split the unread applications among the five of us. The chair has asked us to "try to identify the clear and evident rejections since we have been consistently agreeing on these." We will meet soon to come up with a manageable number of viable files.

February 8, 1994: The Search Committee yesterday settled on seventy quarterfinalists—the thirty from December plus another forty from our individual readings this past two weeks. The other four hundred or so applicants we have rejected completely, and we will start sending them rejection letters soon. Many of the rejected applicants were simply not who we were looking for.

Our next task is to reduce the seventy quarterfinalists to fifteen or so semifinalists. We will do that on February 16th. To prepare to do that, each of us on the Search Committee will be reviewing the applicants of this super seventy and also our notes from the Cincinnati interviews. After that meeting, the applications of the fifteen or so semifinalists will be distributed to all members of the department for comments.

The School of Education here was looking to hire for a position starting January 1994, but the funding for that position was cut over the holidays. The Search Committee wondered if that meant that funding for our position was also in jeopardy, but the chair said that the dean has reassured him there is no problem.

> These are the things that you at home need not even try to understand.
>
> Ernie Pyle
> "On Victory in Europe," *Ernie's War*

February 16, 1994: Today the Search Committee met to make our second cut. After some discussion and voting, we separated our seventy quarterfinalists into four groups. The first group, which we labelled as "Double Stars," are the best candidates, and there are seven of them. Next are the "Single Stars," which number eleven. The third group is the "Pluses," and there are nine of them. The remaining forty-three we have now rejected. The eighteen "Stars" are our semifinalists (which is a little more than the fifteen that we planned, but that's OK), while the "Pluses" are our alternate candidates. The next step is to give members of the department the opportunity to comment on the applications of these eighteen candidates.

Although it would be both difficult and inappropriate for me to go into the details about how we are making these decisions, I do want to point out that our reduction from nearly five hundred applications to fifteen semifinalists is based upon the application materials only. (In the case of those that we saw in Cincinnati, our observations from those interviews were factored into today's decisions.) Only after we receive the comments from the department will we start doing telephone interviews. Then, to decide on our three finalists, we will use the combination of the department's thoughts, telephone interviews, and further deep reading of the application folders by the Search Committee.

At this point, we are a little behind the schedule we established last fall. By now we wanted to have our three finalists

picked. The committee is a little anxious that we may lose a prime candidate to another school if we don't act quickly. One tactic we have undertaken is to call some of our better candidates, to tell them that we are interested in them, and to ask if they are still available. So far none of those that we have called said that they found a position elsewhere.

The committee is also getting a little anxious about funding for this position. Last week a different department at Southern completed a search, decided on a candidate, and made the candidate an offer. Soon after, the offer was "put on hold" for financial reasons. The chair asked the dean what the implications were for our search. The dean told us to proceed, but we are apprehensive. We are ready to defend our need for this position vigorously!

The Search Committee also decided on the wording of a rejection letter to send to those applicants who did not make our first cut. Thinking about my comments in FOCUS two years ago, I now realize that writing a good rejection letter is not easy. On the one hand, you want to treat these applicants with courtesy, and perhaps even sympathy. The opportunity is there to use the rejection letter to educate (provided that the applicant reads it), and you don't want people to go away with a bad attitude about Southern Connecticut State University—after all, we may meet again. On the other hand, you don't want to get into an argument with anyone about how decisions were made. With these ideas in mind, we drafted the following letter:

Dear <Name of Applicant>:

We regret to inform you that you are no longer under consideration for our position of Assistant Professor in Mathematics and Mathematics Education. We have a strong program in mathematics educa-

tion at Southern Connecticut State University, and we are looking for a candidate with a doctorate, preferably with secondary school experience to maintain that strength. The key responsibilities of our position are as follows: to supervise the students in our program who are earning their secondary (i.e., high school) education teaching certificates; and to teach undergraduate courses in mathematics, and undergraduate and graduate courses in mathematics education. That we are not able to make you an offer is more a reflection of our own specific needs than a negative judgment of your credentials. Nevertheless, we do appreciate your interest in Southern, and we hope that you will consider applying to us again should we advertise a position suitable for your qualifications.

Sincerely,

February 28, 1994: We are beginning to get calls from applicants who are wondering about their status in the search process. All questions of this sort are going to the chair who is telling them honestly where they stand.

The first round of rejection letters is now being prepared by our secretary. One question we asked ourselves is whether or not these letters should be individually addressed or if they should read "Dear Applicant." To tie up our secretary and our laser printer to produce over four hundred rejection letters is simply beyond our means, so we are going to go the less personal route and make use of the copying machine. All quarterfinalists who are ultimately rejected will receive a personally addressed letter.

J. Phillip Smith, Dean of the School of Arts and Sciences, negotiates with Dr. M.

We also need to check with the Affirmative Action office now to determine whether or not we have been conducting a broad enough search, according to federal guidelines.

Here is an item of interest: the distribution of the years of graduation of our applicants. Of our nearly five hundred applicants, 49% are receiving their Ph.D.s this year (1994), 18% received them in 1993, 7% in 1992, 5% in 1991, and 3% in 1990. Of our hopefuls, 9% received their doctorates in the 1980s, and 4% of our candidates got their Ph.D.s in the 1970s; 2% earned their degree before 1970. The percentage of our applicants who have not earned Ph.D.s, nor indicate that one is on the way, is 3%—more than I expected.

March 1, 1994: Today the Search Committee met to try to whittle our eighteen semifinalists into a handful of finalists. All of us took a hard look at the eighteen folders, and we received some feedback from department members not on the Search Committee. Everything in the applicant's folder is important at this point: resume, letters of recommendation, transcripts, cover letter—everything. We have cut about half of the semifinalists. The rest we want to contact by phone for one reason or the other. (Each phone contact may involve two or more members of the Search Committee sitting in separate offices on separate telephones, talking to the same candidate—a real conference call!) After these phone contacts, we will have between three or five finalists that we will be inviting on campus.

If a finalist is not from Connecticut, then we will reimburse him or her for travel expenses. Also, we will be sending our finalists information about the talk they will be giving to the faculty here. Because of the nature of our position, if a candidate wants to organize his or her talk as if teaching a class (by, for example, using group work or manipulatives), then that is fine (but not necessary). We are hoping to have finalists start visiting this month.

March 9, 1994: As we start to contact people by phone, we are discovering that a few of them have already been invited to other schools for interviews and have even accepted offers. That news has shot a bit of adrenalin into us.

March 25, 1994: We have now determined our three finalists and have invited them to campus. One of the finalists will be here next Monday, the second on Thursday, and the third on the following Tuesday. The chair found e-mail very useful to set up the interviews.

Each finalist will have a similar schedule on campus. Here is what a typical day will be like:

8:00	Breakfast with interested department faculty
9:00	Interview with the Search Committee
10:00	Campus tour
11:30	Lunch with available department members
12:30	Presentation by the candidate
2:00	Informal discussions with interested department members
3:00	Interview with the dean of the School of Arts and Sciences

During the campus tour, we will show them our high-tech classroom, the "transitional building" that is being built (the first stage of our Master Facilities Plan), and our small classes (maximum enrollment is thirty).

It appears that I will be setting my alarm for an hour or so earlier for these interviews.

We have heard encouraging news about continuing our search. The powers that be have given us strong assurances that when we choose someone to hire, it will not be in vain.

> Thou shalt not do as the dean pleases,
> Thou shalt not write thy doctor's thesis
> On education
>
> W. H. Auden
> "Under Which Lyre"

March 30, 1994: Events passed quickly this week and it appears that our

search is almost over. On Monday, one of our finalists came for an on-campus interview. The Search Committee was impressed with this person. Other members of the department liked the candidate, too, according to the comments that we solicited.

That same day, our other two finalists withdrew their applications. One of our finalists has received two other job offers already, and the other backed away for various reasons.

Today the Search Committee met to discuss possible options. After some deliberations, we decided to offer the position to our Monday visitor. We have resolved to act quickly, since excellent candidates with a special interest or a Ph.D. in mathematics education have been hard to find this year.

At this point, the dean of the School of Arts and Sciences takes over and handles the negotiations. After the meeting, the chair talked to the dean to relate the Search Committee's recommendations about requirements that should be included in the offer letter (e.g., that the candidate have a Ph.D. in hand by a specified date) and about salary. The dean will consult with the academic vice president about these issues.

March 31, 1994: Given our experience this year, I wonder if it is time for the leaders in the mathematics community to say something about the shortage of Ph.D.s in mathematics education? On second thought, the last time someone brought up a shortage of Ph.D.s....

April 21, 1994: After a few weeks of negotiations with the dean, our new colleague—I'll call this person Dr. M—this week accepted our offer.

I suppose it is not too early to speculate about the fall and what really matters in academia: Who will Dr. M be sharing an office with? Will Dr. M be happy here at Southern Connecticut State University? Will we be happy with Dr. M? Like myself, Dr. M will be going through an annual evaluation process to monitor teaching performance and professional growth.

Everyone on the Search Committee is relieved that our job is done. It has been a long process, and all five of us are glad that it was ultimately successful. Of course, we still have to send rejection letters out to our better candidates, the quarterfinalists. Our secretary is working on that right now.

That day therein we read no more.

Dante's *Inferno*

Some Final Thoughts: As of this writing (mid June 1994), we are still receiving in the mail a handful of applications.

The dean and I chatted recently about "departmental memory." He told me a story about a department at Southern that conducted a search one year and another search the next year, with no one on the first search committee finding his or her way onto the second search committee. As a result, the second committee made the same mistakes that the first committee did. Another department hadn't conducted a search in a decade, and when they needed to hire someone, they weren't sure where to start.

Recently the chair and I were wondering what we would change if we had to do another search next year. We both wanted to have a smaller number of applicants and to have the process move along quicker, goals which are not necessarily independent. We agreed that an advertisement which is even more specific about requirements of a candidate would be a good way to start to reduce the number of applicants. Maybe. The following anecdote was recently passed on to me about a different search: "An advertisement specifically mentioned three requirements for the successful applicant. A member of the committee confided to me that out of that mass of resumes, only *five* could be identified as *meeting* the specific requirements in the posting!"

I wonder how much longer we in the mathematics community are going to tolerate this situation: not enough jobs, too many graduates, an application process that is keeping the post office profitable and is taxing everyone's time and resources. None of us earned our Ph.D.s because we wanted to send out scores of applications, write hundreds of letters of recommendation, or read folders whose number is comparable to the pages in an average calculus text. We are intelligent people—we should be able to solve this problem.

Workshops—DIMACS, Rutgers University

March 1995

Mini workshop on Gene Finding and Gene Prediction (to be held at the Genome Center at the University of Pennsylvania, day as yet unscheduled). For more information, contact David Searls, dsearls@cbil.humgen.upenn.edu.

March 20–27: Two mini workshops on protein structure

March 20–21: Global Minimization of Nonconvex Energy Functions including a Distinguished Lecture Series lecture by Herbert Hauptman

March 24: Sequence-Based Methods for Protein Folding

May 1995

May 3–5: Workshop on HIV Sequence Data

May 12: Mini workshop on Database Aspects of Biological Data (probable topic)

July 1995

July 17–18: Mini workshop on Geometrical Methods for Conformational Modeling

September 1995

September 13–15: Algorithm Implementation Challenge Workshop (DNA Sequence Determination from Shotgun Sequence Data)

Organizers: Joachim Messing and Fred Roberts (chairs), Lawrence Shepp and Michael Waterman (co-chairs). The workshops will be held at DIMACS, Rutgers University. For more information on the above workshops, contact DIMACS Center; (908) 445-5928; e-mail: center@dimacs.rutgers.edu; WWW: http://dimacs.rutgers.edu/; TELNET: telnet info.rutgers.edu 90.

LETTERS TO THE EDITOR

A Second Opinion

From Anneli Lax

In "Personal Opinion" (June 1994), Professor Gillman criticizes some suggested model solutions of mathematical problems designed to test problem solving ability of 4th, 8th, and 12th graders. He is reacting to a report on the *1992 Mathematics Assessment* published by the U.S. Department of Education in 1993.

I am sufficiently critical of Gillman's approach in "Personal Opinion" to write a second opinion; his attitude typifies that of many professional mathematicians so preoccupied with their ways of thinking that they are not open to students' homespun solutions. My remarks are based on my personal experiences.

"Jill's Class Trip" is the first example cited or paraphrased:

How many weeks must Jill work to earn $45 for the trip if every week she earns $2 on each of 3 days, $3 on each of 3 other days, and nothing on Sunday?

Now, when colleagues and I experimented with word problems in a class of 9th graders in a New York inner city school, we found that after the students demystified a question (i.e., after they interpreted it, criticized it, made fun of it, altered it to make it more interesting), the youngsters seemed to have no trouble solving it. Extrapolating from our experience, let me demonstrate what might take place.

Student 1. How come she earns only two dollars a day? Don't her boss pay no minimum wage? Or does she work less than half an hour those days?

Student 2. Yeah. What does she do anyway for that kind of pay?

Student 3. So okay. She works three days a week for the miserable sum of two bucks. So if she doesn't spend any, she will have six bucks for three days.

Student 4. And another nine bucks for the three days when she gets the big fat three dollars a day. Big deal! She gets fifteen bucks for this six-day week!

Student 1. What class trip would cost forty-five dollars? Some trips might, but not no class trip.

Student 2. Hey man, remember this is not real; this is math. You're not supposed to think about real trips and real pay. So, say she earn her fifteen bucks in one week, and say she be dumb enough to not spend a cent until she has enough for the forty-five-dollar trip.

Student 1. She won't even have enough after two weeks!

Student 4. Right. She will have thirty dollars. And now she's got to slave another week at that weird job before she has forty-five.

At this point, the class may have to be reminded that it has, in fact, answered the question as earlier interpreted.

In the meantime, a fifth student, who was not paying attention to the conversation between the other four, may say, "Wait a minute. Even if she made three bucks on each of the six days, she would make only eighteen bucks, but since she makes only two bucks on three of these days, that's one buck less three times, so three bucks less a week, so only fifteen bucks a week. And look, fifteen times three is forty-five, so in three weeks she will have the money she needs.

Gillman remarks that "the solution requires more than one step." In any of these and other scenarios, how many steps were used? What is a "one step" problem? Who measures or counts the steps? Let us count the ways of solving, not the number of steps. The difficult part of dealing with "Jill's Class Trip" may well be swallowing the unbelievable 'given data' rather than having to play the school math game.

Gillman reports that only 49% of 8th graders gave an acceptable response to the question

Find two numbers that make the sentence

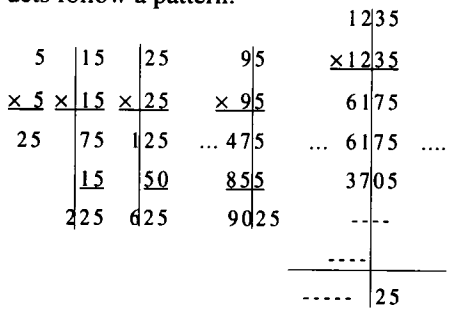
$$54 < 3 \times \square$$

true.

Gillman rightly criticizes the suggested answer: 19, 20. He concludes, "apparently students are trained to solve first, think later." I see no evidence that they are trained either to solve or think in any order, but I see that the question involves the symbols $<$, $\times$, $\square$, and the word "sentence" in a way that takes some getting used to. It requires some knowledge of jargon and vocabulary more than of solving or thinking. I would be interested in comparing responses to this question with responses to

Find two different numbers, call them a *and* b, *which, when multiplied by* 3, *give numbers bigger than* 54.

Next Gillman discusses an extended response problem which asks 12th graders why the square of a number ending in 5 must end in 25. The comments that follow sound very much as if the only attack expected of the students is expanding $(10n + 5)^2$. I should have liked to read some of the extended responses to see what other thoughts might have been expressed. For example, somebody might have noticed that all numbers ending in 5 are odd multiples of 5, and could have developed that thought. A more likely response, especially on the part of students who are comfortable with multiplication but not with algebraic methods, would be simply to square numbers ending in 5 and to see if the products follow a pattern:



Some youngsters would observe, even if they performed the multiplications with a calculator, that the products certainly end in 25; and if they looked at the pencil and paper algorithm as in the above example, they might discover that no matter how large the numbers we square, the last two digits of the factors. So it suffices to try

$$05, 15, 25, \cdots, 85, 95.$$

I am not suggesting that such an attack would be better or more efficient than squaring $10n + 5$, but I do suspect that in asking for "extended solutions," we subconsciously look for extensions of *our* way of thinking and are not sufficiently open to our students' thoughts, often poorly expressed.

Finally, let me take issue with Gillman's treatment of the last illustration he cites, an extended response problem for 12th graders:

Under a proposed income tax, you pay nothing up to $10,000, then 6% on any excess over $10,000. The effective tax rate is the percent of total income that you pay in tax. Can this be 5%? Can it be 6%?

Again Gillman conjectures, on the basis of "the suggested solution" that the "abysmal performance is due in part to the plodding way students are taught to handle equations." He then gives his solution and ends the article with, "The reader can now see something of the spirit and power of mathematics, as well as its elegance, beauty, and charm." This reader is not charmed; I doubt that many are, and here is why.

In showing us his solution, Gillman begins with "clearing clutter as soon as possible," i.e., adjusting the units in which the independent variable is expressed in a convenient way. I wonder how many times an experienced mathematician has had the x-axis of a graph run off the paper or discovered that his sequence of equations all contained some large factor k before he or she learned to scale or divided both sides of an equation by k, or multiplied both sides by 10^n to clear "decimal clutter." Clever scaling and choice of coordinates are subtle skills crucial in many applications of mathematics and should be nurtured. Yet Gillman uses the contemptuous expression "clutter" when he sees a rather laudable literal translation of words into symbols: income is x dollars, its excess over 10,000 is $x - 10{,}000$, 6% of that is $.06(x - 10{,}000)$ while 5% of the income is $.05x$. So the first question indeed seems equivalent to: Does the equation

$$.06(x - 10{,}000) = .05x$$

have a solution? Incidentally, in spite of Gillman's claim that his alternative "inhibits copying errors," it has an unfortunate typo in the first line of both tables.

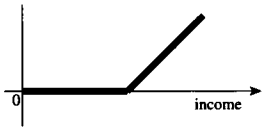
Gillman then accepts the invitation, given in the instructions, to answer the second question in words: "Can the effective rate be 6%? Of course not." The "of course" is an uncalled for put-down. A thoughtful student may well struggle with the following dilemma.

Suppose somebody has absolutely no income. Then he pays no tax. His effective tax rate can be anything, say t%, since t% of 0 is 0. So why can't $t = 6$? Why doesn't this dilemma show itself in the equation (cluttered or uncluttered)?

Because the expression for "in excess of 10,000" was expressed by $(x - 10{,}000)$, which words fine when $x \geq 10{,}000$; but when $x < 10{,}000$, we say there was no excess, i.e., we think of excess as

$$\text{Excess} = \begin{cases} x - 10000 & \text{for } x \leq 100000 \\ 0 & \text{for } x < 100000 \end{cases}$$

and so the graph of .06 Excess looks like this:



Thus, for somebody making less than $10,000, the effective tax rate and the tax specified by the 6% rule give the same result: no taxes due.

Gillman's verbal solution does not help; he defines tax rate as tax divided by income, which does not handle the case of 0 income.

It may be useful to analyze extended responses in order to learn what students are thinking even when they are not thinking what we think they ought to be thinking.

Anneli Lax
Vermontville, New York

Gillman replies:

The report concludes that the results on Jill's Class Trip "provide insight into students' difficulty with numbers and operations questions calling for more than one step to the solution." A one-step problem would provide the information that Jill earns $15 a week.

The actual test calls the inequality

$$54 < 3 \times \square$$

a "number sentence," a friendly term I met, along with boxes for variables, at SMSG in 1964. I think both are widely used today. "Solve first, think later" refers to the common tactic of first solving the corresponding equation $(54 = 3x)$ and then proceeding from there.

I applaud Lax's emphasis on experimenting with examples of squares ending in 25; the actual test question takes this very approach, displaying the squares of 15, 25, and 35, conjecturing the general result, and requesting a proof. But then it provides the hint: $(10n + 5)^2 \times ?$ On rereading my article, I find no suggestion that the only way to proceed is via the formula, nor any hint that I am not open to students' homespun solutions. The report itself is wedded to the binomial expansion, asserting that the correct formula is "central" in solving the given problem.

In the context of the tax problem, expressing income in units of $1000 seems reasonably straightforward, requiring no clever scaling (and the device may be familiar from charts and tables in newspapers and magazines). I have for many years watched calculus students struggle with dispensable symbols as the notion is cemented in their minds that math is drudgery. The typos in the tables come from gremlins, not the manuscript. Rate is a ratio, the effective tax rate being the ratio of tax to total income; when the income, and therefore the tax, are zero, this ratio is undefined. My reference to charm was intended only for the geometric solution (otherwise I would have made it a paragraph of its own).

The report states: "One-fifth of the high school seniors left their papers blank. Nearly two-thirds (66 percent) did not demonstrate understanding of the initial premise of the question—that only income in excess of $10,000 would be taxed." This may be due to the phrasing that introduced the problem: "One plan for a state income tax requires those persons with income of $10,000 or less to pay no tax and those persons with income greater than $10,000 to pay a tax of 6 percent only on the part of their income that exceeds $10,000"—a contorted, 45-word, comma-less sentence "requiring" certain citizens to pay no tax.

Leonard Gillman
Austin, Texas

From Hugh McGuire

I write in response to the article "Can Students Solve Math Problems?" by Leonard Gillman, which appears in the June 1994 issue of FOCUS (pp. 12–13).

My conjecture (or personal opinion) is that

perhaps the poorness of students' mathematical performances described in that article is due to the lack of clarity and relevance in mathematical problems—in the problems tested, as described in that article, and conceivably in the problems used in schools.

Gillman's article comments on a U.S. Department of Education report which I have not read, so my remarks are not fully informed; I comment only on the contents of Gillman's article.

I discuss some mathematical problems specified in the article; in each case, I quote the problem from the article.

1. "Jill's Class Trip" asks how many weeks Jill must work to earn $45 for the trip if every week she earns$2 on each of three days, $3 on each of three other days, and nothing on Sunday.

• While reading this problem, I 'stumbled' (in reading) on the words "the trip"; I wondered: what trip? Then I realized that "the trip" was merely an excuse for the necessity to earn $45. But by then, my concentration was broken.

• I wondered on which three days $2 was earned, and on which $3 was earned. As stated, the situation somehow feels unreal: in real life, a statement of facts begins with particulars—such as amounts earned on the specific days Monday, Tuesday, Wednesday, etc.—and then proceeds to abstractions. This issue actually became significant when I started solving the problem, for if particular amounts are not tied to particular days, the answer to the problem can be—instead of "3 weeks"—"it depends." For suppose work starts with some $3-days at the end of one week and ends, a little less than three weeks later, with some $3-days at the beginning of another week. Then an amount of time strictly less than three weeks suffices. It's analogously possible that a few days more than three weeks are necessary.

• I would restate the problem somewhat like the following:

Jill wants to earn $45 to pay for a field trip with her class. She finds regular work at various odd jobs (raking leaves, babysitting, helping an elderly neighbor buy weekly groceries, etc.) which, in summary, yield $2 each Monday, Wednesday, and Friday, and $3 each Tuesday, Thursday, and Saturday. Regardless of which day of the week Jill starts this work schedule, after how many weeks will she have earned $45?

2. A short-answer problem for Grade 8 asks for two numbers that make the sentence $54 < 3 \times \square$ true.

• "$54 < 3 \times \square$ " is not a sentence! (Even symbolic logic would encounter difficulties with the □.) And numbers don't 'make' sentences true! And requesting two numbers in that manner (i.e., with those words) confuses matters: will both somehow simultaneously be used in the 'sentence'? I believe the problem could be more clearly stated, e.g., as follows:

The following incomplete mathematical formula is missing a number, in the □:

$$54 < 3 \times \square$$

Give two numbers such that either one of them can be put in the □ to make the completed formula true.

3. An extended-response problem for Grade 12 asks why the square of a number ending in 5 must end in 25.

• What does it mean for a number to "end in 5"? Similarly for 25. Must the problem be solved for decimal numbers such as 3.5? (Regarding other possibilities, hopefully bases other than 10 are not being considered.) The following statement of the problem may be clearer:

For any whole number whose last or 'ones' digit is "5", the last two digits of the square of the number are "25". For example, the square of 75 is 5625. Why is this true (for any number whose last digit is "5")?

4. Under a proposed income tax, you pay nothing on income up to $10,000, then 6% on any excess over $10,000. The effective tax rate is the percent of total income that you pay in tax. Can this be 5 percent? Can it be 6 percent?

• What does "income " mean?

• Asking "can" here is tremendously vague. For any specific person, with a specific income, the effective tax rate either is or is not 5 percent; "can" makes no sense in such a specific case; the numbers yield a certain value, and that's it. Terminology other than "can" may help the student consider possibilities.

• Here's a rephrasing:

A simple scheme for assessing tax on people's income is that the first $10,000 earned by any person is not taxed, but then 6% of any further amount that is earned must be paid as tax. Now, the "effective" tax rate for a person is the percent of *total* income that the person pays as tax. Under the described scheme for taxation, is it possible for some person to have an effective tax rate of 5%? Is it possible for some person to have an effctive tax rate of 6%?

Gillman mentions the manner in which mathematics is taught as a root cause of students' poor peformances on those problems. I agree with this assessment of the situation; but I have a somewhat different stance on the particulars. I believe students learn to cope with most problems by applying almost mechanical rules. An example of such a rule which might 'appear in' a student's head is as follows:

When faced with a "percent" problem, look for a large amount and a small amount and divide the former by the latter to find the percentage; or look for an amount and a percentage, and either multiply or divide the former by the latter to find another amount; otherwise... 'flail.'

Standard teaching may fail to prevent students' operating so mechanically.

More pragmatic (and probably more effective) mathematics requires understanding a real situation, formalizing it, applying formal methods to calculate something, and then translating the result of the calculation into a pragmatic result. (This last step may comprise merely specifying units, e.g., "weeks.") If only calculation is taught, then only that should be tested (e.g., "What is 6% of the difference between $60,000 and $10,000?") But if we want to include the other aspects of complete mathematics, then we should do so coherently. My rephrasings of those problems probably can be improved; to the extent possible, they should be improved. I believe a guiding principle should be the goal of phrasing exercises in a manner comprehensible to those who must solve them.

Sincerely,

Hugh McGuire
Graduate student
Stanford, California

A Career Kit for Advisors

Andrew Sterrett

Underclass Student: "I like math, but I don't think that I want to teach. What do most math graduates do?"

Professor: "Many math majors become actuaries."

Underclass Student: "Yes, I've heard that. What else do they do?"

Professor: "——"

And on the same day...

Another Upper-class Student: "This has been a great major, but I think I'll postpone going to graduate school. How do I go about getting a job?"

Professor: "Better talk with people in the placement office."

Upper-class Student: "But don't you have any suggestions specifically for math majors?"

Professor: "——"

If you are as stumped as this professor when your students inquire about what they can do with a math major or how they should go about finding a job, perhaps you and your department need to put together a career information kit. This "kit" should contain not only printed material, but some real live people—graduates, local placement personnel, and even faculty members from other departments who will be happy to discuss how a mathematics background can be used in their disciplines. Here are a few suggestions for starting your own kit:

1. ***Career Information in the Mathematical Sciences: A Resource Guide*** This booklet, produced by the Conference Board of the Mathematical Sciences (CBMS) with support from the Department of Energy, contains fifty-five references for career information intended for students ranging from junior high school through college. It is available, in any number and without charge, from the Mathematical Association of America, 1529 18th St. NW, Washington, DC 20036,

Attention April White; or call (800) 331-1622.

2. **CBMS Career Information Kit** Again with support from the Department of Energy, CBMS has accumulated kits of career information produced by the mathematical sciences professional societies. In addition to the *Resource Guide*, these kits contain information about careers in applied mathematics, statistics, actuarial science, operations research, and teaching. CBMS will distribute one thousand kits without charge at forthcoming annual meetings of the American Mathematical Association of Two-Year Colleges, the American Counseling Association, and the AMS–MAA Joint Annual Meetings in San Francisco; and five thousand kits at the annual meeting of NCTM in Boston. If you attend one of these meetings, pick up your kit at the CBMS booth in the exhibit area. Resources do not permit the distribution of these kits to individuals or to departments, but all of the CBMS materials are listed in the *Resource Guide*.

3. ***Mathematicians At Work*** These are one-page essays written by mathematical scientists and distributed to faculty advisors of MAA student chapters. Advisors of student chapters have received fifty-five essays to date. New ones are distributed each fall to chapter advisors. The essays are printed on high quality paper so that copies are easily made for individual faculty members and students, the career guidance office, bulletin boards, and loose-leaf folders. For information on starting an MAA student chapter, write to Jane Heckler at the MAA (see address in 1).

4. **Recent Graduates in Your Own Department** There is no better way to inform your majors of potential careers in the mathematical sciences than to let them hear from your own successful graduates—what they are doing and how they found their jobs. Bring back a panel of your graduates to provide specific evidence that there is life after graduation. There is a high likelihood that your college or university placement and alumni offices will help you identify some of your graduates to invite back to the campus. Also check with your career advising and placement office to determine whether they have a reasonable collection of career information about the mathematical sciences—more than to suggest that math majors find careers in banking, insurance industries, and as computer programmers.

5. ***Math Horizons*** Every issue of *Math Horizons* contains articles about careers and/or finding jobs. To date we have seen "Seven Steps to Finding a Job," "Math and Jobs: Look What You Can Do!" "Math Majors Making Money?" "Interviewing Tips From the Pros," and "How to Really Get a Job." This most recent article provides an excellent model for obtaining useful information from your own graduates and can be easily replicated on individual campuses. Editor Don Albers promises to continue the emphasis on career information in future issues of *Math Horizons*. For information on obtaining *Math Horizons* for your students (and for yourself), write to the MAA, Attention Lisa Johnson.

6. ***Computer- and Mathematics-Related Occupations*** Bulletin 2450-4, #029-001-03163-7; 1994-95; $2.00, check payable to "Superintendent of Documents"; Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402. This bulletin includes information about actuaries, computer programmers, systems analysts, economists, marketing research analysts, engineering, data processing managers, mathematicians, operations research analysts, and statisticians. For each occupation, information is provided on working conditions; employment; training, qualifications, and advancement; job outlook; earnings; and related occupations.

7. ***Combined Membership List*** The *CML* lists twenty-eight companies, laboratories, and agencies in Virginia where mathematicians are employed, ninety-four sites in California, and twenty-eight sites in Texas. These lists, found in the back of the *CML*, provide many suggestions for your job-

hunting seniors regardless of their locales of interest.

There is a good chance that your placement office has copies of the following:

8. ***Job Choices in Science & Engineering*** College Placement Council, Inc.; (800) 544-5272; 1995; $16.75. A directory of employment opportunities for college graduates in engineering, sciences, the computer field, and other technical options.

9. ***Peterson's Job Opportunities for Engineering, Science, and Computer Graduates*** Peterson's customer service at (800) 338-3282; 1995; $18.95 + $5.75 shipping.

For those students interested in graduate school, include these in your kit:

10. ***Assistantships and Graduate Fellowships in the Mathematical Sciences*** Published by the American Mathematical Society; (800) 321-4267; $18.00; AMS, P.O. Box 6248, Providence, RI 02940.

11. ***What's Happening in the Mathematical Sciences*** Also published by the AMS; free, $4.00 for postage and handling.

12. ***Prentice Hall Guide for Fellowships for Math and Science Students*** Published by Prentice Hall, Inc.; 1993; $29.95; Order Processing Center, PO Box 11071, Des Moines, IA 50336-1071.

Finally, there is one creature to add to your kit of career information:

13. **MAA Gopher** Many of the *Mathematicians at Work* essays are available from the MAA Gopher, as are career articles from *Math Horizons*. As information becomes available about REUs and other opportunities for students, that too, will be available on the MAA Gopher. Instructions for reaching the MAA Gopher are found in the August 1994 issue of FOCUS.

Andrew Sterrett is Professor Emeritus of mathematical sciences at Denison University, and Assistant Director of Programs at the MAA.

NSF–CBMS Regional Research Conferences in the Mathematical Sciences

Contingent upon National Science Foundation funding, it is anticipated that seven NSF–CBMS regional research conferences will be held in the summer of 1995. These seven will bring to 254 the total number of such conferences held in the twenty-six-year history of this NSF–CBMS Regional Research Conference Series.

These conferences are intended to stimulate interest and activity in mathematical research. Each five-day conference features a distinguished lecturer who delivers ten lectures on a topic of important current research in one sharply focused area of the mathematical sciences. The lecturer subsequently prepares an expository monograph based upon these lectures, which is normally published as a part of a regional conference series. Depending upon the conference topic, the monograph is published by the American Mathematical Society, the Society for Industrial and Applied Mathematics, or jointly by the American Statistical Association and the Institute of Mathematical Statistics.

Support for about thirty participants is provided and the conference organizer invites both established researchers and interested newcomers, including postdoctoral fellows and graduate students, to attend.

Pending NSF funding, the seven conferences anticipated to be held in 1995 are listed below. Information about an individual conference may be obtained by contacting the conference organizer. Information about the series and guidelines for submitting proposals for future conferences may be obtained by writing or calling the Conference Board of the Mathematical Sciences, 1529 18th St NW, Washington, DC 20036; (202) 293-1170.

Numerical Linear Algebra on Parallel Processors

James W. Demmel, lecturer

June 12th–16th, University of San Francisco

Peter S. Pacheco, organizer; (415) 666-6630; peter@usfca.edu

Approximation Dynamics with Applications to Numerical Analysis

George R. Sell, lecturer

June 1st–5th, University of Missouri, Columbia

Carmen Chicone and Yuri Latushkin, organizers; (314) 882-6331; (314) 882-8275; carmen@chicone.cs.missouri.edu; mathyl@mizzou1.missouri.edu

Nondestructive Evaluation and Inverse Problems

Gunther Uhlmann, lecturer

June 12th–16th, University of Kentucky

Peter D. Hislop and Russell M. Brown, organizers; (606) 257-5637; (606) 257-3951; hislop@ms.uky.edu; rbrown@ms.uky.edu

Probabilistic Aspects of Single Orbit Dynamics

Benjamin Weiss, lecturer

June 18th–22nd, California State University, Bakersfield

Kamel N. Haddad, organizer; (805) 664-2150; khaddad@ultrix5.csubak.edu

Tight Closure, Big Cohen–Macaulay Algebras, and Uniform Artin Rees Theorem

Craig Huneke, lecturer

June 25th–29th, North Dakota State University

Joseph Brennan, organizer; (701) 238-8195; brennan@plains.nodak.edu

Probability, Algorithms, and Combinatorial Optimization

J. Michael Steele, lecturer

July 17th–21st, Michigan Technological University

Anant P. Godbole, organizer; (906) 487-2884; anant@math.mtu.edu

Index Theory, Coarse Geometry, and Topology of Manifolds

John Roe, lecturer

August 15th–19th, University of Colorado, Boulder

Carla E. Farsi, Guoliang Yu, and Jeffrey S. Fox, organizers; (303) 492-7422; (303) 492-2396; (303) 492-6418; farsi@euclid.colorado.edu; gyu@euclid.colorado.edu; jfox@euclid.colorado.edu

1995 Small Grants for Development of Mathematics-Based Intervention Projects

The MAA plans to award small grants for development of mathematics-based intervention projects in spring 1995. SUMMA (Strengthening Underrepresented Minority Mathematics Achievement) is soliciting college and university mathematicians and their departments and institutions to submit planning proposals for the advance work necessary to host mathematics-based intervention projects for middle and high school students, targeting underrepresented minority students. These projects may replicate already existing successful projects, adapt components of such projects, or be innovative. In any case, the planned activities should include those characteristics that are known to exist in successful projects as documented in *Lessons for HBCUs from Precollege Mathematics and Science Programs*. These lessons are summarized at the end of this announcement. The outcome of the planning should be a formal proposal for a project to be submitted to public or private agencies.

Objectives

Specifically the objectives of the SUMMA Small Grants Program are to:

- encourage mathematicians to develop projects to increase minority participation in mathematics;

and to provide support to project directors including the following

- provide funds for project directors to visit established projects
- make it possible for the project director to work with the host institution to recruit faculty and in other ways develop the foundation for the project
- carry out a feasibility study
- provide the project director the opportunity to participate in a proposal writing workshop to be held in August 1995 in Burlington, Vermont just before the AMS–MAA Joint Summer Meetings
- secure technical assistance in proposal writing and fund raising
- make it possible for the project director to contact private foundations, public agencies, and industry for support of the project.

Nature of the Grant

Grants are less than or equal to $5000 and will be made to the institution of the project director to be spent within the year. (Project directors have an obligation in accepting the grant to design a project and submit versions of a proposal beginning in fall 1995 until funded, with the assistance of the SUMMA staff.) To provide maximum flexibility, unexpended funds may be carried forward. An institution is expected to supply matching funds or in kind support as an indication of commitment to the development of the project. **While the MAA/SUMMA will fund the planning activities, it will not fund the project itself. These grants will not support any institutional indirect costs.**

Who May Apply

Grants will be made to faculty at

- minority institutions; or
- colleges and universities which have student bodies with a high percentage of underrepresented minorities (at least 20%) and a track record of success in developing minority students' interest in mathematics and science; or
- colleges and universities in which the institution or department has demonstrated that the faculty have the willingness and capacity to replicate or adapt successful projects.

Evaluation of Proposals

Proposals will be evaluated by members of the MAA Committee on Minority Participation in Mathematics, the director of SUMMA, and the executive director of the MAA.

The (maximum) three-page (single-spaced) proposed plan should include:

- Concept: What ideas and philosophy about mathematics and education do you have for a project? Describe the mathematics content and activities you expect to provide participants.
- Rationale: In what way will your institution be a welcome host for the project?
- Objectives: What are the objective(s) of your planning project?
- Activities: What tasks do you plan to undertake to design your project?
- Personnel: What are the name, position, and qualifications of the proposed project director? Who else will be involved in the planning? How?
- Evaluation: How will you judge the success of this planning?
- Budget: How will your planning funds be spent—personnel, travel, materials, telephone, workshop attendance (mathematicians receiving grants are expected to attend a workshop on August 3–4, 1995), release time, etc? An additional budget page is requested from all proposers.
- Commitment: What is the potential for long-term commitment of the host institution?
- Future Funding: What is the likelihood of institutionalization through local or state funding (perhaps after start-up federal funding from a variety of programs)?
- Support: Can you demonstrate an ability to mobilize internal and community resources to sustain an intervention project?
- Adaptation: How might a successful existing project be adapted to your local conditions, or what is the need for innovation?
- Timeline: When will you carry out the planning activities?

Submission of Proposals

Proposals should be submitted as soon as possible, but no later than March 15, 1995. All proposers will be notified by March 31, 1995. The MAA/SUMMA intends to make ten to twelve grants. The SUMMA staff is available to discuss your potential proposal at any time.

For further information, contact: Dr. William Hawkins, SUMMA Director, or Dr.

Florence Fasanelli, Director of SUMMA Intervention Programs, MAA, 1529 18th St., NW, Washington, DC 20036; (202) 387-5200; fax: (202) 265-2384; e-mail: summa@maa.org.

Characteristics of Effective Projects

What has been learned? Despite the differences among current highly successful intervention projects, there are some characteristics which all effective projects targeting minority students seem to have in common. These have been identified in several reports and are synthesized in this list.

- Project goals are clearly articulated and measurable
- Strong academic component; focus on enrichment, not remediation
- Hands-on learning opportunities and use of computers
- Teachers highly competent in the subject matter who believe that students can learn the material
- Heavy emphasis on everyday applications of mathematics and on careers in the field
- Teaching strategies that take into account the needs, socioeconomic background, and cognitive development of adolescents
- Multi-year involvement with students
- Strong directors and a committed and stable staff;
- Involvement of staff members who look like the target population
- Stable, long-term funding base with multiple funding sources
- Recruitment of participants from a relevant target population in a defined area
- Involvement with universities, colleges, industries, schools, community-based organizations
- Parental and community support
- Development of a peer support system
- Evaluation, long-term follow-up, careful data collection
- Networking through a consortium

1995 Summer Workshops for Mathematicians who Teach Statistics

Again this year, the MAA, with support from the NSF, is sponsoring a series of summer workshops for mathematicians who teach statistics but who do not have recent or advanced training in the subject. (See the November 1993 issue of *UME Trends* for more details.) In the first two years of this project, we received 350 applications for the 120 places at five workshops. For 1995, the final year of the project, there will be four workshops with a total of ninety-six places available.

According to a recent survey by the Conference Board of the Mathematical Sciences, introductory statistics courses are much more often taught in departments of mathematics than in departments of statistics. It is a worthy but demanding challenge for a faculty member who is not trained as a statistician to shape such a course to meet the spirit of the various guidelines and recommendations from the MAA and the American Statistical Association. The goal of these workshops is to provide background and resources that will help faculty to meet that challenge more effectively.

Four days of each week-long workshop will be divided between presentations by leading applied statisticians and related computer lab activities. The rest of the time, teams of four participants each, with guidance and assistance from the workshop coordinator, will design and carry out projects involving collection and analysis of statistical data or activities suitable for a statistics lab. After the workshop ends, team members will remain networked by e-mail with each other, with the statistician presenters, and with the workshop coordinator, first during the remainder of the summer as they develop and adapt their projects for use in their own teaching, and then throughout the fall as they try out their projects in the classroom. Each regional workshop will hold a one-day reunion after the tryout period, in connection with a regional or national meeting of the MAA.

Participants or their home institutions are expected to cover the cost of travel to the workshop site and reunion. Each workshop will provide room and board for twenty-four participants. In addition, participants will receive course materials which will include copies of *Perspectives in Contemporary Statistics*, *Statistics for the Twenty-First Century*, a personal copy of the Minitab statistical analysis package used at the workshop, and $100 towards the cost of travel, room, and board for the one-day reunion.

The application deadline for the 1995 workshops is March 3, 1995. Project Directors George Cobb of Mount Holyoke College and Mary Parker of Austin Community College will send more detailed information and an application form to department chairs. To receive a personal copy, please contact Jane Heckler, STATS Project Registrar, MAA, 1529 18th St. NW, Washington, DC 20036-1385; (202) 387-5200; fax: (202) 265-2384.

1995 Statistical Thinking and Teaching Statistics (STATS) Workshops

Colorado State University, Ft. Collins, CO May 31st–June 7th

Thomas Boardman, Coordinator; James zumBrunnen, Site Manager

University of Wisconsin, Oshkosh, WI June 4th–11th

K.L.D. Gunawardena, Coordinator; Norbert Kuenzi, Site Manager

University of Delaware, Newark, DE June 18th–25th

John Schuenemeyer, Coordinator; Lillian Russell, Site Manager

University of California, Santa Barbara, CA June 25th–July 2nd

Carolyn Dobler, Coordinator; Ann Watkins, Site Manager

MAA Contributed Papers in Burlington

The Mathematical Association of America and the American Mathematical Society will hold the annual MathFest from Sunday, August 6, 1995 through Tuesday, August 8, 1995 in Burlington, Vermont. The complete meetings program will appear in the April 1995 issue of FOCUS and the May 1995 issue of the *AMS Notices*. This preliminary announcement is designed to alert participants about the MAA's contributed papers sessions and their deadlines.

Please note that the days scheduled for these sessions, as well as other details, remain tentative. The organizers listed below solicit contributed papers pertinent to their sessions; proposals should be directed to the organizer whose name is followed by an asterisk (*). For additional instructions, see the Submission Procedures box below.

Sessions generally must limit presentations to ten minutes, but selected participants may extend their contributions up to twenty minutes. Each session room contains an overhead projector and screen; blackboards will not be available. You may request one additional overhead projector, a 35mm slide projector, or a 1/2-inch or 3/4-inch VHS VCR with one color monitor. Persons needing additional equipment should contact, as soon as possible, but prior to May 5, 1995: Donovan H. Van Osdol, Department of Mathematics, University of New Hampshire, Durham, NH 03824; e-mail: dvanosdo@math.maa.org.

Implications of the NCTM Standards for College Level Teaching

Sunday and Monday afternoons

Darien Lauten* Department of Mathematics, University of New Hampshire, Durham, NH 03824-3591; (603) 868-7133; fax: (603) 868-4096; e-mail: dlauten@ christa.unh.edu

New secondary mathematics curriculum projects funded by the National Science Foundation engage students in learning situations aligned with the NCTM Curriculum and Evaluation Standards for School Mathematics. Characteristics of these projects include changes in mathematics content, use of technology, new pedagogical approaches, mathematics in context, inclusion of all students, and emphasis on student understanding of mathematics. As a result of these projects, students will arrive at post-secondary institutions with new expectations and experiences. This session will address project approaches, teacher development issues, evaluation, and student learning.

Symbolic Computation in the Undergraduate Mathematics Classroom

Sunday and Monday afternoons

Ronald Sklar* Department of Computer Science, St. John's University, St. Vincent's College, Grand Central & Utopia Parkways, Jamaica, NY 11439; (718) 990-6161 X7212; fax: (718) 990-1882; e-mail: ymrscus@sjumusic.stjohns.edu

Richard O'Lander, St. John's University

The creative use of computer algebra systems is resulting in a revolution in the way we teach mathematics. These systems have been effectively used in teaching calculus, linear algebra, differential equations, combinatorics, probability, and statistics. This session invites papers on experiences with the use of a symbolic computation system in teaching mathematics. Subject areas not mentioned above are especially welcome.

Innovative Teaching in First-year College Mathematics Courses

Sunday and Tuesday afternoons

Aaron I. Stucker* Department of Mathematics and Statistics, Washburn University, Topeka, KS 66621; (913) 231-1010 X1491; e-mail: zzstuc@acc.wuacc.edu

Howard L. Penn, U.S. Naval Academy

This session will present talks describing innovative techniques in the teaching of mathematics courses typically taught in the first year of college. Innovative techniques include (but are not limited to) the use of technology, writing projects, and cooperative learning.

Achieving K-12 and Higher Education Collaboration in Systemic Reform Programs

Sunday and Monday afternoons

R. D. Anderson* Louisiana Systemic Initiative Program, 1885 Wooddale Boulevard, 11th floor, Baton Rouge, LA 70806; (504) 922-0690; fax: (504) 922-0688

More information on this session is available on the MAA Gopher or from the organizer.

Use of Interactive Video Games in Teaching/Learning Mathematics

Sunday and Monday afternoons

Richard Stephens* Department of Mathematics and Computer Science, Western Carolina University, Cullowhee, NC 28723-9049; (704) 227-7245

More information on this session is available on the MAA Gopher or from the organizer.

See *Papers* on page 28

Submission Procedures for Contributed Paper Proposals

After you have selected a session to which you wish to contribute a paper, forward the following directly to the organizer (indicated above with an asterisk (*)):

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

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

Your summary must reach the designated organizer by Monday, April 24, 1995.

The organizer will acknowledge receipt of all paper summaries. If the organizer accepts your paper, you will receive a standardized abstract form. Use this form to prepare a brief abstract. Please return the completed form to the organizer by Monday, May 8, 1995. Abstracts received after the deadline will not be published in the booklet of abstracts which will be available in the meetings registration area during the conference.

DO NOT FORWARD COMPLETED ABSTRACTS TO THE MAA OR TO THE AMS. THEY ARE TO BE SENT TO THE SESSION ORGANIZER.

MAA Professional Development Activities

SPRING–SUMMER 1995

The following is a listing of all MAA or MAA section sponsored professional development activities for spring and summer 1995 about which information was received by December 5, 1994. Each listing contains the date, title, principal speaker(s), location, and contact person. More information on some of these activities will be found elsewhere in this issue of FOCUS. A more up-to-date listing of professional development activities is posted on the MAA Gopher.

April 22 Minicourse: An Introduction to Research in the Teaching and Learning of Undergraduate Mathematics: Examples in Calculus. Joan Ferrini-Mundy and Karen Graham; Simmons College, Boston, Massachusetts. Contact Donna Beers, Simmons College, 300 The Fenway, Boston, MA 02115-5898; (617) 521-2389; e-mail: dbeers@vmsvax.simmons.edu

May 25–June 11 Workshop: Constructivist Methods in Undergraduate Mathematics Teaching: Calculus.[1] Ed Dubinsky, Keith Schwingendorf, and David Mathews; Purdue University, West Lafayette, Indiana. Contact Terry Loro, Department of Mathematics, Purdue University, West Lafayette, IN 47907; (317) 494-1982; fax: (317) 494-6318; e-mail: loro@math.purdue.edu.

May 31–June 7 Workshop: Summer Workshop for Mathematicians Who Teach Statistics. Thomas Boardman and James zumBrunnen; Colorado State University, Ft. Collins, Colorado. Contact Jane Heckler, STATS Project Registrar, The Mathematical Association of America, 1529 18th St. NW, Washington, DC 20036-1385; (202) 387-5200; fax: (202) 265-2384; e-mail: jheckler@maa.org.

June 1–11 Workshop: Constructivist Methods in Undergraduate Mathematics Teaching: Abstract Algebra.[1] Ed Dubinsky, Keith Schwingendorf, and David Mathews; Purdue University, West Lafayette, Indiana. Contact Terry Loro, Department of Mathematics, Purdue University, West Lafayette, IN 47907; (317) 494-1982; fax: (317) 494-6318; e-mail: loro@math.purdue.edu.

June 4–11 Workshop: Summer Workshop for Mathematicians Who Teach Statistics. K. L. D. Gunawardena and Norbert Kuenzi; University of Wisconsin, Oshkosh, Wisconsin. Contact Jane Heckler, STATS Project Registrar, Mathematical Association of America, 1529 18th St. NW, Washington, DC 20036-1385; (202) 387-5200; fax: (202) 265-2384; e-mail: jheckler@maa.org.

June 5-9 Workshop: Mathematics Laboratories with DERIVE. Marvin Brubaker and Carl Leinbach; Frostburg State University, Frostburg, MD. Contact Jack Biggs, Department of Mathematics, Frostburg State University, Frostburg, MD 21801; (410) 543-6740, e-mail: bafusaro@sae,towson.edu.

June 5–23 Summer Institute: Institute in the History of Mathematics and its Use in Teaching. V. Frederick Rickey and Victor J. Katz; The American University, Washington, DC. Contact V. Frederick Rickey, MAA, 1529 18th St. NW, Washington, DC 20036-1385; (202) 387-5200; fax: (202) 265-2384; email: rickey@bgsuvax.bgsu.edu.

June 15–17 Short Course: Symmetry and Group Theory. Doris Schattschneider; University of Dayton, Dayton, Ohio. Contact Tom Gantner, Department of Mathematics, University of Dayton, Dayton, OH 45469-2316; (513) 229-2511; fax: (513) 229-2566; e-mail: gantner@udavxb.oca.udayton.edu.

June 18–23 Short Course: The Teaching of Calculus. Arnold Ostebee and Paul Zorn; University of Maine, Orono, Maine. Contact Clayton W. Dodge, 5752 Neville/Math, University of Maine, Orono, ME 04469-5752; (207) 581-3908; e-mail: dodge@gauss.umemat.maine.edu.

June 18–25 Workshop: Summer Workshop for Mathematicians Who Teach Statistics. John Schuenemeyer and Lillian Russell; University of Delaware, Newark, Delaware. Contact Jane Heckler, STATS Project Registrar, MAA, 1529 18th St., NW, Washington, DC 20036-1385; (202) 387-5200; fax: (202) 265-2384; e-mail: jheckler@maa.org.

June 25–July 2 Workshop: Summer Workshop for Mathematicians Who Teach Statistics. Carolyn Dobler and Ann Watkins; University of California, Santa Barbara, California. Contact Jane Heckler, STATS Project Registrar, MAA, 1529 18th St NW, Washington, DC 20036-1385; (202) 387-5200; fax: (202) 265-2384; e-mail: jheckler@maa.org.

June 26–30 Short Course: Modular Forms, Elliptic Curves, and Fermat's Last Theorem. Fernando Gouvea; Allegheny College, Meadville, Pennsylvania. Contact George Bradley, Mathematics and Computer Science Department, Duquesne University, Pittsburgh, PA 15282-0001; (412) 396-5115; e-mail: bradley@duq3.cc.duq.edu.

July 10–21 Workshop: Cooperative Learning in Undergraduate Mathematics Education. Ed Dubinsky and Janet Ray; Purdue University, West Lafayette, Indiana. Contact Terry Loro, Department of Mathematics, Purdue University, West Lafayette, IN 47907; (317) 494-1982; fax: (317) 494-6318; e-mail: loro@math.purdue.edu.

[1] Not sponsored by the MAA or a section, but will be of special interest to MAA members.

Papers from page 27

Popularizing Mathematics

Sunday and Tuesday afternoons

Eric Muller* Department of Mathematics, Brock University, St. Catharines, ONT L2S 3A1 Canada; (905) 688-5550 X3297; fax: (905) 682-9020; e-mail: emuller@spartan.ac.brocku.ca

Bernard R. Hodgson, Université Laval

Papers on successful activities to popularize mathematics are solicited. Of special interest are activities aimed at popularizing mathematics both outside the classroom, among families, seniors, policy makers, etc., and in the university classroom for students enrolled in mathematics "service" courses, including prospective elementary school teachers. Submissions should include some documentation of the activities, some information on who developed and ran them, the segment of the population at whom they were aimed, how often the programs have run, and some indication of their degree of success.

Mathematics Awareness Week, April 23–29, 1995

Mathematics Awareness Week is held each year to increase public understanding of and appreciation for mathematics. This year's theme is "Mathematics and Symmetry." More information can be obtained from the Joint Policy Board for Mathematics ((202) 234-9570) and on the MAA Gopher (gopher.maa.org). MAW visuals are available via the WorldWide Web; information can be found on the MAA Gopher. (See page 7.)

Activities for Mathematics Awareness Week are generally organized by college and university departments, institutional public information offices, student groups, and related associations and interest groups. They include a wide variety of workshops, competitions, exhibits, festivals, lectures, and symposia.

The number and breadth of activities increases annually. For example, one college regularly sponsors a high school mathematics day to encourage women to continue their studies in mathematics. At one university, two departments—mathematics and architecture—cooperated to plan and produce an interactive traveling exhibit that provides hands-on experience for such topics as codes, tilings, chaos, geometry, graphs, and computer science.

Coordination and support for Mathematics Awareness Week is provided by the Joint Policy Board for Mathematics. Additional financial support comes from the United States Army Research Office.

The accompanying article (see right) on the theme for Mathematics Awareness Week 1995 was written by Paul Davis (Worcester Polytechnic Institute) and Martin Golubitsky (University of Houston). Review and ideas were provided by Jeffrey Adams (University of Maryland), Martin Isaacs (University of Wisconsin), Peter Olver (University of Minnesota), Marjorie Senechal (Smith College), and Doris Schattschneider (Moravian College).

Mathematics and Symmetry

Paul Davis and Martin Golubitsky

Symmetry is all around us. We see symmetry in everyday objects—in buildings, in floor and wall tiles, in gears, and even in automobile hubcaps. We see symmetry in many natural forms—in the bilateral symmetry of the human form, in the rotational and kaleidoscopic symmetry of blossoms, in the sinuous spiral symmetry of vines and shells, and in the translation symmetry of honeycombs and fish scales. Symmetry also reveals itself in the decorative arts of many cultures, including, for example, in the decorative designs of the Moors at the Alhambra, in the weavings of the Indians of the American Southwest, and in the curious interlocked creatures that are found in the work of the mathematically perceptive modern graphic artist M. C. Escher. Indeed, the symmetry evident in the decorative art of a particular culture may serve as a cultural marker.

Symmetry appears on a grand scale in the formulation of distance in special relativity and even in the shapes of galaxies, and on a microscopic scale in the classification of crystal structure. Symmetry also plays a pivotal role in mathematics—from the verification that a general polynomial of degree five or higher cannot be solved by formula, to the classification of types of geometry, to the existence of conservation laws.

To mathematicians, symmetries are defined as transformations that leave an object or a picture or an equation unchanged. These transformations are called the symmetries of the object; together they form a mathematical structure known as a group—the symmetry group of the object.

Objects such as the human form or a perfectly symmetric butterfly have bilateral symmetry because they cannot be distinguished from their reflections across a mirror plane. Similarly, repeating patterns, or more vividly wallpaper patterns, are pictures that can be picked up, shifted, and put down again so that the picture is undisturbed. Objects with helical symmetry are those that are invariant under screw motions about a central axis.

It is through the study of groups that different types of patterns are distinguished. Using group theory, mathematicians can prove that there are exactly seventeen ways to construct repeating wallpaper patterns (or periodic planar tilings). Indeed, group theory has been one of the most exciting branches of mathematics during the past century, beginning with Lie's discovery of continuous groups through to the recent classification of finite simple groups. Investigating the vast connections between group theory and topology, geometry, and analysis continues to be a central theme in mathematics research. Beginning with Galois theory and continuing to current research, symmetry enables us to find solutions to equations—first to algebraic equations and now to differential equations.

Symmetry is also central to the mathematical description of many natural phenomena. The catalog of three-dimensional repeating patterns is identical to the catalog of ways that atoms can arrange themselves on crystal lattices. Chemists and mathematicians have classified the 230 crystallographic groups—the 230 forms of crystal structure—by analyzing in detail the possible combinations of rotations, reflections, and translations that leave a crystal lattice unchanged. Symmetry is important in material science and elasticity where it is incorporated into the constitutive relations that govern the structure and behavior of solids and liquids.

Symmetry is basic to our understanding of the hydrogen atom and molecular spectroscopy, to elementary particles and the theory of quarks, as well as to the two crowning achievements of twentieth century physics—the theory of relativity and quantum mechanics. Indeed, one might even characterize the current search for a 'unified field theory'—a single theory to describe all forces of nature—as a search for the fundamental symmetry group of the physical universe, from which all the basic laws of physics will follow.

Symmetry has appeared in technology in surprising ways. In computer vision the symmetries of human perception (projective transformations) are incorporated into the design of mathematically based image processing systems which may have important applications to medical imaging.

In applications to control theory, rotation and translation symmetries must be taken into account when designing feedback controllers for both aircraft and satellites.

Just as the absence of symmetry has striking effects in art and music, the absence or loss of symmetry is of great interest in models of natural phenomena, often with dramatic consequences. Symmetry breaking occurs when structures buckle, when water boils, and (possibly even) when spots form on leopards and stripes form on tigers. Twenty years ago, mathematicians and physicists demonstrated a route to turbulence that involves the development of more complicated fluid flow patterns signaled by a succession of losses of symmetry. These kinds of exploration have given symmetry an apparently paradoxical role—the role of charting the onset of complicated or chaotic behavior. The images shown on this year's Mathematics Awareness Week poster are formed using a combination of symmetry and chaotic dynamics. Their detailed complex structure is due to chaotic dynamics while their apparent regularity and familiarity is due to symmetry.

Arrangements that show a high degree of order may fail to have any global symmetry, yet symmetry may have a role in describing and classifying these patterns. Tiles that can only fit together in ways that have no translation symmetry and newly found 'quasicrystals' that display symmetry forbidden by the conventional model of crystals are two exciting areas of current research.

MSEB Launches Study of Mathematics for the World of Work

On November 18th the Mathematical Sciences Education Board of the National Academy of Sciences held a workshop at which mathematics and vocational educators, mathematicians, business and industry representatives, and policy makers discussed the mathematical preparation of the technical workforce, including questions of core curriculum, tracking, articulation, and student concerns.

The workshop, supported by the Alfred P. Sloan Foundation, is the first step in a long-term MSEB project to build the dialogue between the communities of mathematics and vocational educators in order to develop mathematics programs that address student needs for both academic and vocational preparation.

Workshop participants agreed on the need to:

- Integrate vocational and academic programs;
- Identify mathematics that is latent in the workplace;
- Disseminate concrete examples of mathematics in work situations;
- Align disciplinary and occupational skills standards;
- Promote examples of successful programs; and
- Improve communication between vocational and mathematics educators.

They also identified many issues that need further exploration, including:

- Is vocational education a path to a different goal or a different path to the same goal?
- Can a single mathematics curriculum serve both vocational and academic needs?
- Is a "separate and equal" track for vocational education appropriate or possible?
- Who will develop mathematics curricula for vocational education?
- Which are more important as preparation for work—basic or higher order skills?
- Is mastery of basic skills a prerequisite to learning higher order skills?

The MSEB will publish a workshop report early in 1995 which will be for sale from the National Academy Press. For further information about the workshop and its follow-up, contact Susan Forman by e-mail at sforman@nas.edu, or by mail at the Mathematical Sciences Education Board, 2101 Constitution Ave. NW, HA476, Washington, DC 20418.

Institute in the History of Mathematics and its Use in Teaching

The MAA will organize the Institute in the History of Mathematics and its Use in Teaching at American University, Washington, DC, June 5–23, 1995, and for three additional weeks in June 1996, with work continuing through an electronic network during the academic year 1995–96. The teaching staff will consist of well known historians of mathematics, including, in the first year, V. Frederick Rickey, Victor J. Katz, Steven H. Schot, Ronald Calinger, Judith Grabiner, and Helena Pycior. Activities at the institute will include reading of original sources, survey lectures, small group projects, field trips to three great libraries, and discussions of methods of conducting a history of mathematics course. Participants will be prepared to make presentations on their work at the Joint Mathematics Meetings.

Applications are welcome from faculty teaching at small institutions, at minority-serving institutions, and institutions that prepare secondary teachers. Facilities at American University are fully accessible. Dormitory space for families of participants is available. Completed applications will be due by March 15th and applicants will be notified of their acceptance by early April. For more information and application forms, write to V. Frederick Rickey, MAA, 1529 18th St. NW, Washington, DC 20036-1385; e-mail: rickey@maa.org.

NASA's Flight Opportunities for Science Teacher EnRichment:

The FOSTER Program for Science Teachers

What is FOSTER? The National Aeronautics and Space Administration is flying science teachers on board NASA's Kuiper Airborne Observatory (KAO). Through the unique capabilities of this airborne observatory, teachers experience cutting edge scientific research and the discovery process on overnight astronomical research missions on board the KAO. These teachers are part of the Flight Opportunities for Science Teacher EnRichment (FOSTER) project, a pre-college teacher enrichment project at NASA Ames Research Center. Science on board the KAO involves many disciplines: astrophysics and astronomy, planetary sciences, atmospheric sciences, aeronautics, physics, chemistry, engineering, computer sciences, and mathematics. As FOSTER participants, teachers attend a summer workshop at NASA Ames Research Center, and return to fly with a team of pilots, scientists, engineers, mission specialists, and technical staff on board the KAO to observe the infrared universe.

Who can participate? Teachers in grades 3 through 12 are eligible to apply for the 1995 program which begins with the summer workshop, July 5–14, 1995, at NASA Ames Research Center. FOSTER teacher flights on the KAO will be scheduled July through September. Teachers are required to apply in teams from two separate schools in the same district or geographic region. Generally these teams are comprised of a high school and junior high (or middle) school teacher team, or a junior high (or middle) school and elementary teacher team. Teachers from the eleven western states served by the NASA Ames Research Center Educational Programs Office are eligible to apply for 1995. These states are Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming. Applications are available January 1, 1995, and due in March 1995.

Summer Workshop at NASA Ames Research Center To prepare for their flights, teachers participate in an intensive workshop at NASA Ames Research Center during the summer. The workshop includes lectures, lessons, tours, and activities related to modern astrophysics and airborne astronomy. During the workshop, the teachers are provided with curriculum materials and activities available through NASA and others. They try out new lessons to bring their FOSTER experiences to the classroom and their fellow teachers. College credit is available for participation in FOSTER.

Internet Training and Access In addition, the workshop offers hands-on telecommunications training. Teachers learn to access the Internet to communicate between schools, to contact NASA scientists and engineers, and to access on-line resources such as FOSTER On-Line and Spacelink. Participating teachers are provided with Internet accounts and, if needed, a modem for use at their school site.

School Site Visits by NASA During the school year, FOSTER teachers host a visit by a NASA Aerospace Education Specialist for teacher workshops, assemblies, and classroom visits at their school site. NASA scientists, engineers, and others are also available to share their work and experiences with students via Internet or for visits to schools.

How Is FOSTER Funded? FOSTER is a joint project of NASA Ames Research Center and the SETI Institute, and is funded by NASA's Astrophysics Division. For the summer workshop, housing at Stanford University is provided, plus transportation including airfare up to $500 per round trip, and meals. Teacher flights on board NASA's KAO are also funded for transportation, housing, and meals.

For further information or to request an application, contact FOSTER Project, SETI Institute, 2035 Landings Dr., Mountain View, CA 94043; voice mail: (415) 960-4539; fax: (415) 961-7099; e-mail: wendy_horton@seti-inst.edu; edna_devore@seti-inst.edu. The NASA contact is Garth A. Hull, Chief, Educational Programs Office, NASA Ames Research Center, MS 204-12, Moffett Field, CA 94035-1000; voice mail: (415) 604-5543; fax: (415) 604-3445.

Annual Ohio Section Summer Short Course

Symmetry and Group Theory

Presented by Doris Schattschneider (Moravian College)

June 15–17, 1995, University of Dayton in Dayton, Ohio

This short course will emphasize a visual, hands-on approach to understanding the symmetry groups of two- and three-dimensional objects through the use of computer software, patterns and tilings, polyhedral models, and videotapes. Many abstract concepts encountered in a first course in group theory can be illustrated in a graphic manner using this approach.

The registration fee is $100. Air-conditioned dormitory suites consisting of a living room, bath, and two bedrooms with two single beds in each bedroom are available with a price per night of $20 (half a double), $40 (single), $80 (suite). A Thursday evening banquet will be held; cost of attendance is $16. Other meals may be purchased in the student union. Registration is open until forty $50 deposits are received or May 15th, whichever is earlier.

For more information or to register, contact Tom Gantner, Department of Math, University of Dayton, Dayton, OH 45469-2316; (513) 229-2511; fax: (513) 229-2566; e-mail: gantner@udavxb.oca.udayton.edu.

THE BEST IN MATHEMATICAL

Lion Hunting and Other Mathematical Pursuits

A Collection of Mathematics, Verse, and Stories by Ralph P. Boas, Jr.

Gerald L. Alexanderson and Dale H. Mugler, Editors

As a young man at the Institute for Advanced Study in Princeton, Ralph Philip Boas, Jr., together with a group of other mathematicians, published a light-hearted article on the "mathematics of lion hunting" under a pseudonym (1938). This sparked a sequence of articles on the topic, several of which are drawn together in this book.

Lion Hunting includes an assortment of articles that show the many facets of this remarkable mathematician, editor, writer, and teacher. Along with a variety of his lighter mathematical papers, the collection includes Boas' verse and short stories, many of which are appearing for the first time. Anecdotes and recollections of his numerous experiences and of his work and meetings with many distinguished mathematicians and scientists of his day are also included.

The mathematical articles in this collection cover a range of topics. They include articles on infinite series, the mean value theorem, indeterminate forms, complex variables, inverse functions, extremal problems for polynomials, and more.

Boas' wit and playful humor are reflected in the verses included in this collection. The verses reflect the phases of his career as author, editor, teacher, department chair, and lover of literature. A section of the book describes the feud that Boas supposedly had with Bourbaki. Also included are many amusing anecdotes about famous mathematicians.

We profit from Boas' labor, and treasure it as an inheritance. We should allow ourselves in some measure to walk along his path. This collection will allow the reader a glimpse of that path.

240 pp., Paperbound, 1994,
ISBN 0-88385-323-X
List: $35.00 MAA Member: $25.00
Catalog Code: DOL-15/FOC

Algebra and Tiling

Sherman Stein and Sándor Szabó

Often questions about tiling space or a polygon lead to other questions. For instance, tiling by cubes raises questions about finite abelian groups. Tiling by tripods or crosses raises questions about cyclic groups. From tiling a polygon with similar triangles, it is a short step to investigating automorphisms of real or complex fields. Tiling by triangles of equal areas soon involves Sperner's lemma from topology and valuations from algebra.

The first six chapters of **Algebra and Tiling** form a self-contained treatment of these topics, beginning with Minkowski's conjecture about lattice tiling of Euclidean space by unit cubes, and concluding with Laczkowicz's recent work on tiling by similar triangles. The concluding chapter presents a simplified version of Rédei's theorem on finite abelian groups: if such a group is factored as a direct product of subsets, each containing the identity element, and each prime order, then at least one of them is a subgroup. A remarkable geometric implication of this result is developed in Chapter 2.

Algebra and Tiling is accessible to undergraduate mathematics majors, as most of the tools necessary to read the book are found in standard upper division algebra courses, but teachers, researchers and professional mathematicians will find the book equally appealing. Beginners will find the exercises and the material found in the appendices especially useful. The "Problems" section will appeal to both beginners and experts in the field. The book could serve as the basis of an undergraduate or graduate seminar, or a source of applications to enrich an algebra or geometry course.

224 pp., Hardcover, 1994
ISBN 0-88385-028-1
List: $34.00 MAA Member: $26.00
Catalog Code: CAM-25/FOC

A Radical Approach to Real Analysis

David Bressoud

This book is an undergraduate introduction to real analysis. Use this book as a textbook for an innovative course, or as a resource for a traditional course. If you are a student and have been through a traditional course, yet still do not understand what real analysis is about and why it was created, read this book.

This course of analysis is radical; it returns to the roots of the subject, but it is not a history of analysis. It is rather an attempt to follow the injunction of Henri Poincaré: let history inform pedagogy. The author wrote the book as a first encounter with real analysis, laying out its context and motivation in terms of the transition from power series to those that are less predictable, especially Fourier series. Bressoud marks some of the traps into which even great mathematicians have fallen in exploring this area of mathematics.

The book begins with Fourier's introduction of trigonometric series and the problems they created for the mathematicians of the early nineteenth century. Cauchy's attempts to establish a firm foundation for calculus follow, and the author considers his failures and his successes. The book culminates with Dirichlet's proof of the validity of the Fourier series expansion and explores some of the counterintuitive results Riemann and Weierstrass were led to as a result of Dirichlet's proof.

To facilitate graphical and numerical investigations, *Mathematica* commands and programs are included in the exercises. However, you may use any mathematical tool that has graphing capabilities, including the graphing calculator.

336 pp., Paperbound, 1994
ISBN 0-88385-701-4
List: $29.00 MAA Member: $22.00
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EXPOSITION ... JUST PUBLISHED!

All the Math That's Fit to Print

Articles from the Manchester Guardian

Keith Devlin

Between 1983 and 1989 Keith Devlin, research mathematician, author, and educator, wrote a semi-monthly column on mathematics and computing in the English national daily newspaper, *The Manchester Guardian*. This book is a compilation of many of those articles. It is witty, entertaining, and easy to read.

The mathematical topics range from simple puzzles to deep results including open problems such as Faltings Theorem and the Riemann Conjecture. You will find articles on prime numbers, how to work out claims for traveling expenses, calculating pi, computer simulation, patterns and palindromes, cryptology, and much more.

This book is meant for browsing by anyone who regularly reads a serious newspaper and has some interest in matters scientific or mathematical. Keith Devlin tells us "from the mail I received I know that the readers of the column were a varied bunch. They ranged from students at schools in their early teens (occasionally even younger!), to retired people in their nineties (often the ones who best succeed in cracking the brain teasers I occasionally included in my articles); from prison inmates to executives in the computer industry; from truckers to schoolteachers; both men and women."

It you think that nothing of interest has happened in mathematics since the time of Pythagoras, this book will change your mind. Keith Devlin presents mathematics as a living human enterprise, both a science and an art.

345 pp., Paperbound, 1994
ISBN 0-88385-515-1
List: $32.50 MAA Member: $25.00
Catalog Code: ATMA/FOC

Linear Algebra Problem Book

Paul Halmos

This is a book for mathematicians at all levels. Paul Halmos tells us, "Even if I know some answers, I don't think I understand a subject until I know the questions. The questions in mathematics are called problems—and although I learned some linear algebra a long time ago, until now I have made no serious effort to examine the problems that the solutions are based on. I wrote this book to organize those questions—problems—in my own mind."

This book can be either the main course or the dessert for someone who needs linear algebra—and nowadays that means every user of mathematics. It can be used as the basis of either an official course or a program of private study.

If used as a course, the book can stand by itself, or if so desired, it can be stirred in with a standard linear algebra course as the seasoning that provides the interest, the challenge, the motivation that is needed by experienced scholars as much as by beginning students.

The best way to learn is to do, and the purpose of this book is to get the reader to DO linear algebra. The approach is Socratic: first ask a question, then give a hint (if necessary), then, finally, for security and completeness, provide the detailed answer.

340 pp., 1994, Paperbound
ISBN 0-88385-322-1
List: $35.00 MAA Member: $25.00
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Use order form on page 34, or call 1-800-331-1622

Assessing Calculus Reform Efforts

A Report to the Community

James R. C. Leitzel and Alan C. Tucker, Editors

Assessing Calculus Reform Efforts: A Report to the Community provides a review of various aspects of the calculus reform movement. This study gives an assessment of the current attitudes and involvement of mathematical sciences departments—their faculty and students—in efforts to revise calculus instruction.

A key finding of the assessment study is that *how* calculus is taught has changed more than *what* is taught. The changes in instructional practice, more frequent use of technology, and increased focus on building students' conceptual understanding are finding their way into both precalculus and post-calculus mathematics courses. This has encouraged increased interest in research about how undergraduate students learn mathematics. Many of the institutions that currently report using reform materials in experimental sections have plans to move their efforts to course-wide adoption in the near future. The fact that in the past two years over 95% of institutions using a reform text continue using a reform text the next year (for at least some sections) indicates that calculus reform is likely to be around for the foreseeable future.

Data is provided on the number of institutions at each of the levels of postsecondary education that are engaged in reform efforts and also gives information on faculty and student involvement, and reviews of texts produced by some of the major curriculum development projects. The appendices to the report include brief descriptions of selected calculus reform texts and a complete listing of the NSF awards made during the seven years of the Calculus Initiative.

100 pp., Paperbound 1994
ISBN 0-88385-093-1
List: $15.00
Catalog Code: NTE-37/FOC

Resources for Calculus Collection

Wayne Roberts, Macalester College, Project Director

Third Printing

This five-volume set provides new materials with which instructors can refresh the teaching of college-level calculus. The independent volumes are composed of contributions from a wide assortment of college mathematics instructors. The set, produced through a National Science Foundation grant to the Associated Colleges of the Midwest and the Great Lakes Colleges Association, join in spirit other efforts to improve mathematics instruction. All are most useful as curriculum resource materials in the hands of those teaching calculus. —*CHOICE*

Learning By Discovery

A Lab Manual For Calculus

Anita Solow, Editor

Contains 26 laboratory modules, that can be used as lab components in your course, or assigned as independent projects. The labs are written without specific computer commands, so students read mathematics, not text. Suggestions are provided for implementing these labs on *Derive, Maple* and *Mathematica*. Many can be done on graphics calculators.

184 pp., Paperbound, 1993

ISBN 0-88385-083-4

List: $26.00
Catalog Code: NTE-27/FOC

Calculus Problems For a New Century

Robert Fraga, Editor

Emphasizes conceptual understanding over rote drill. Graphs and tables, rather than rules, are used to define functions, in the belief that "real world" data generally come that way. The problems are organized in groups that parallel traditional grouping of ideas, making it possible to use them as supplements to most texts. Most of the problems can be done without the use of a calculator or computer.

448 pp., Paperbound, 1993

ISBN 0-88385-084-2

List: $26.00
Catalog Code: NTE-28/FOC

Applications of Calculus

Philip Straffin, Editor

Students see how calculus can explain the structure of a rainbow, guide a robot arm, or analyze the spread of AIDS. Each module starts with a concrete problem and moves on to provide a solution. The discussions are detailed, realistic and pay careful attention to the process of mathematical modeling. Exercises, solutions, and references are provided.

280 pp., Paperbound, 1993
ISBN 0-88385-085-0
List: $26.00
Catalog Code: NTE-29/FOC

Problems For Student Investigation

Michael B. Jackson and John R. Ramsay, Editors

Students will learn how to use calculus to solve real problems, how to use the library to find mathematical sources, how to read and write mathematical material, and how to cooperate with their peers in solving difficult problems. Learning that they can solve what at first seems an inscrutable mathematical problem can only increase students' mathematical confidence.

224 pp., Paperbound, 1993

ISBN 0-88385-086-9

List: $26.00
Catalog Code: NTE-30/FOC

Readings For Calculus

Underwood Dudley, Editor

Presents readings on the history of calculus and of mathematics, on the nature of mathematics and its applications, on the learning of calculus, and on the place of calculus and mathematics in society. Can be used as a supplement to any calculus text, showing students that there is more to calculus than getting the right answer. Exercises and problems included.

224 pp., Paperbound, 1993

ISBN 0-88385-087-7

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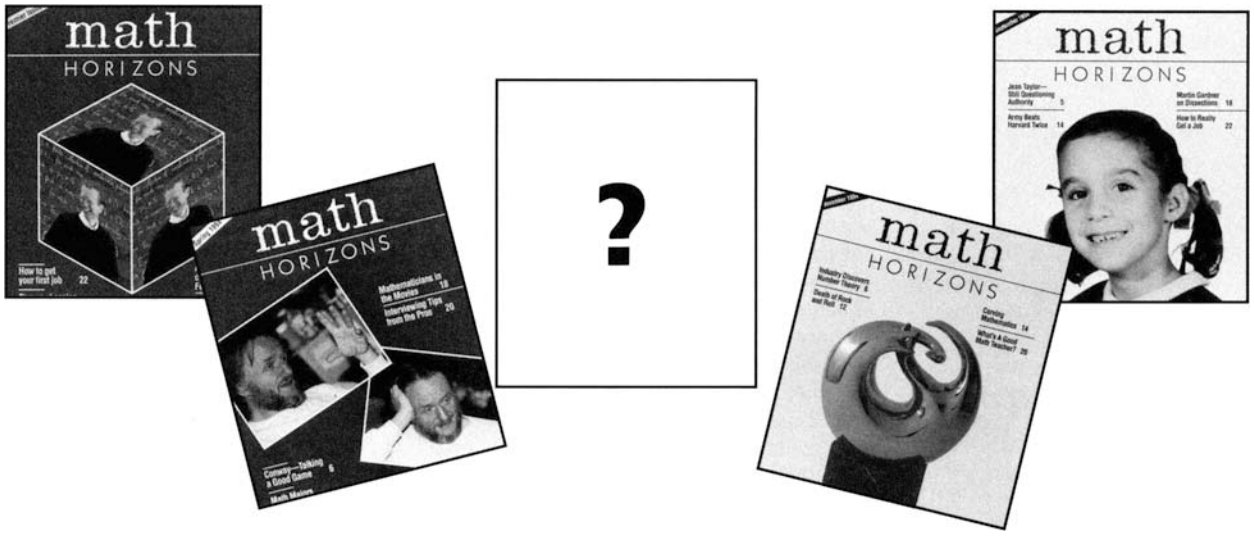

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Dartmouth College
John Wesley Young Research Instructorship in Mathematics

The John Wesley Young Research Instructorship in Mathematics is a two-year post-doctoral appointment for promising new or recent Ph.D.s whose research interests overlap a department member's. Current departmental interests include areas in algebra, analysis, combinatorics, computer science, differential geometry, logic and set theory, number theory, probability and topology. Teaching duties of four ten-week courses spread over two or three quarters typically include at least one course in the instructor's specialty and include elementary, advanced and (at instructor's option) graduate courses. Nine-month salary of $35,000 supplemented by summer (resident) research stipend of $7,778 (two-ninths). Send letter of application, resume, graduate transcripts, thesis abstract, description of other research activities and interests if appropriate, and 3 or preferably 4 letters of recommendation (at least one should discuss teaching) to Betty Harrington, Department of Mathematics, 6188 Bradley Hall, Hanover, NH 03755-3551. Applications received by Jan. 15 receive first consideration; applications will be accepted until position is filled. Dartmouth College is committed to affirmative action and strongly encourages applications from minorities and women.

Bemidji State University

Assistant Professor of Mathematics. Anticipated probationary position to begin August 30, 1995, subject to availability of funds. Earned doctorate in Mathematics at time of appointment with emphasis in any area of pure or applied mathematics or statistics. Expertise in implementing graphic calculators and computers in the classroom is desirable. All applicants must be able to lawfully accept long-term employment in the United States at the time of an offer of employment. Send letter of application, curriculum vita, copies of transcripts (officials required at the time of employment), and three (3) letters of reference sent directly by referrer to: Dr. Kenneth Lundberg, Interim Dean, College of Social and Natural Sciences, Bemidji State University, Bemidji, MN 56601-2699. Inquiries about the position may be directed to Dr. Tom Richard, Department Chair. Telephone: (218) 755-2832. Review of applications will begin on February 15, 1995, and continue until position is filled. Equal opportunity educator and employer.

California State Polytechnic Univ.

Tenure-track teaching position in Mathematics Education at the Assistant Professor level, subject to funding. Doctorate in Mathematics or Mathematics Education, experience in K-12 mathematics teaching or teacher education and potential for related research required. Application, resume, copy of transcripts, and three current reference letters to be postmarked by 3/13/95; position starting 9/95. Cal Poly Pomona is actively seeking to maintain its heritage and identity as a comprehensive center of education that serves a dynamic, culturally diverse region. For information or to apply, contact: Math Ed Search Committee, Mathematics Department, California State Polytechnic University, 3801 W. Temple Ave., Pomona, CA 91768-4033. (909) 869-3467. EOE/AA.

University of Southern Indiana
Mathematics Department
Mathematics Faculty

The University of Southern Indiana invites applications for two full-time tenure-track positions as Assistant/Associate Professor in the Mathematics Department beginning Fall 1995. Position I: Responsibilities include instructing courses in algebra, precalculus, calculus, and abstract algebra or analysis. Position requires a Ph.D. in mathematics or substantial completion of degree. Candidates with a specialization in the area of algebra or analysis will be given favorable consideration. Position II: Responsibilities include instructing courses in algebra, precalculus, calculus, and mathematics for elementary teachers. Position requires a terminal degree in Mathematics or Mathematics Education or substantial completion of the degree. Candidates with a background in teaching a variety of courses at the undergraduate level will be given favorable consideration. The University is committed to excellence in teaching, scholarship and professional activity, and service to the University and the community. Review of applications will begin February 10, 1995, and continue until positions are filled. Submit letter of application indicating position of interest (I or II), curriculum vitae, and the names and addresses of three professional references to: Dr. David Kinsey, Chair, Mathematics Department, University of Southern Indiana, 8600 University Boulevard, Evansville, IN 47712. AA/EOE.

Mathematics/CIS Department–Kutztown University is inviting applicants for a tenure-track Assistant Professor in Mathematics for Fall, 1995. Position involves teaching elementary and/or secondary mathematics education courses at the graduate and undergraduate levels, teaching mathematics at the undergraduate level, and supervising student teachers. Requirements include: Ph.D. in mathematics or mathematics education with a master's degree in mathematics; extensive experience in the use of calculators and computers in the teaching of mathematics in elementary/secondary school; evidence of continuing scholarly growth and the potential to make contributions in teaching, research, publication and service to the university and community at large. Experience supervising student teachers in elementary/secondary mathematics is desirable. Send letter of application, a current resume, official graduate and undergraduate transcripts, three current letters of recommendation and copies of available publications to: Search Committee Chair, Department of Mathematics and Computer Science, Kutztown University, Kutztown, PA 19530-0730. Applications must be received by March 10, 1995. Kutztown University is an Affirmative Action/Equal Opportunity Employer and actively solicits applications from qualified women and minority candidates.

Trenton State College

Department of Mathematics and Statistics

Anticipated Faculty Vacancy for Fall 1995

Tenure-track position at the Assistant Professor level (salary $33,732-$50,609): Req'd: Ph.D. in Statistics or Probability; demonstrated commitment to quality teaching; strong research potential. Preference will be given to candidates with post-doctoral experience in teaching and research. Send vita and three letters of recommendation including at least one letter regarding candidate's teaching ability to: Chair, Search Committee, Dept. of Mathematics & Statistics, TRENTON STATE COLLEGE, CN4700-Hillwood Lakes, Trenton, NJ 08650-4700. Deadline for application: March 1, 1995, review process will begin February 1, 1995. Non-US citizens must include a statement of current visa status. The department currently enrolls over 250 majors in Mathematics, Mathematics Education, and Statistics. To enrich education through diversity, TSC is an AA/EOE.

Marymount University
Chair
Department of Mathematics
Arlington, VA

Marymount University is seeking a chair of the Department of Mathematics at the associate or full professor level beginning in the fall of 1995. Ph.D. in mathematics, strong teaching skill and research accomplishments required. Administrative experience preferred. The Department includes five full-time faculty and twenty-three majors.

Marymount University is an independent, comprehensive university related to the Catholic Church. The University enrolls 4,000 students in 22 undergraduate and 20 master's programs. The main campus is located on a hillside in residential Arlington, VA, ten minutes from Washington, DC.

Review will begin on February 1, 1995, and continue until the position is filled. Applicants should submit a letter of application, a curriculum vitae, and five references with telephone numbers to Chair, Search Committee for Mathematics, c/o Office of the Dean of the School of Arts and Science, Marymount University, 2807 N. Glebe Road, Arlington, Virginia 22207-4299.

Marymount University is an Equal Opportunity/ Affirmative Action Employer. Women and minorities are strongly encouraged to apply.

Assistant Professor of Mathematics

Full-time tenure-track Assistant Professor, beginning Fall 1995, pending budget approval, to teach 12 credits of undergraduate mathematics per semester & share departmental duties. Salary range: $28,000 - $32,000, depending upon credentials & experience.

MINIMUM REQUIREMENTS: Masters in Mathematics or related field, plus some doctoral work; strong commitment to undergraduate teaching. Teaching experience & quality of teaching is of prime concern.

PREFERRED QUALIFICATIONS: Doctorate in Mathematics or Mathematics Education; background in applications of mathematics welcome.

Direct position inquiries to Dr. Richard C. Weimer, (301) 689-4384, and employment inquiries to Human Resources, (301) 689-4105 (Voice/TDD). To apply, send letter of interest, resume, transcripts, and three letters of recommendation, not later than February 21, 1995, to: Frostburg State University, Office of Human Resources, ATTN: Assistant Professor Mathematics (Position #95-427-FOCUS), Frostburg, MD 21532.

FSU is an Affirmative Action/Equal Opportunity Employer. Minority & women candidates are strongly encouraged to apply.

Division of Mathematics and Computer Science
Lander University
Greenwood, SC 29649

Two positions in mathematics, (1) Asst. Prof. tenure-track. Required: Ph.D., specialization is open. (2) Instructor, one year appointment with possibility of annual renewal for up to five years. Required: MA or MS in math. Preferred for both: eighteen graduate hours in Computer Science, teaching and grant writing experience. Teach undergraduate math. Positions are for nine months. Teaching load is 12 cr.h. Position start August 1995. Screening continued until the position is filled. Supply letter speaking to your qualifications, a current curriculum vitae, and names, addresses, and phone numbers of at least three references to Bruce F. White, Division Chair.

Lander University is an EO and AA Employer. We are proud of the diversity among our students, faculty, and staff, and most strongly encourage women and members of minorities to apply.

Central Michigan University

The Department of Mathematics invites applications for a tenure-track position in the area of collegiate mathematics education. The position is at the assistant professor level although candidates with a strong record of teaching and research in the area may be considered for an appointment at the associate professor level. Candidates should have a Ph.D. in Mathematics, Statistics, or Mathematics Education and show evidence of having conducted research in the teaching and learning of collegiate mathematics. The successful candidate will be expected to help in the development of the Department's new Ph.D. Program in Mathematics with Concentration in the Teaching of College Mathematics. Duties include teaching and research with a usual teaching load of nine semester hours, Salary is competitive and benefits include University-paid retirement, medical, dental, disability, and group life insurance. Central Michigan University has an enrollment of 16,500 of which 1,700 are graduate students, and offers Bachelor's, Master's, and Ph.D. degrees. The Department of Mathematics, which includes pure and applied mathematics, statistics, and mathematics education, has 32 tenure-track faculty. Please send resume, transcripts and names of three references to Professor Richard J. Fleming, Chair, Department of Mathematics, Central Michigan University, Mt. Pleasant, MI 48859. Consideration of applications will begin February 27, 1995, but applications will be received until the position is filled. CMU (AA/EO Institution) encourages diversity and resolves to provide equal opportunity regardless of race, sex, disability, sexual orientation, or other irrelevant criteria.

Wheaton College
Wheaton, IL

Department of Mathematics/Computer Science announces full-time, tenure-track faculty position beginning August 1995 as Assistant or Associate Professor. Doctorate in computer science desired as well as interest in continued professional growth. Department has seven full-time faculty; offers major in both mathematics and computer science. Contact Dr. Robert Brabenec, Department of Mathematics/Computer Science, Wheaton College, Wheaton, IL 60187, 708/752-5869, brabenec@rachel.wheaton.edu.

Wheaton College is an evangelical Christian liberal arts college whose faculty and staff affirm a Statement of Faith and adhere to lifestyle expectations. The college complies with federal and state guidelines for nondiscrimination in employment. Women and minority applicants are encouraged to apply.

Department of Mathematics
College of Natural Sciences and Mathematics
Indiana University of Pennsylvania

Indiana University of Pennsylvania invites applications for a tenure-track position in Statistics to begin in the Fall of 1995. The appointment is anticipated at the Assistant Professor level. Associate Professor is possible in the case of exceptional qualifications.

Responsibilities:

1. To teach undergraduate and graduate courses with emphasis on courses in statistics.

2. To provide leadership in the development and implementation of statistics courses.

3. To direct students in a graduate internship program and to direct graduate student projects in statistics.

4. To help establish an academic and professional relationship between the undergraduate and graduate programs at IUP and local and regional business/industrial organizations.

Required Qualifications:

1. Ph.D. in Statistics or Ph.D. in mathematical area with emphasis in statistics.

2. Teaching and/or field experience preferred but not required.

3. Experience in using statistical packages such as SAS and SPSS.

Review of applications will begin January 2, 1995 and will continue until the position is filled.

Send letter of application, resume, undergraduate and graduate transcripts, and three current letters of reference (one of which should address teaching potential) to: Search Committee, Mathematics Department, Indiana University of Pennsylvania, Indiana, PA 15705, telephone 412-357-2608, internet: ADDAVIS@GROVE.IUP.EDU, bitnet: ADDAVIS@IUP.

IUP is an affirmative action/equal opportunity employer.

Georgia Southern University
Department of Mathematics and Computer Science

Several positions starting September 1, 1995. Salary dependent upon qualifications. Indicated degrees are required by starting date. All deadlines are postmark deadlines. Send letter of application indicating position desired, curriculum vitae, unofficial transcripts of all college work, evidence of dedication to outstanding teaching, and name, address, telephone number, and e-mail address of three references by the indicated deadline to [search chair], [search number], Department of Mathematics and Computer Science, Landrum Box 8093, Georgia Southern University, Statesboro, GA 30460-8093.

The names of applicants and nominees, resumes, and other general non-evaluative information are subject to public inspection under the Georgia Open Records Act. Georgia Southern is an Equal Opportunity/Affirmative Action Institution. Persons who need accommodation(s) in the application process under the Americans with Disabilities Act should notify the search chair.

Mathematics. Three tenure-track positions. Instructor or assistant professor. M.A. or M.S. in mathematics required. Three years teaching experience is preferred. Duties include freshman-level mathematics courses. Search Chair: Dr. John A. Rafter. Search # 29851. Deadline: March 1, 1995.

Statistics. One tenure-track position. Instructor or assistant professor. M.A. or M.S. in statistics or mathematics with an emphasis in statistics is required. Three years teaching experience is preferred. Duties include teaching introductory statistics courses and freshman-level mathematics courses. Search Chair: Dr. John A. Rafter. Search # 29850. Deadline: March 1, 1995.

Temporary mathematics positions. Pending a funding decision due in April, several temporary positions may be added at the Instructor level to teach freshman level mathematics courses. Three years teaching experience is preferred. Fifteen credit hours teaching load per quarter. M.A. or M.S. in mathematics required. Search Chair: Dr. John A. Rafter. Search #29852. Deadline: April 17, 1995.

Hendrix College
Computer Science

The Department of Mathematics invites applications for a new tenure-track assistant professor position in computer science beginning August 1995. A Ph.D. in computer science, promise of excellence in teaching, and a commitment to continued scholarship are essential. Applicants must be qualified to teach both computer science courses and mathematics courses that support the computer science program. Responsibilities of the position include teaching two courses per term (fall, winter, spring), directing undergraduate research, and providing leadership for program advancement in computer science.

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

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

Evaluation of applications will begin February 15, 1995 and continue until the position is filled. Hendrix College is an Equal Opportunity/Affirmative Action employer. Women and minority candidates are especially encouraged to apply.

Hunter College of
The City University of New York

Department of Mathematics and Statistics

Two tenure-track Assistant Professor faculty positions available September, 1995. Salary Range: $29,931-$52,213 depending on expertise. Doctoral degree required. We are interested in mathematicians (all fields) and statisticians (all fields). Send CV and three letters of reference by 17 March 1995 to:

Professor Richard Churchill, Chair
Department of Mathematics and Statistics
Hunter College
695 Park Avenue
New York, NY 10021

An Equal Opportunity/Affirmative Action Employer.

SUNY-Farmingdale

Assistant Professor, Mathematics - fall 1995 anticipated tenure-track vacancy - to teach courses ranging from remedial through all levels of undergraduate mathematics. Teaching emphasized, with scholarship and service expected. Minimum qualifications: Doctorate in mathematics, statistics, or operations research. The Department is particularly interested in candidates with expertise in applied mathematics, however, other areas will be considered. Preference will be given to candidates possessing expertise in the use of technology to teach mathematics. Consideration will be given to candidates who expect to complete all degree requirements by August 15, 1995 (essential for appointment). Correspondence must identify the title of the position. Letter of application and resume, including the names and telephone numbers of three references (no letters of reference, please) must be received by March 31, 1995. Address correspondence to: Dr. Robert V. Mark, Dean, School of Arts and Sciences, BOX A, State University of New York, College of Technology, Farmingdale, NY 11736. The College is an Equal Opportunity/Affirmative Action Employer.

East Baptist University
Marshall, Texas

Applications are invited for a senior-track faculty position in mathematics beginning fall 1995. The successful candidate should have the Ph.D. or Ed.D. in mathematics or mathematics education with an interest in teaching in both areas. Candidates near completion of the doctorate will be considered. An appreciation for teaching in an institution with a commitment to education in the Christian tradition and the ability to excel in undergraduate teaching are required. Applications taken through March 15, 1995, or until position is filled. Marshall is located in the rolling hills and piney woods of East Texas, 35 miles west of Shreveport, Louisiana, and 150 miles west of Dallas. Send resume to Rutledge McClaren, Chairperson, Department of Mathematics and Computer Science, 1209 North Grove, Marshall, Texas 75670-1498.

Montana State University

Mathematics. Assistant Professor of Mathematics, Computer Science, and Statistics at Montana State University-Billings. Full-time, tenure-track position (contingent on funding) to begin Fall Semester 1995 (August 1995). The person for this position should hold a Ph.D. in Mathematics and provide the department with expertise in computing systems. Responsibilities include, but are not limited to: 1) demonstrated ability or potential to teach a variety of courses in mathematics, statistics, and computer science — Montana State University-Billings is primarily a teaching institution and encourages applicants who are committed to excellence in teaching; 2) revising and making curricular and pedagogical improvements to existing mathematics, statistics, and computer science courses to reflect changes and increased use of technology in these fields and in their real world application — the Department uses computers in a variety of ways to teach mathematics, computer science, and statistics, and the successful candidate should have experience with computer mathematical systems such as Mathematica; 3) adding to the intellectual vitality of the Department with original scholarship and participating in departmental and other seminars; 4) advising students who are seeking a major/minor in mathematics or a minor in computer science; 5) participating in departmental and campus committees. For a detailed vacancy announcement contact the Human Resources Office at the address/phone number listed below. Screening of applications to begin February 28, 1995, and will continue until position is filled. Submit cover letter with statement of teaching philosophy and research interests, curriculum vita, copies of transcripts and three (3) letters of recommendation to Chair, Search #95-7, Math Screening Committee, Human Resources/EEO-AA Office, Montana State University-Billings,

1500 North 30th Street, Billings, MT 59101-0298, (406) 657-2278. ADA/AA/EEO.

Mathematics: Assistant Professor. The Mathematical Sciences Department of Muhlenberg College is accepting applications for a tenure-track faculty position at the Assistant Professor rank, starting August, 1995. A Ph.D. in Mathematical Sciences in required. Three courses per semester teaching load. Individuals with training or experience in the use of technology in the classroom will be given priority. Teaching excellence is required, and all faculty are expected to continue their professional activities. Applicants should submit a resume, a letter detailing their teaching experience and research, and three letters of reference. Send application materials to: Dr. John Meyers, Head, Mathematical Sciences Department, Muhlenberg College, Allentown, PA 18104-5586. EOE.

Mathematics

Pacific University, Forest Grove, OR, is seeking an Assistant Professor of Mathematics in a tenure-track position to teach a variety of courses. The department serves a student body half of whom intend to major in a science and all are required to take a math course. Applicants with an applied analysis emphasis are preferred. Ph.D. and a strong commitment to and demonstrated excellence in undergraduate teaching required. Send vitae and three letters of recommendation to Professor Mike Clock, Chair, Department of Mathematical Sciences, Pacific University, Forest Grove, OR by February 1, 1995.

Pacific University is a residential liberal arts college of 1000 undergraduates and expects to have 1200 students by 1999. Half of the undergraduates intend to major in science. The faculty of 75 is dedicated to quality teaching and service to students. The University also has five professional graduate programs with a total of 700 students and is located 25 miles west of Portland. OE/AAE.

Faculty Position

Associate/assistant professor, tenure-track, beginning August 1995. Teach average 12 hours/semester. Requires Ph.D. in statistics or mathematics, evidence of excellent teaching and of ability for continued research or scholarly activity. Preference given to applicants in applied statistics or applied mathematics (with background in mathematical modeling). Send application letter, resume, transcripts, three reference letters to: Dr. Jack Scheidt, Chair, Mathematics Department, University of Wisconsin-La Crosse, La Crosse, WI 54601. All materials must be received by March 1, 1995. All positions contingent on funding. Names of applicants who haven't requested confidentiality in writing, and all finalists, must be released on request. Women, minorities encouraged to apply. AA/EOE.

Occidental College
Los Angeles, California

Applications are invited for a tenure-track position in the Department of Mathematics at the Assistant Professor level. Occidental College is a selective college of the liberal arts and sciences which serves a diverse student body of 1600 in an undergraduate teaching environment which encourages curricular innovation, interactive learning techniques, and methods and programs for providing students access to a range of professional and intellectual pursuits. The Mathematics Department consists of nine full-time faculty members. The normal teaching schedule is five semester courses per year, and faculty members receive a sabbatical semester every four years. The college is located in northeast Los Angeles, easily accessible to a number of research institutions. Salary is competitive. An excellent benefits package includes a choice of health care plans, tuition grants for children of faculty, and a mortgage subsidy program. Only applications which contain the following information will be considered: a current resume, three letters of reference (at least one evaluating teaching experience, performance, and potential), a statement of commitment to teaching in a liberal arts college environment, and a statement of professional goals including a description of current research plans. All materials must be received by January 23, 1995. Address all materials to Faculty Search Committee, Department of Mathematics, Occidental College, 1600 Campus Road, Los Angeles, CA 90041. Occidental College is committed to equity and excellence in education and strongly encourages applications from women and minorities.

Valparaiso University

Valparaiso University, Dept. of Math and Comp. Sci., Valparaiso, IN 46383. Located 1 hour from Chicago loop. Pending budget approval, applications are invited for a tenure-track position in math, at the asst. prof. level beginning August 1995. Ph.D. in math desired, required for tenure. Teaching experience, experience in preparing secondary teachers, familiarity with calculus reform helpful. App. from women and minorities esp. encouraged. Candidates should be willing to work in a scholarly community committed to Christian higher education and the Lutheran tradition. Send letter of app. and vita by March 31 to: Patrick Sullivan, Chair.

ARE YOU DEDICATED TO QUALITY MATHEMATICS TEACHING IN A PRIVATE, LIBERAL ARTS COLLEGE NEAR THE HEART OF A DYNAMIC CITY?

We are. If you are, too, then tenure-track and one-year positions are available starting 9/95. You should provide evidence that you are an exciting, creative teacher willing to work with an innovative mathematics curriculum. Ideally, one tenure-track position is for an analyst, one for a remedial mathematics specialist. One leave replacement should be able to teach probability/statistics. You should hold an appropriate doctorate. Please send letter of intent, resume, and evidence of creative, innovative teaching to Larry Copes, Chair, Department of Mathematics, Augsburg College, Minneapolis, MN 55454 (copes@augsburg.edu). Applications will be accepted at least until 3/1/95. Augsburg is an Equal Opportunity Employer.

Gustavus Adolphus College Department of Mathematics and Computer Science

Applications are invited for two visiting positions in mathematics. These are one-year positions with the strong possibility of renewal for a second year. A Ph.D. in mathematics is expected for these positions. Preference for one of the positions will be given to those candidates with special interests in applied mathematics and/or mathematical physics. Teaching load is three courses per semester. Candidates should have a record of effective undergraduate teaching. Review of applications will begin Feb. 15 and continue until the positions are filled. Send letter of application, vita, graduate transcripts, and three letters of recommendation to Mike Hvidsten, Chair, Department of Mathematics and Computer Science, Gustavus Adolphus College, St. Peter, MN 56082. (e-mail: hvidsten@gac.edu) At least one letter should specifically address teaching.

Gustavus Adolphus College is a liberal arts college affiliated with the Evangelical Lutheran Church of America and is located about 65 miles southwest of Minneapolis/St. Paul. The mathematics and computer science department has 13 members. The department is located in the recently constructed Olin Hall of Science and has state-of-the art high-tech classrooms and computer facilities. It is the policy of Gustavus Adolphus College to provide equal educational and employment opportunities for all. We specifically encourage applications from women, minorities and persons with disabilities.

Calendar

National MAA Meetings

August 6-8, 1995 Seventieth Annual Joint Summer Meeting. University of Vermont-Burlington, Burlington, VT

Sectional MAA Meetings

ALLEGHENY MOUNTAIN April 7-8, 1995, Duquesne University, Pittsburgh, PA

EASTERN PENNSYLVANIA & DELEWARE April 8, 1995, King's College, Wilkes-Barre, PA

FLORIDA March 3-4, 1995, Valencia Community College-East Campus, Orlando, FL

ILLINOIS March 31-April 1, 1995, Monmouth College, Monmouth, IL

INDIANA March 31-April 1, 1995, Tri-State University, Angola, IN

INTERMOUNTAIN April 7-8, 1995, Idaho State University, Pocatello, ID

IOWA April 21-22, 1995, University of Northern Iowa, Cedar Falls, IA

KANSAS April 14-15, 1995, Wichita State University, Wichita, KS

KENTUCKY March 31-April 1, 1995, Transylvania University, Lexington, KY

LOUISIANA-MISSISSIPPI March 3-4, 1995, Mississippi State University, Biloxi, MS

MD-DC-VA April 7-8, 1995, Thomas Nelson Community College, Hampton, VA

METROPOLITAN NEW YORK May 6, 1995, Manhattan College, Bronx, NY

MICHIGAN May 5-6, 1995, Grand Valley State University, Allendale, MI

MISSOURI April 7-8, 1995, Central Missouri State University, Warrensburg, MO

NEBRASKA April 1995, Creighton University, Omaha, NE

NEW JERSEY April 29, 1995, William Paterson College, Wayne, NJ

NORTH CENTRAL April 21-22, 1995, Carleton College, Northfield, MN

NORTHEASTERN June 9-10, 1995, Bates College, Lewiston, ME

NORTHERN CALIFORNIA October 21-22, 1995, Cal Polytech State University, San Luis Obispo, CA (joint meeting with S. California Section)

OKLAHOMA-ARKANSAS March 31-April 1, 1995, Southwestern Oklahoma State Univ., Weatherford, OK

PACIFIC NORTHWEST June 15-17, 1995, Whitman College, Walla Walla, WA

ROCKY MOUNTAIN April 21-22, 1995, University of Southern Colorado, Pueblo, CO

SEAWAY April 21-22, 1995, Hobart & William Smith Colleges, Geneva, NY

SOUTHEASTERN March 31-April 1, 1995, University of North Carolina-Asheville, Asheville, NC

SOUTHWESTERN April 7-8, 1995, University of Texas at El Paso, TX

SOUTHERN CALIFORNIA October 21-22, 1995, Cal Polytech State University, San Luis Obispo, CA (joint meeting with N. California Section)

TEXAS March 30, 31, April 1, 1995, Baylor University, Waco, TX

WISCONSIN April 7-8, 1995, University of Wisconsin-Green Bay, Green Bay, WI

Other Meetings

October 21–24, 1995 Seventeenth annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME–NA XVII), Columbus, Ohio. Deadline for proposals is February 20th. For a copy of the first announcement and call for papers, contact: Doug Owens, 253 Arps Hall, Ohio State University, 1945 N. High St., Columbus, OH 43210-1172; (614) 292-8021; fax: (614) 292-7695; e-mail: owens.93@osu.edu.

July 30–August 4, 1995 Ninth Iberamerican Conference on Mathematics Education (IACME IX), Santiago, Chile. Contact: Organizing Committee, IACME IX, Casilla 33081, Correo 33, Santiago, Chile; fax: 56-02-6811739; e-mail: hgonzale@eculides.usach.cl.

August 14–20, 1995 Symmetry: Natural and Artificial–Third Interdisciplinary Symmetry Congress and Exhibition, Washington, DC (Old Town Alexandria). For information, contact Gyorgy Darvas, Symmetrion–The Institute for Advanced Symmetry Studies, PO Box 4, Budapest H-1361, Hungary; phone: 36-1-131-8326; fax: 36-1-131-3161; e-mail: h492dar@ella.hu; alternate contact: Denes Nagy, Institute of Applied Physics, University of Tsukuba, Tsukuba Science City, Japan 305; 81-298-53-6786; fax: 81-298-53-5205; e-mail: nagy@kafka.bk.tsukuba.ac.jp.

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