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On the cover: A Costa Surface made out of Legos. Article begins on page 4.

FOCUS Deadlines

	August/September	October	November
Editorial Copy	July 8	—	September 16
Display Ads	July 10	August 20	September 24
Employment Ads	June 11	August 13	September 10

A New President for the MAA

At the close of the Joint MAA-AMS meeting in Baltimore in January 2003, Ron Graham became the fiftieth President of the MAA. It was an eventful meeting for Graham, since he also received the Steele Prize for lifetime achievement as a research mathematician (see page 16).

Graham did his undergraduate work at the University of Chicago, the University of California at Berkeley, and (courtesy of the U.S. Air Force) at the University of Alaska. He earned his Ph.D. at the University of California at Berkeley in 1962. He worked at Bell Labs for 37 years, eventually becoming Chief Scientist at what was then the AT&T Bell Laboratories. He is now at the University of California at San Diego.

Ron Graham has served the MAA on many committees and was First Vice-President of the MAA in 1982-1983. in 1972 he was awarded the Pólya Prize in Combinatorics by the Society for Industrial and Applied Mathematics. The MAA awarded him the Carl B. Allendoerfer Award in 1990, the Lester R. Ford Award in 1991, and he was an Earle Raymond Hedrick Lecturer in 1994. In 1996, he was featured on the cover of *Math Horizons*. That article highlighted his activity as a juggler; he has, in fact, been the president of the International Jugglers Association.

Ron Graham took over as President of the MAA at the end of the January Joint Meetings. His term will extend until the end of the January 2005 Joint Meetings.

At the MAA Business Meeting, Graham explained that "Everything I've done up to now is preparation for this job." That includes serving as President of the American Mathematical Society from 1993-1994. Graham is the sixth person to be president of both the MAA and the AMS. The first, E.R. Hedrick, was the MAA president in 1916 and AMS president in 1929-1930. E.J. McShane was MAA president in 1953-1954 and AMS president in 1959-1960. R.L. Wilder was AMS President in 1955-1956 and MAA President in 1965-1966. Saunders Mac Lane was President of the MAA in 1951-1952 and the AMS in 1973-1974. R.H. Bing was President of the MAA in 1963-1964 and the AMS in 1977-1978. Only Wilder and Graham were President of the AMS before being president of the MAA.

Mathematics Magazine and *The College Mathematics Journal* Now on JSTOR

Full text versions of *Mathematics Magazine* and *The College Mathematics Magazine* are now available online at JSTOR, joining *The American Mathematical Monthly* in that important online archive of scholarly journals. JSTOR can be accessed at http://www.jstor.org.

JSTOR (short for *Journal Storage*) is an electronic archive of scholarly journals in many fields. It contains both searchable text and high-quality images of the journal pages. Articles can be viewed online, downloaded, or printed.

The *Mathematics Magazine* archive contains every issue published between l927 (volume 1) and l997. The *College Mathematics Journal* archive contains all issues published since its inception in 1970 (as volume 1 of *The Two Year College Mathematics Journal*) through l997. Each year, one more volume will be added to each archive, so that all but the most recent five years of each of the MAA's journals will be accessible.

Access to JSTOR requires a subscription, usually on an institutional basis. Institutions can subscribe to various different collections of journals. *Mathematics Magazine* and *The College Mathematics Journal* are part of JSTOR's Arts and Sciences II Collection. (The *Monthly* is part of Arts and Sciences I.) Each collection requires a separate institutional subscription. Both collections include many other journals.

As it has done for the *Monthly*, the MAA hopes to offer access to individual members soon.

Alder Awards Will Recognize Talented Young Teachers

Before his recent death, Henry Alder endowed a new MAA teaching award, to be known as the Henry Alder Award for Distinguished Teaching by Beginning College or University Mathematics Faculty. The awards "are to be made to college or university faculty who have taught full time in a mathematical science in the United States or Canada for at least two but not more than seven years since receiving their Ph.D. and whose teaching has been extraordinarily successful. Their effectiveness in teaching undergraduate mathematics must be documented and shown to have influence beyond their own classroom."

The awards will be given every year at one of the national meetings of the Association. Linda Sons will be chairing the committee that will recommend the procedures for nomination and selection of winners.

Mathematical LEGO® Sculptures

By Andrew Lipson

I'm not quite sure how it first occurred to me to build a Möbius band out of LEGO bricks, but the thought was irresistible.

There is a large and active adult LEGO community on the internet. (If you're interested, http://www.lugnet.com, the unofficial "LEGO Central" for fans, is a good place to start looking.) Like many others among its members, I had played with LEGO as a child and forgotten about it. Decades later, and with children of my own, it slowly dawned on me that first, the little Danish bricks are still fun to play around with, and second, I could afford to buy a lot more of them than I ever had before.

There are some extremely impressive LEGO constructions on the web. There are people who build elaborate castles, people who make huge train layouts, people who make vehicle reproductions, and a few who specialize in large sculptures. Eric Harshbarger (http:/www.ericharshbarger.com) is the undisputed champion of this subgenre and has made life-size figures, a grandfather clock, and even a desk out of LEGO. Henry Lim (http://www.henrylim.org/LEGOSculptures.html) has made, among other things, a 14-foot stegosaurus and a full-size working harpsichord from LEGO bricks. Clearly, I could not compete with these masters, but for some reason it didn't seem to have occurred to anyone to make abstract sculptures from LEGO, let alone anything mathematical.

I didn't trust my artistic abilities enough to try building the Möbius band by eye. While I wasn't in any doubt that I'd be able to make one, I wanted something that would be aesthetically and mathematically pleasing. I decided to write a computer program to generate the outline of the model. The program would subdivide space into cells the shape of a 1x1 LEGO brick (the height of a brick is exactly 6/5 times the horizontal distance between studs), and produce output telling me which cells should be occupied. Of course a model built entirely of 1x1 LEGO bricks would not hold together without gluing (heresy!) so this would leave me the challenge of actually constructing it out of larger bricks in such a way that the structure would be reasonably robust. In order to make the problem more interesting, I chose a parameterization of the surface that meant that the model would balance on a single short section of the edge.

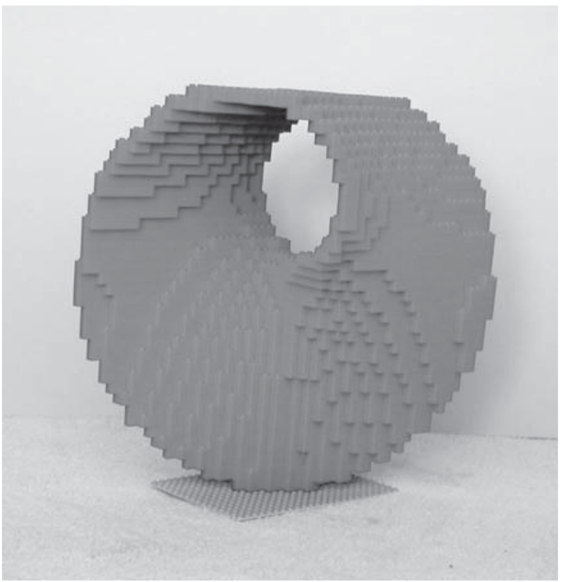


Figure 1: A LEGO Möbius band.

Figure 2: The figure-eight knot 4_1

My first attempt was just over 5 inches high, and I was sufficiently pleased with it to attempt some larger versions, culminating in the model shown in Figure 1, which is about 14 inches high. There were several challenges along the way. While the makers of LEGO produce a great variety of pieces, including plates that are 1/3 of the height of a brick, I wanted to make the Möbius band using only standard rectangular bricks. The most commonly available sizes are 1xn and 2xn bricks, for n=1,2,3,4,6 and 8, with n=3,6 and 8 being significantly rarer than the others. Unfortunately I discovered that in building a curving wall which is essentially one brick thick throughout (another design goal), I kept having to dive into my stock of 1x3 bricks, which dwindled alarmingly. The overhanging "roof" of the structure, which is horizontal at the top, also constrained my options (I admit it — I cheated a bit by deviating from my computer instructions to allow the top to hold together).

If a surface, why not a knot? Shortly after completing the Möbius strips, I decided to attempt the trefoil knot 3_1, the simplest non-trivial embedding of the unit circle in Euclidean 3-space [1]. I was rather less sure of myself this time. I decided to parameterize the knot as a curve on the surface of a torus, thickening it to a diameter of about three Lego studs. The result was only moderately successful, but encouraged me to attempt a more ambitious structure — the figure-eight knot 4_1. This time I chose a parameterization that shows off the rather nice tetrahedral skew-symmetry of this knot. Building this model was quite challenging. My experience with the trefoil indicated that I needed to thicken the curve by slightly more than the three studs I had previously used to have any hope of the structure being self-supporting. In fact, the long curving arches of the structure shown in Figure 2 required repeated backtracking as it was built. It did not become evident until close to the top of the structure which parts lower down were suffering the most stress and were likely to fall apart under the weight. The final result, however, was very satisfying .

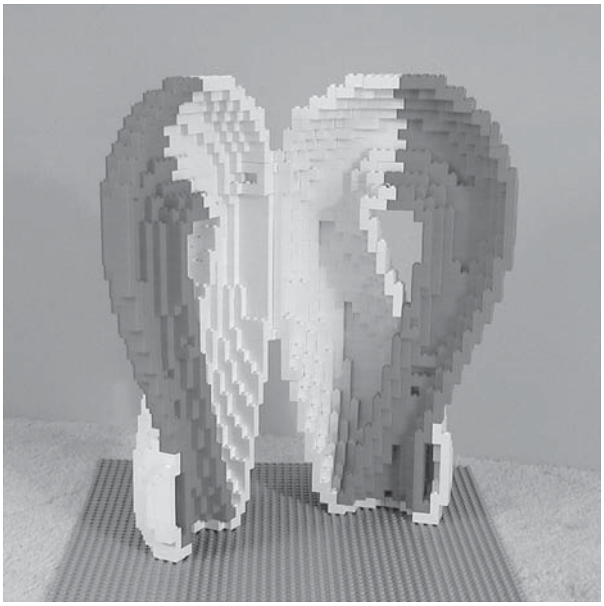


Figure 3: A hinged Klein bottle

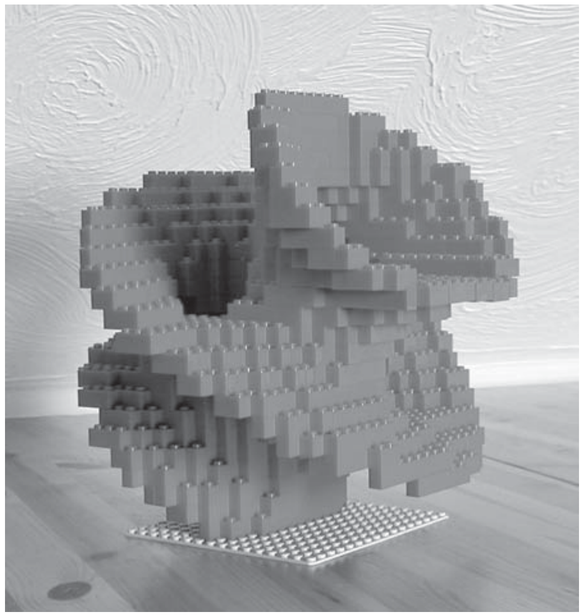


Figure 4: A Costa surface.

And there it would have stopped, were it not for the involvement of a colleague. Knowing that it would provoke me to prove him wrong, he commented that most of the interesting minimal surfaces would probably be too difficult to construct in this way. How could anyone ignore such a challenge?

A minimal surface is one with mean curvature zero [2]. Locally, a small patch of such a surface has minimal area among all surfaces sharing the same boundary. They have been widely popularized as the shapes formed by bounded soap bubbles. For my purposes, of course, the interest of minimal surfaces is that they provide a small library of mathematically interesting and pleasing shapes to build, with a variety of associated construction challenges. The study of minimal surfaces has been intertwined with computation; the ability to use computers to visualize has led to new insights, and this added a small *frisson* given my intention to use computer programs to aid my Lego constructions.

But which minimal surface to try? I daydreamed about producing a Costa surface — the beautiful new complete minimal embeddable surface discovered by Costa in 1984 [3]— but reluctantly decided that this would be too ambitious, at least for the time being. I settled for Enneper's surface and the Catalan surface, both of which looked easy enough to attempt.

Although I no longer claim the title, I was once a topologist. Naturally I would have to build a Klein bottle! The major difficulty here was a new one; what parameterization should I use? There were several constraints. I wanted something that would look recognizably like the classic bottle shape, with the tube feeding in through the outer wall of the bottle. I wanted the overall shape to be aesthetically pleasing, and I wanted, despite the constraints of working with Lego bricks, for a gap genuinely to run around between the inner and outer tubes near the mouth of the bottle. I played around with *Mathematica* for a couple of days before coming up with something I found acceptable. When I built the bottle, I broke my usual "bricks only" rule and allowed myself a couple of Lego hinges so that the model could be opened up. It is well known that a Klein bottle can be obtained by gluing together the edges of two Möbius strips, and the model shows this!

Well, you get the idea. One thing led to another and an initial whim turned into a hobby. Many of us have at some point enjoyed painstakingly building polyhedra or other mathematical models from paper or card. Certain areas of mathematics have a distinctly tactile pleasure in addition to their abstractly mathematical aesthetic qualities. In fact, one of the nice things about these LEGO constructions is just how accessible they seem to be to non-mathematicians.

But why LEGO? One would have thought that small rectangular bricks would be the very last thing from which one might build models of smooth surfaces! But, of course, that's part of the point. There is a very obvious contrast between the medium and the content in these models. The fun is in producing something that lets the eye shift back and forth between seeing something angular and bricky, and seeing something smooth. This is one of the reasons why I have never attempted to build a mathematical LEGO sculpture bigger that about 15 inches high; too large, and the resolution becomes *too* good! The fun is in picking a scale just the right size so that the intended shape can be conveyed without losing the detail of what it's made of.

There are other aspects of LEGO that pique my mathematical interest as well. I mentioned that my programs produce as output a description of which cells in a rectangular grid need to be filled. It takes very little experience to discover that filling in a specified set of cells with a given selection of LEGO bricks is distinctly non-trivial — especially when one is working under the constraint that the entire structure needs to hold together and that the only solid connections are, as with LEGO, those between vertically adjacent bricks. I have very nearly convinced myself that connected LEGO space-filling is in general an NP-hard problem, although in practice I have hardly ever found I had to backtrack by more than two or three layers while building. Of course, I'd be delighted to be shown that the problem is in fact easy. Constructive proofs preferred!

Oh, yes. And I can't end without bragging that I *did* eventually produce the Costa surface I had hoped for. How do you like *them* apples, Fred? (Figure 4)

[1] Lickorish, W.B.R. *An Introduction to Knot Theory*. Springer 1997

[2] Osserman, Robert. *A Survey of Minimal Surfaces.* Dover, 1986

[3] Costa, A. "Examples of a Complete Minimal Immersion in R^3 of Genus One and Three Embedded Ends." *Bol. Soc. Bras. Mat.* **15**, 47-54, 1984.

Andrew Lipson trained as a knot theorist and now works as a computer programmer, specializing in algorithmic optimization. His various LEGO constructions can be seen at http://www.lipsons.pwp.blueyonder.co.uk/lego.htm and he can be contacted by email at andrewlipson@blueyonder.co.uk.

NSF Beat March 2003

By Sharon Cutler Ross

One of the changes that the mathematics community has experienced in the last few years is an increased dialog and cooperation between those who train teachers of mathematics and those who train mathematicians. Currents from the changing job market, from reform efforts in undergraduate mathematics education, and from the increasing challenges facing K-12 education have all contributed to a heightened awareness of the necessity and the benefits of dealing with pre-service and in-service teacher training as a joint effort of mathematics and mathematics education faculty. In order to support these trends, the National Science Foundation is revamping the Division of Undergraduate Education (DUE) Faculty Enhancement program; and the Division of Elementary, Secondary, and Informal Science Education (ESIS) Science, Technology, Engineering, and Mathematics Teacher Preparation program. These two programs will be replaced by the Teacher Professional Continuum (TPC) program administered jointly by DUE and ESIS.

The Teacher Professional Continuum program will not be a merging of the old programs, but a fresh approach to the issues and needs of teacher recruitment, preparation, retention, and further professional training. The emphasis will be on building research-based knowledge in the area of preparing and educating teachers. The intent is to produce studies on teacher learning and on teaching practices. Of particular interest are the transition period as new teachers become practicing professionals and strategies to strengthen and diversify the K-12 teacher group. The Foundation hopes to see materials and tools developed that will be of use through the continuum of teacher training from pre-service to in-service.

A related program that is also designed to strengthen and diversify the pool of K-12 teachers of science and mathematics is the Noyce Scholarship program. These scholarships may make K-12 teaching an attractive option for science, technology, engineering, and mathematics majors or practitioners who are interested in becoming teachers.

At the time this article was written (January 2003), the final budget had not been approved for the NSF, so more details about the TPC program were not available, but grants are likely to be for multi-year projects involving collaboration of mathematics, science, mathematic education, and science education faculty. Preliminary proposals will likely be required. By the time of publication the full solicitation for TPC is available on the NSF website. *(See page 28.–Ed.)*

Math Awareness Month 2003: Mathematics and Art

By Joseph Gallian

April is Math Awareness Month! The theme for this year is *Mathematics and Art*. Each MAM theme has an accompanying poster that depicts the theme in a significant way. The 2003 poster features a computer generated Escher-like image in the Poincaré model of the hyperbolic plane designed by Douglas Dunham.

The connection between Mathematics and Art dates back thousands of years. From the geometry in the buildings in ancient Greece to the topology in modern sculptures, artists have been inspired by mathematical shapes and forms. The Mathematics Awareness Month website at http://www.mathforum.org/mam/03 lists many resources that can help explore this theme, including the poster, essays, and links. To get you started, here are just a few of them.

Web Sites

Jill Britton's spectacular web site on symmetry and tessellations at http://ccins.camosun.bc.ca/~jbritton/jbsymteslk.htm has numerous activities and links to many other sites on related topics.

A truly outstanding site at http://www.georgehart.com/sculpture/sculpture.html features the work of George W. Hart, a computer scientist and award winning sculptor of constructive geometric forms who deals with patterns and relationships derived from classical ideals of balance and symmetry. Articles about Hart's sculptures have appeared in the *New York Times, Science News* and *Natural History.* The site has articles written by Hart and interviews with Hart.

You can find mathematically inspired sculptures, puzzles and jewelry by the artist Charles O. Perry at http://www.charlesperry.com. Perry's work is on display at the offices of the Mathematical Association of America, the American Mathematical Society, the National Council of Teachers of Mathematics and the American Center for Physics. He has received numerous awards.

The mathematically inspired sculpture of Helaman Ferguson is featured at http://www.helasculpt.com. Articles about his work have appeared in *Science, Science News, SIAM News* and *The Mathematical Intelligencer*. A photograph of his *Fibonacci Fountain* was on the cover of the January issue of *FOCUS*. The site includes a statement from the artist about what motivated him to become a sculptor. Helaman and Claire Ferguson won the Joint Policy Board for Mathematics Communications Award in 2002.

Courses

Paul Calter teaches a survey course on mathematics in art and architecture at Dartmouth College. The course web site is http://www.dartmouth.edu/~matc/math5.geometry. The course explores the many places where the fields of art and mathematics overlap. Topics include: sculpture in ancient Greece, use of proportion in art, perspective, perspective machines and cameras, the golden section, knots, and symmetry, twentieth-century geometric art, chaos, and fractals.

Helmer Askalan teaches a course on Mathematics in Art at the National University of Singapore. The web site is http://www.math.nus.edu.sg/aslaksen/teaching/math-art-arch.shtml. Topics include the golden ratio, Platonic solids, kaleidoscopes, symmetry, tilings, polyhedra, and perspective.

Books

Mathematics and Art by Claude P. Bruter, Springer, 2002. This book illustrates how polyhedra, group theory, dynamical systems, and topology have provided inspiration for artists.

M. C. Escher's Legacy, edited by D. Schattschneider and M. Emmer, Springer, 2003. This book, which comes with a CD-ROM, grew out of a 1998 centennial celebration of the birth of the artist M.C. Escher. It contains 40 articles by artists and scientists whose work has been directly inspired by Escher.

About Math Awareness Month

Math Awareness Month, held in April each year, first began in 1986 with a mandate to increase public understanding of and appreciation for mathematics. A proclamation by President Ronald Reagan said in part:

Despite the increasing importance of mathematics to the progress of our economy and society, enrollment in mathematics programs has been declining at all levels of the American educational system. Yet the application of mathematics is indispensable in such diverse fields as medicine, computer sciences, space exploration, the skilled trades, business, defense, and government. To help encourage the study and utilization of mathematics, it is appropriate that all Americans be reminded of the importance of this basic branch of science to our daily lives.

During that first Mathematics Awareness Week, expanded in 1991 to be Mathematics Awareness Month (MAM), activities were concentrated in Washington, D.C. with a Capitol Hill reception and exhibit at the Smithsonian Institution. Since then participation and support has increased to include many thousands of students and teachers, in high schools, colleges, and universities across the nation. The Mathematical Association of America, the American Mathematical Society, and the Society for Industrial and Applied Mathematics—three of the largest mathematical organizations in the country—coordinate efforts to publicize this event to reflect the wide and comprehensive world of mathematics and how it affects each and every one of us.

Among the themes from previous years are Mathematics and the Environment, Mathematics and Manufacturing, Mathematics and Medicine, Mathematics and Symmetry, Mathematics and the Internet, Mathematics and Imaging, Mathematics and Biology, Mathematics and the Ocean, and Mathematics and the Human Genome.

Mathematics and Art—So Many Connections

By Doris Schattschneider

The theme Mathematics AND Art may seem strange to those who are more used to thinking Mathematics OR Art, but, in fact, there are many connectors to fill the blank in Mathematics ___ Art and its twin Art ___ Mathematics. The many interconnections between mathematics and art provide a wealth of material from which organizers of Math Awareness Month events can select. In this brief essay, I'll highlight a few of the possible ways to fill in the blanks above. I hope that this will stimulate you to explore many others.

Mathematics produces art

At the most practical level, mathematical tools have always been used in an essential way in the creation of art. Since ancient times, the lowly compass and straightedge, augmented by other simple draftsmen's and craftsmen's tools, have been used to create beautiful designs realized in the architecture and decoration of palaces, cathedrals, and mosques. The intricate Moorish tessellations in tile, brick, and stucco that adorn their buildings and the equally intricate tracery of Gothic windows and interiors are a testament to the imaginative use of ancient geometric knowledge.

During the Renaissance, several artists used simple grids and mathematically based devices to accurately portray scenes on a flat surface, according to the principles of linear perspective. Several of Dürer's engravings give a glimpse of these techniques. The symbiosis of art and mathematics during these times as linear perspective and projective geometry were developing is one of the most striking examples of art and mathematics evolving almost simultaneously in new directions.

Today's mathematical tools are more sophisticated, with digital technology fast becoming a primary choice. In the hands of an artist, computers can produce art, powered by unseen complex internal mathematical processes that provide their magical abilities. Mathematical transformations provide the means by which an image or form in one surface or space is represented in another. Art is illusion, and transformations are important in creating illusion. Isometries, similarities, and affine transformations can transform images exactly or with purposeful distortion, projections can represent three (and higher)-dimensional forms on two-dimensional picture surfaces, even curved ones. Special transformations can distort or unscramble a distorted image, producing anamorphic art. All these transformations can be mathematically described, and the use of guiding grids to assist in performing these transformations has been replaced today largely by computer software. Compasses, rulers, grids, mechanical devices, keyboard, and mouse are physical tools for the creation of art, but without the power of mathematical relationships and processes these tools would have little creative power.

Escher II: Infinite Reflection, by Kelly M. Houle. Charcoal on illustration board. The drawing is a 360-degree distorted image which the cylindrical mirror transforms into a famous photo of Escher.

Mathematics generates art

Pattern is a fundamental concept in both mathematics and art. Mathematical patterns can generate artistic patterns. Often a coloring algorithm can produce "automatic art" that may be as surprising or aesthetically pleasing as that produced by a human hand. Colored versions of the Mandelbrot set and Julia sets are striking examples of this: each is generated by iterating the function $f(z) = z^2 + C$. In the case of the Mandelbrot set we start from $z_0 = 0$ and set $z_{n+1} = f(z_n)$ for each point C in the complex plane, and the point C is colored according to rules based on whether the absolute value of z_n eventually exceeds 2 and the number of iterations after which this occurs. Other fractals, as well as images based on attractors, are also produced by iteration and coloring according to rules. The intricacy of these images, their symmetries, and the endless (in theory) continuance of the designs on ever-smaller scales, makes them spellbinding.

Much more mundane mathematical patterns can also provide surprising art. For example, begin with an array of numbers (such as a large data set, a sequence, a modular operation table, or Pascal's triangle) and color the numbers in the array according to some rule. Often surprising patterns — even art — emerge. Recursive algorithms applied to geometric figures can generate attractive self-similar patterns. Begin with a curve, a closed figure, or a simple spatial form, apply an algorithm to alter that figure by adding to (or subtracting from) specified parts of that figure, then repeat the algorithm recursively. Many nonperiodic tilings (such as the Penrose tilings) can also be generated automatically, beginning with a small patch of tiles and then applying a recursive "inflation" algorithm.

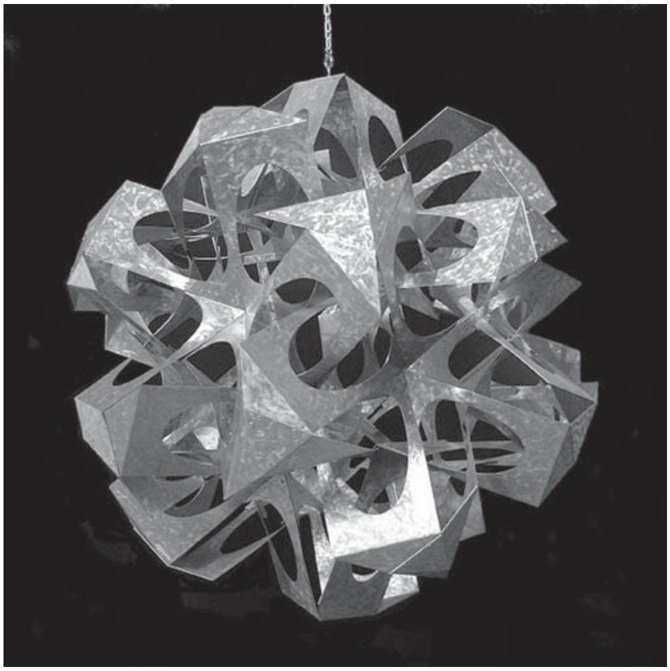
Transformations and *symmetry* are also fundamental concepts in both mathematics and art. Mathematicians actually define symmetry of objects (functions, matrices, designs or forms on surfaces or in space) by their invariance under a group of transformations. Conversely, the application of a group of transformations to simple designs or spatial objects automatically generates beautifully symmetric patterns and forms. In 1816, Brewster's newly invented kaleidoscope demonstrated the power of the laws of reflection in automatically generating eye-catching rosettes from jumbles of colored shards between two mirrors. Today computer programs use symmetry groups to generate rosettes, borders, wallpaper designs, and Escher-like circle-limit designs such as featured on the 2003 Math Awareness Month poster. Each of these designs begins with a small fragment or motif (chosen judiciously or randomly) whose transformed images fill out the full design. Periodic tessellations, whether geometric or Escher-like, can be automatically generated by computer programs or by hand, following recipes that employ isometries.

Art illuminates mathematics

When mathematical patterns or processes automatically generate art, a surprising reverse effect can occur: the art often illuminates the mathematics. Who could have guessed the mathematical nuggets that might otherwise be hidden in a torrent of symbolic or numerical information? The process of coloring allows the information to take on a visual shape that provides identity and recognition. Who could guess the limiting shape or the symmetry of an algorithmically produced fractal? With visual representation, the mathematician can exclaim, "now I see!"

Since periodic tessellations can be generated by groups of isometries, they can be used to illuminate abstract mathematical concepts in group theory that many find difficult to grasp in symbolic form: generators, cosets, stabilizer subgroups, normal subgroups, conjugates, orbits, and group extensions, to name a few.

In the examples above, illumination of mathematics is a serendipitous outcome of art created for other reasons. But there are examples in which the artist's main purpose is to express, even *embody* mathematics. Several prints by M.C. Escher are the result of his attempts to visually express such mathematical concepts as infinity, duality, dimension, recursion, topological morphing, and self-similarity. Perhaps the most striking examples of art illuminating mathematics are provided by the paintings of Crockett Johnson and the sculptures of Helaman Ferguson.



Whoville, a 35-inch aluminum sculpture by George Hart. see the April issue of Math Horizons for more on Hart's sculpture.

From 1965 to 1975, Johnson produced over 100 abstract oil paintings, each a representation of a mathematical theorem. Ferguson's sculptures celebrate mathematical form, and have been termed "theorems in bronze and stone." Each begins with the idea of capturing the essence of a mathematical theorem or relationship, and is executed by harnessing the full power of mathematically-driven and hand-guided tools.

Mathematics inspires art

Patterns, designs, and forms that are the "automatic" product of purely mathematical processes (such as those described in "Mathematics generates art") are usually too precise, too symmetrical, too mechanical, or too repetitive to hold the art viewer's attention. They can be pleasing and interesting, and are fun to create (and provide much "hobby-art") but are mostly devoid of the subtlety, spontaneity, and deviation from precision that artistic intuition and creativity provide. In the hands of an artist, mathematically-produced art is only a beginning, a skeleton or a template to which the artist brings imagination, training, and a personal vision that can transform the mathematically perfect to an image or form that is truly inspired.

Wallpaper patterns and tessellations can be pleasing from a decorative point of view; few would be viewed as art. Escher did not view his tessellations as art, but as fragments to be an integral part of his complex prints. Makoto Nakamura's art also employs this technique. Jinny Beyer, a designer and quilt artist, uses her artistic intuition and color sense to turn tessellations into art. Kaleidoscopic designs are the inspiration for quilted art by Paula Nadelstern; her use of color and composition subtly break mathematical rules.

Dick Termes uses photography and grids to guide his projections of images onto the surface of a sphere, but his "Termespheres" bear his personal interpretation. Anamorphic artists István Orosz and Kelly Houle are guided by mathematical rules of transformation as they create mysterious distortions of images on the picture plane, but also use their intuition and imagination, checking with a mirrored cylinder as the work develops.

Pure mathematical form, often with high symmetry, is the inspiration for several sculptors who create lyrical, breathtaking works. With practiced eye and hand, relying on their experience with wood, stone, bronze, and other tactile materials, the artists deviate, exaggerate, subtract, overlay, surround, or otherwise change the form into something new, often dazzlingly beautiful. With the advent of digital tools to create sculptural images, the possibilities of experimentation without destruction of material or of producing otherwise impossible forms infinitely extends the sculptor's abilities.

Mathematics constrains art

We often hear of "artistic freedom" or "artistic license", which imply the rejection of rules in order to have freedom of expression. Yet many mathematical constraints cannot be rejected; artists ignorant of these constraints may labor to realize an idea only to find that its realization is, indeed, impossible. Euler's theorem ($v + f = e + 2$) and Descartes' theorem (the sum of the vertex defects of every convex polyhedron is 720°) govern the geometry of polyhedra. Other theorems govern the topology of knots and surfaces, aspects of symmetry and periodicity on surfaces and in space, facts of ratio, proportion, and similarity, the necessity for convergence of parallel lines to a point, and so on. Rather than confining art or requiring art to conform to a narrow set of rules, an understanding of essential mathematical constraints frees artists to use their full intuition and creativity within the constraints, even to push the boundaries of those constraints. Constraints need not be negative—they can show the often limitless realm of the possible.

Voluntary mathematical constraints can serve to guide artistic creation. *Proportion* has always been fundamental in the aesthetic of art, guiding composition, design, and form. Mathematically, this translates into the observance of ratios. Whether these be canons of human proportion, architectural design, or even symbols and letter fonts, ratios connect parts of a design to the whole, and to each other. Repeated ratios imply self-similarity, hardly a new topic despite its recent mathematical attention. One of the earliest recorded notices of it is in Euclid's Prop. 30, Book VI, the division of a segment in extreme and mean ratio (also known as the golden cut, or golden section). A segment AB is to be divided internally by point E so that the ratio of the whole AB to the part AE equals the ratio of the (larger) part AE to the (smaller) part EB. This geometric task produces the common ratio $AB/AE = (1 + \sqrt{5})/2$, known as the golden ratio, denoted as ϕ (or τ). The ratio has many unique, almost magical mathematical properties (for example, $\phi^2 = \phi + 1$, and $1/\phi = \phi - 1$), and it is these properties, as well as connections to the Fibonacci sequence, that have fascinated artists and architects, enabling them to produce designs and compositions with special properties. Other ratios and special geometric constructions (root rectangles, reciprocal rectangles, and grids of similar figures) also guide composition and design.

Art engenders mathematics

It is to be expected that in the execution of an artwork, mathematical questions will arise that the artist (or fabricator) must answer. This goes with the territory. In many instances, artists will struggle to answer the questions on their own in order to reach the answer in a way that makes sense to them. Escher did this in seeking to answer the question "How can I create a shape that will tile the plane in such a way that every tile is surrounded in the same way?" Sometimes these questions need the attention of trained mathematicians, engineers, or software designers and provide interesting practical problems to solve. The intricate textile patterns of designer Jhane Barnes result from close collaboration with mathematician Bill Jones and computer software designer Dana Cartwright of Designer Software.

There are also frequent instances where finished works of art suggest purely mathematical questions, ones that the artist never imagined, nor needed to consider. Folk art from other times and other cultures is a rich source for mathematical questions. Celtic knots and art from African cultures are two examples. Modern sculptures can also lead to mathematical questions. Escher's tessellations and some prints have been the source of several mathematical challenges, most not yet settled. Two of these mathematical questions seek to understand the relationships between local and global symmetry.

A most mathematical artist

I want to end this essay with a bit more about the work of the Dutch graphic artist M.C. Escher (1898-1972), who is perhaps the most astonishing recent example of an artist whose work contains a multitude of connections between mathematics and art. Escher was not mathematically trained, and even struggled with mathematics as a school student. Yet he did not reject mathematics, but instead figured out in his own way, using various (mostly pictorial) sources, the mathematics that he needed in order to realize his ideas and visions. Escher celebrated mathematical forms: polyhedra as decoration, stars, or living structures, Möbius bands, knots, and spatial grids. He used (and sometimes fused) various geometries in his work—Euclidean in his tessellations, hyperbolic in his Circle Limit series, projective in depicting scenes in linear perspective, spherical in prints and his carved spheres. He employed topological distortions and transformations, strange or multiple perspectives, and visual recursion. He explored the topic of symmetry and tessellation in the plane, on the sphere, and in the Poincaré disk, developing his own "layman's theory" of classification of types of planar periodic tilings and symmetric coloring of them, anticipating mathematician's and crystallographer's later studies of these topics. He asked and answered, in his own way, combinatorial geometric questions. He depicted abstract mathematical concepts in visual metaphors. And though Escher's work gained him the admiration of mathematicians and scientists, he felt isolated as an artist. Today there are many artists whose work is directly or indirectly inspired by Escher's work. While he has left us his own legacy, others are continuing to explore some of the paths he blazed and also are striking out on new paths from these.

This essay is a shorter version of Doris Schattschneider's contribution to the MAM 2003 web site. The online version at http://www.mathforum.org/mam/03 includes full references (and links) for each of the topics and artists mentioned.

IN FOCUS: The January 2003 Joint Mathematics Meetings

More than five thousand mathematicians came to the Joint Meetings of the AMS and MAA in Baltimore this January. As always, the meetings were a dizzying affair, with plenary talks, panel discussions, special sessions, and committee meetings all happening simultaneously while the book exhibits tempted participants to leave all that behind and spend their hard-earned money. Since the MAA has about 25,000 members, at least 20,000 of you weren't there. While we can't bring you anything like a real summary of all that went on, the following pages are a sampler. Perhaps next time you will be there!

My Adventures in Baltimore

By Fernando Q. Gouvêa

I usually arrive a day early for national meetings of the MAA, because as editor of FOCUS and MAA Online I need to attend the meeting of the Board of Governors, which typically happens the day before the meeting begins. This time, though, I arrived even earlier, and only made a short appearance at the Board. Instead, I spent two days attending the MAA Short Course on ancient mathematics. That also meant that I was already there Sunday night when there was a small fire at the Sheraton. After some excitement we were all moved to another hotel for what turned out to be a two-day stay. Because of all this, I was late for Eleanor Robson's talk on *Mesopotamian Mathematics*. The part I did get to listen to was very nice. Robson encouraged interested participants to learn cuneiform and get into the game themselves; perhaps one or two will!

My badge, sporting the MAA Business Meeting "dot" and my own additions identifying me as editor of FOCUS and MAA Online. I forgot to add the circumflex in Gouvêa.

The talks that followed, that day and the next, were all very useful and interesting. I particularly enjoyed Reviel Netz's discussion of Archimedes and Kim Plofker's overview of Indian Mathematics. On the Tuesday, the speakers held a joint question session. That afternoon, the short course group went to the Walters Art Museum to see the Archimedes Palimpsest and learn about how it is being studied.

On Wednesday things began in earnest. The first event for me was a panel discussion on "Truth in Using History of Mathematics in Teaching Mathematics." I was one of the panelists, perhaps representing non-historians who make serious use of history in their classes. The panel was organized by HOMSIGMAA, the MAA special interest group on the history of mathematics. To some extent, we were preaching to the choir, since many of those present were historians or at least part-time historians. But the topic generated some useful and interesting discussion, and I enjoyed myself.

I ended up going to far fewer of the plenary talks than I had hoped to, and never did make it to any of the special sessions. Partly this was because of having to be at so many committee meetings, but the other reason was the sheer abundance of things to do and people to talk to. I did go to talks by Ed Scheinerman, Joe Silverman, Noam Elkies, Robin Wilson, and Ivor Grattan-Guinness. I particularly enjoyed Robin Wilson's talk on the four-color theorem.

I always attend the prize session and the MAA business meeting. This is in part because of my responsibilities as a "member of the press." (Does FOCUS count as "the press"?) But the prize session is also an opportunity to honor people who have made significant contributions to mathematics and to our professional organizations. We listened to the MAA and AMS presidents announcing the winners and reading from their citations, squinted a little to try to see the winner's faces from a distance, and applauded. It was a happy moment.

Though there wasn't all that much business to transact, the MAA business meeting was enjoyable. Ann Watkins gave Ron Graham a gavel to use when presiding over MAA meetings, and then gave all members in attendance a "dot." It seems that some members have expressed envy of the colorful dots worn by NExT fellows (a different color each year), and even more so of the large collection of dots that those who have worked with several generations of NExT fellows have on their badges. So we all got dots for attending the business meeting. They said "I survived the MAA business meeting." Which is true. Not that it was all that hard to survive.

People who know me know that I'm crazy about books. So they wouldn't be surprised to hear that I spent a lot of time at the exhibits. I talked to publishers about sending review copies of their books to MAA Online, asked them about what was new, bought a few books, annoyed the folks at the MAA booth, bought a icosahedral stress reliever, had John di Pillis make a caricature of me (sitting on a pile of books, of course) and even spent some time signing books. Bill Berlinghoff and I signed copies of our "gentle history," *Math through the Ages*, at the MAA booth. It was fun to do, and gave us a chance to talk to lots of people.

People think of the exhibits as being about books. That's partly true, but there's other stuff, too. I was particularly happy to see Helaman Ferguson and his sculptures.

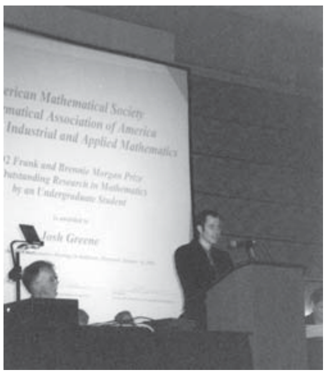
I don't know whether the residents of Baltimore noticed the 5,000 mathematicians in their midst. Perhaps they were too distracted by the cold. I had a good time, learned some things, got to see people I like, met new people, went to some great restaurants and to some that were not-so-great, and even bought a few books.

Fernando Gouvêa (and yes, the circumflex is required) is Professor of Mathematics at Colby College in Waterville, ME. Despite having been born in Brazil, he likes cold weather and thought the temperature in Baltimore was quite nice. He is the author or co-author of four books.

Josh Greene Wins the 2002 Morgan Prize

One of the highlights of the January Joint Meetings is the Morgan Prize Lecture, in which the winner of the Morgan Prize for Outstanding Research by an Undergraduate gives a talk on his or her work. The 2002 Morgan Prize went to Josh Greene of Harvey Mudd College. Greene's work is in combinatorics, dealing specifically with Kneser's Conjecture (proved by Lovász in 1978) which states that if the k-element subsets of a n-element set are partitioned into n-2k+1 classes then one of the classes must contain a pair of disjoint subsets.

Greene's beautiful new short proof of this theorem is explained in his paper "A new short proof of Kneser's conjecture," which appeared in the December issue of the *American Mathematical Monthly*. The citation for the prize points out that "In his senior thesis, Greene addresses further associated combinatorial questions and has already provided two new simplified proofs of Schrijver's theorem on chromatic-critical subgraphs of Kneser graphs. His insight in topological combinatorics bypasses traditional technical difficulties in this area, and experts predict that his method will become the standard approach in this rapidly developing area of mathematics."



The winner: Josh Greene receives the Morgan Prize.

Josh Greene giving his Morgan Prize lecture.

Josh Greene was born and raised in the sprawling suburbs of Columbia, Maryland. After early unsuccessful attempts to become an artist and pro hockey player, Josh took up an interest in science and mathematics during high school. Beginning in his junior year, he studied astrophysics under the guidance of Dr. Jay Norris at NASA / Goddard Space Flight Center, and was named a Finalist in the 1998 Westinghouse Science Talent Search for his work there. In the summer of 1998, Josh was a student at the Hampshire College Summer Studies in Mathematics, which sparked his interest in combinatorics, and he returned to teach at the program in 1999 and 2002. He matriculated at Harvey Mudd College in 1998, where he enjoyed a broad education and learning from a dedicated, enthusiastic faculty, graduated with distinction in mathematics in 2002. During college, Josh also participated in the Budapest Semesters in Mathematics, Joseph Gallian's Research Experience for Undergraduates in Duluth, Minnesota, and the Director's Summer Program. Each program uniquely shaped his research experience and current interests, which include discrete mathematics, number theory, and topology.

Josh is currently building houses with Habitat for Humanity in Appalachia through the Americorps service program, and he plans to enter the University of Chicago next fall to pursue a doctorate in mathematics. When he is not studying or communicating mathematics, Josh enjoys hockey, Frisbee, nature, and trying to determine the meaning of life.

Report on the Undergraduate Student Poster Session in Baltimore

By Mario Martelli

The 2003 Undergraduate Student Poster Session was a resounding success. I received 108 applications. The room of the Baltimore Convention Center reserved for the event could accommodate only 80 and I had to say "no" to many interesting research projects. Fortunately, thanks to an unpredictable sequence of events, Jim Tattersall, Associate Secretary of the MAA, was able to offer the same room for a morning session that was attended by 23 teams. Although I could not organize an evaluation for the posters displayed at this additional session, I received three books from Cambridge University Press and we had a random drawing among the participants. Thanks to my recommendation quite a few people, including Ron Graham, the new President of the MAA, came to see the morning posters.

The afternoon session was a sight to be seen. The 42' x 80' room was packed with 192 undergraduates presenting their posters, 115 judges evaluating them, and many visitors and friends. Those who attended the session for the first time could not believe their eyes. Those who had attended previous sessions told me repeatedly that the posters are getting better every year. Among the judges offering their help there was a large group of Project NExT fellows and consultants. I cannot thank them enough for providing crucial support. Part of the credit goes to Joe Gallian, who sent an e-mail to the entire Project NExT family asking them to get in touch with me to offer help. I used 43 judges from this group. I also asked 6 of them to be my "standby judges," necessary to solve all last minutes emergencies. (There were a few.) I want to recognize the contribution of 12 faculty members from the California State University system. I will not mention their names here, but I was moved by their presence.

Sixteen posters were recognized as standing out among equals. The prize: $100 each. The money was offered by the MAA, AMS, AWM, CUR and by some anonymous donors. The posters recognized are listed in alphabetical order.

The afternoon poster session drew a large crowd.

Poster # 5 on *Semiregular relative difference sets* authored by Christine Berkesh (Butler University), Jeff Ginn and Erin Militzer (Central Michigan University), and Erin Haller (University of Missouri, Rolla). The research was done at Central Michigan University (NSF-REU program). The supervisor was Ken Smith.

Poster # 6 on *Analysis of a food chain with an added competitor* authored by Brian Bockelman (State University of West Georgia), Elisabeth Green (University of Nebraska-Lincoln), Leslie Lippitt (Iowa State University), Jason Sherman (Kent State University). The research was done at the University of Nebraska-Lincoln (NSF-REU). The supervisors were Bo Deng and Wendy Hines.

Poster # 7 on *Canards in the forced Van der Pol equation* authored by Katherine Bold (University of Texas at Austin). The research was done at Cornell University (NSF-REU). The supervisor was John Guckeneimer.

Poster # 16 on *Biquaternionic projective space* authored by Scot Childress (California State, University Fullerton). The research was done at California State University, Fullerton (Sally-Casanova Predoctoral Fellowship). The supervisor was Alfonso Agnew.

Poster # 19 on *Asymptotic analysis of finite deformation in a nonlinear transversely isotropic incompressible hyperelastic half-space subjected to a tensile point load* authored by Ethan Coon (University of Rochester). The research was done at James Madison University (NSF-REU). The supervisors were Debra and Paul Warne.

Poster # 22 on *A computational model for the motion of flagella* authored by Oscar Del Valle (University of California, San Diego), Heather Flores (University of Nebraska-Lincoln), and Stefan Mendez-Diaz (University of Chicago). The research was done at the University of Puerto Rico Humacao (NSF-REU and NSA). The supervisor was Victor Moll.

Poster # 34 on *The rigidity of plane grids and some new extensions* authored by Sandra Gregov and Joe Aiken (York University). The research was done at York University (NSERC Canada). The supervisor was Walter Whiteley.

Poster # 48 on *How hard is the knight tour?* authored by Ananda Leininger (MIT), and Kevin McGown (Oregon State University, Corvallis). The research was done at Oregon State University, Corvallis (NSF-REU). The supervisor was Paul Cull.

Poster # 50 on *Mixed vs. independent predation terms in one predator, two prey system* authored by Leslie Lippitt (Iowa State University), Elisabeth Green (University of Nebraska-Lincoln), and Jason Sherman (Kent State University). The work was done at the University of Nebraska-Lincoln (NSF-REU). The supervisors were Bo Deng and Wendy Hines.

Poster # 56 on *A mathematical model for an electro-pneumatic pulsed jet actuator* authored by Borislav Mezericher (Queens College) and Matthew Willyard (University of Rochester). The research was done at the Worcester Polytechnic Institute (support from the Center for Industrial Mathematics and Statistics). The supervisor was Bogdan Vernescu.

Poster # 59 on *Polynomials and power series in the Sierpinski gasket* authored by Jonathan Needleman (Oberlin College). The work was done at Cornell University (NSF-REU). The supervisor was Bob Strichartz.

Poster # 65 on *K*-ultrahomogeneous graphs* authored by Stephanie Proctor (California State University, Fullerton), and Chris Jankowski (Notre Dame). The work was done at the University of Notre Dame (NSF-REU). The supervisor was Dan Isaksen.

Poster # 68 on *The effects of mass transportation during the deliberate release of smallpox* authored by Karen Rios-Soto (Cornell University), Emilia Huerta-Sanchez (Cornell University), and Guarionex Jordan-Salivia (University of Iowa). The work was done at Cornell University (supported by the Mathematical and Theoretical Biology Institute). The supervisor was Carlos Castillo-Chavez.

Poster # 69 on *Cyclotomic factorization* authored by Jeremy Rouse (Harvey Mudd College). The research was done at Harvey Mudd College. The supervisor was Arthur Benjamin.

Poster # 78 on *Optimal control and coupled solid-state lasers* authored by John Workman (University of Tennessee, Knoxville). The research was done at the University of Tennessee, Knoxville (NSF-REU). The supervisor was Suzanne Lenhart.

Poster # 82 on *Constructing the moduli spaces of Riemann surfaces with a G(k,l,m,n) action* authored by Kathryn Zurh (Mount Holyoke College). The research was done at Rose-Hulman Institute of Technology (NSF-REU). The supervisor was Allen Broughton.

All students attending the poster session and everybody reading this report should regard every presenter as a winner. Just

Aparna Higgins, flanked by Mario Martelli and Colin Adams, announces the winning posters.

to be there after being selected by a professional mathematician, and after the poster was accepted among others set aside is the recognition of a great accomplishment. The prizes are given ex-equo, that is, among equals. Many posters were ranked by the judges only one or two points lower than the posters recognized.

The winners, with Mario Martelli and Colin Adams.

Everyone should also keep in mind that although all judges are committed to a fair evaluation, they bring to it personal preferences and different evaluating styles. This year I was very pleased to be able to award prizes to some young undergraduates who had attended the poster session before and did not receive a prize the first time. Students, please do not give up. You will find a set of judges who really appreciate your work.

I wish I could describe all posters, but the editor of FOCUS is not going to give me the space I would need. (*Indeed! –Ed.)* I want to say, however, that a great number of students did their work in connection to NSF-REU programs. I received 8 posters from the program organized by Herbert Medina and Ivelisse Rubio at the University of Puerto Rico Humacao. Cornell came in strong at 11 posters, some from the NSF-REU program and a larger number from the Mathematical and Theoretical Biology Institute directed by Carlos Castillo-Chavez. Four posters came from the NSA NSF-REU program at Miami University, and another four from the NSF-REU program at California State University, San Bernardino. Three posters came from the NSF-REU program at Central Michigan University, and another three from the NSF-REU program at the University of Nebraska-Lincoln.

Of course, all the institutions that sponsored (and funded!) students are close to my heart. I count on your full participation next year in Phoenix. I have a formal promise from Jim Tattersall, Associate Secretary of the MAA that we will get a bigger room. We will invite the press to see how energetic, enthusiastic, and well informed our undergraduates are.

Congratulations to all students! My heartfelt thanks to the Advisors, to the Judges, to Colin Adams for finding the prize money, and to Aparna Higgins for standing on an unstable platform to announce the winners with a lot of humor and many appropriate comments. I would be delighted to see all of you at the 2004 Winter Meeting in Phoenix.

Mario Martelli teaches at Claremont McKenna College. He has been organizing student poster sessions at the Joint Mathematics Meetings for many years.

MAA Prizes and Awards at the Baltimore Joint Meetings

Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics

Clarence F. Stephens

Certificates of Meritorious Service

Larry J. Morley, Illinois Section (ISMMA)
Karin Chess, Kentucky Section
Alvin R. Tinsley, Missouri Section
Lester H. Lange, Northern California Section
Luise-Charlotte Kappe, Seaway Section
Fredric Tufte, Wisconsin Section

Deborah and Franklin Tepper Haimo Awards for Distinguished College or University Teaching of Mathematics

Judith Victor Grabiner, Pitzer College
Ranjan Roy, Beloit College
Paul Zeitz, University of San Francisco

Chauvenet Prize

Thomas C. Hales
"Cannonballs and Honeycombs"
Notices of AMS, April 2000, vol. 47, no. 4, 440-449.

All of the prize winners sitting patiently on the stage waiting for their moment of glory.

Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate

Joshua Greene
"A new short proof of Kneser's conjecture"

Other Prizes and Awards Announced in Baltimore

Prizes and Awards from the American Mathematical Society:

Leroy P. Steele Prize for Mathematical Exposition:
John B. Garnett

Leroy P. Steele Prize for Seminal Contribution to Research:
Michael Morley and Ronald Jensen

Leroy P. Steele Prize for Lifetime Achievement:
Ronald L. Graham and Victor W. Guillemin

George David Birkhoff Prize in Applied Mathematics:
Charles Samuel Peskin and John Norman Mather

Frank Nelson Cole Prize in Algebra:
Hiraku Nakajima

Levi L. Conant Prize:
Nicholas Katz and Peter Sarnak

Ruth Lyttle Satter Prize:
Abigail Thompson

Prizes and Awards from the Association for Women in Mathematics

Alice T. Schafer Prize for Excellence in Mathematics by an Undergraduate Woman:
Kate Gruher

Louise Hay Award for Contributions to Mathematics Education:
Katherine Puckett Layton

Joint Policy Board for Mathematics Communications Award

Robert Osserman

For more information on the prizes and awards see the February issue of FOCUS or visit http://www.maa.org/news/awards_jan03.html *and the links therein.*

Secretary's Report on the Joint Meetings

By Martha J. Siegel

President Ann E. Watkins opened the Business Meeting of the MAA with a tribute to Henry L. Alder. She also devoted some time at the Board of Governors meeting to recalling Alder's outstanding contributions as a wonderful and caring leader within the MAA. A former Secretary and President of the Association, Henry led the organization in a variety of areas. One of the most notable contributions was his meticulous work with the first Haimo Awards Committee. In his careful way, Henry provided for the MAA as he accepted his recent illness. At its meeting in November 2002, the Executive Committee approved the regulations for another teaching award—this time for people at the beginning of their careers—from an anonymous donor. Unbeknownst to the Executive Committee, Henry (the benefactor) had died the day before its meeting. At these January meetings, the Board of Governors approved the new Henry L. Alder Awards for Distinguished Teaching by Beginning College or University Mathematics Faculty. We will appoint a committee to administer the award.

One of the most significant items to report is the recent gift of more than $3,000,000 from Virginia and Paul Halmos for the establishment of the MAA Conference Center. (See the February issue of *FOCUS* for details.) The historic Carriage House adjacent to the MAA Headquarters building will be renovated to accommodate a small Conference Center, which will be used for meetings and seminars to advance the activities of the MAA in professional development and in the study of mathematics. I want to offer special thanks to Jerry Alexanderson who helped to make the idea of the gift a reality and to Jerry Porter, who was a masterful manager of the stock transfer. Members of the Advisory Board for the new Conference Center are Gerald Alexanderson (chair), Art Benjamin, Sr. Helen Christensen, Hortensia Soto-Johnson, Carl Pomerance, Kenneth Ross, David Scott, and Larry Wallen. Jerry Alexanderson also heads the Building Committee for the Center.

The newest members of the Icosahedron Society are the Mary P. Dolciani Halloran Foundation and, of course, Virginia and Paul Halmos.

The new software system installed over the past year has reduced our reliance on outsourcing and has resulted in our complete ownership of our own database. We will be launching e-commerce very shortly and we intend to increase our staff in the information systems area to support the many member and non-member services that we hope to offer. The non-member services are meant to serve the community, increase revenue, and attract members.

Project NExT continues to be one of our premier programs, but it is in continual need of our financial support. Please consider making a gift (or urging others to make a gift) that would support one or more Fellows annually. We are happy to announce that some of the CBMS member organizations such as AMS and NCTM have agreed to sponsor one or more Fellows. Contact the office if you know of someone who might be interested in providing such support.

The major actions of the Board of Governors at its meeting on January 14 are summarized below. The Board has approved the following meetings of the Association:

July 31-August 2, 2003, in Boulder CO
January 7-10, 2004, Phoenix, AZ
August 12-14, 2004, in Providence, RI
January 5-8, 2005, in Atlanta, GA
August 4-6, 2005, in Albuquerque, NM
January 12-15, 2006, in San Antonio, TX
January 4-7, 2007, in New Orleans, LA
January 6-9, 2008, in San Diego, CA
January 7-10, 2009, in Washington, DC

The Board approved the Dues Matrix for 2004, including $1 to $5 increases over 2003 dues in the primary membership categories.

Martha Siegel

Retired people who qualify may retain membership at no cost, receiving *FOCUS* and member privileges such as reduced rates for meeting registrations and book discounts. Such Retired Members may subscribe to a journal by paying a fee. The Board of Governors has approved a Bylaws change to the effect that Retired Member's journal fees should not be stipulated in the Bylaws of the Association. This will come to a vote of the membership at the next Business Meeting. Details on the proposed Bylaws changes will appear in the May issue of FOCUS.

Membership Director Jim Gandorf reported that membership is holding fairly steady. We have six SIGMAAs now and more than 1500 paid SIGMAA memberships to date.

The Board has approved electronic voting as an option for national elections. A commercial firm will run the election from its website. Ballots will be sent by mail, and also will appear on the web site. Members are encouraged to vote online (very secure and simple) but they may continue to choose to use the US mail. Ballots will be mailed by April 1. I want to thank Julie Kraman in the MAA office for having carefully arranged and prepared for this innovation.

The State of Illinois in which we are incorporated has ruled that electronic voting may replace mail ballots. In order to be sure that there is no confusion, the Board of Governors approved several small changes in the Bylaws. These will also appear in the May issue of FOCUS and will be voted on at the next Business Meeting.

The Board approved Section Bylaw changes for the California Sections, and the Indiana, MD-DC-VA, Michigan, and the Pacific Northwest Sections. There were some boundary changes in the Southern and Northern California Sections and the name of the Northern California Section will be changed to the Northern California, Nevada, and Hawaii Section.

The Board voted to reorganize the Committee on the American Mathematics Competitions (CAMC). CAMC will be a small executive-type committee. Elgin Johnston is the chairperson. There will also be a large Advisory Board comprising representatives appointed by the MAA President on the advice of supporting organizations. Titu Andreescu is finishing his Ph.D. and is preparing to leave his position as Director of Competitions. We have begun our search for a Director of the Mathematical Olympiad Summer Program. The Board voted to formally thank Titu for his dedication and hard work on behalf of the AMC.

A revision of the *Guidelines for Programs and Departments in the Mathematical Sciences* was recently approved by the Board and can be found on MAA Online (see http://www.maa.org/guidelines/guidelines.html). I urge you to make use of this excellent document — a credit to John Fulton's skill and persistence. These Guidelines have received the endorsement in principle by both the American Statistical Association and the Council of the American Mathematical Society.

The Board elected Lowell Beineke Editor-elect of the *College Mathematics Journal* and Jennifer Quinn and Arthur Benjamin Editors-Elect of *Math Horizons*. Their five-year editorial terms begin January 2004.

April is Mathematics Awareness Month. This is a project of the Joint Policy Board on Mathematics. The theme this year will be Mathematics and Art. We are lucky to have MAA Second Vice-President Joe Gallian heading up the effort. I urge you to check the website at http://mathforum.org/mam/03. See also the article on page 7.

The President appointed three new Coordinating Council Chairs. Barbara Faires will chair the Council on Awards, Richard Gibbs will chair the Council on Competitions, and Anita Solow will head up the Council on Human Resources. We acknowledge the outstanding service of the outgoing chairs: Linda Sons at Awards, Frank Giordano at Competitions, and Robert Megginson at Human Resources. Let me formally thank the other chairs, Jim Lewis at Education, Ken Ross at Meetings, and Jerry Alexanderson at Publications. They keep the organization running!

The Board elected Joan Ferrini-Mundy as Governor-at-Large for Teacher Education for a three-year term. We are grateful to M. Kathy Heid, who served in that role for three years. The Board will also miss Walter Stromquist, Governor-at-Large for Mathematicians Outside Academia. The Board elected Carl Pomerance to replace Walter as Governor-at-Large representing that constituency. We welcome him. Claudia Carter, Governor-at-Large for High School Teachers, has resigned from the Board; Daniel Teague of the North Carolina School for Science and Mathematics was elected to fill the remaining two years of her term on the Board.

We acknowledge, with gratitude, the contributions of several Governors who are leaving the Board at this time. Kenneth A. Ross, Former President; David Stone, Chair of the Committee on Sections; Walter Stromquist, Governor-at-Large Mathematicians Outside Academia; and M. Kathy Heid, Governor-at-Large for Teacher Education.

David Stone of Georgia Southern University has provided exemplary service and leadership for the MAA for six years as chair of the Committee on Sections, member of the Executive Committee, and member of the Board of Governors. In July, the Board elected Nancy L. Hagelgans, of Ursinus College and the EPADEL Section, to chair the Committee on Sections, and we welcome her to the Executive Committee and to the Board. We thank David for all his hard work.

When Former Presidents leave the Board, it is always difficult to say goodbye. Ken Ross has been on the Board for 19 years and he has served as Section Governor, Secretary, Associate Secretary, President, chair of numerous committees, and is currently chair of the Coordinating Council on Meetings. He is a wise and dedicated leader of the MAA. We thank him for all he has done so far and expect many more years of his contributions and counsel.

We say goodbye to Ann Watkins as President and congratulate her on a very active and inspirational presidency. She has led the Association with great attention to our mission and our membership. And she will wear the mantle of Past President with great aplomb. We expect that she will have many invitations to emcee as her sense of humor and ability in this role is now no secret! She will continue as a member of the Executive Committee through 2003 and will remain on the Board for several years more.

And we welcome Ronald L. Graham, President. We congratulate him on winning the American Mathematical Society's Steele Prize for Lifetime Achievement. The MAA believes that you ain't seen nuthin' yet! The best of his achievements are yet to come!

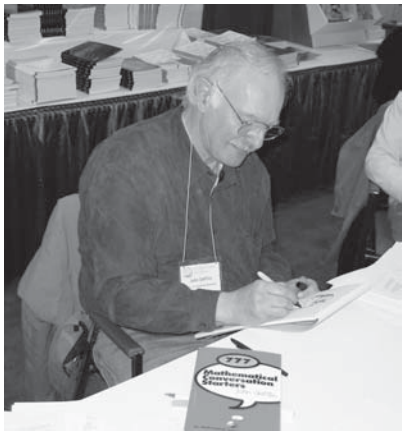
As you can imagine, meetings do not just happen. They take careful and imaginative planning. I wish to express appreciation for the fine work of the members of the Program and Local Arrangements Committees for the Baltimore Joint Mathematics Meetings, with a special thank you to (new Grandpa) Associate Secretary Jim Tattersall. It was a wonderful meeting, with record attendance. I hope the Joint Meetings will come back to Baltimore soon.

Martha J. Siegel is MAA Secretary and teaches at Towson University, just outside of Baltimore.

Message board and meeting area at the Baltimore Convention Center.

Ready to go: the MAA Book Exhibit at the beginning of the meeting.

Ann Watkins, MAA President.



John de Pillis does carictures of participants at the MAA booksale.

Demo on ecommerce at the MAA Board of Governor's meeting.

Paul Sally, Invited Speaker.

Where everyone wanted to be: participants entering the book exhibits.

The managing editor of FOCUS struts her stuff before the Board of Governors.

Martha Siegel, MAA Secretary

Fred Rickey gives instructions to short course participants on how to get to the Walters Art Museum.

An unusual concentration of historical expertise: Joe Dauben, Eleanor Robson, and Reviel Netz listen to a talk at the short course on ancient mathematics.

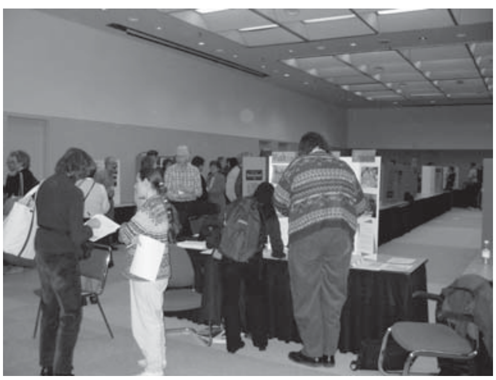
Ron Graham, incoming MAA President.

Robin Wilson explains the four-color theorem.

Robin Wilson in a four-color shirt just before his talk on the four-color theorem.

Participants gathered in the Baltimore Convention Center to catch up with colleagues.

Almost all gone: the MAA booksale at the end of the meeting.



Poster session on NSF-funded projects in Mathematics Education.

The other place everyone wanted to be: the longest line at the meetings was the line for the email lab.

Benoit Mandelbrot and James Yorke Win Japan Prize

Benoit B. Mandelbrot, 78, Sterling Professor of Mathematical Sciences, Yale University; and James A. Yorke, 61, Distinguished University Professor of Mathematics and Physics, University of Maryland, have won the Japan Prize. They will share the $412,000 prize money from the Science and Technology Foundation of Japan.

The Japan Prize recognizes "original and outstanding achievements that contribute to the progress of science and technology and the promotion of peace and prosperity of mankind."

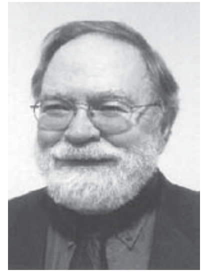

Benoit B. Mandelbrot

Mandelbrot has been called the "father of fractals." In l993, when he won the Wolf Prize for Physics, Mandelbrot was cited for "having changed our view of nature." Physicist Michael V. Berry has written that""fractal geometry is one of those concepts which at first sight invites disbelief but on second thought becomes natural that one wonders why it has only recently been developed." John Wheeler (the Princeton physicist) wrote that "no one will be considered scientifically literate tomorrow who is not familiar with fractals."

"Fifty years ago" said Mandelbrot, "when I began to study complexity for its own sake, I was very lonely," Mandelbrot said. "Today, it is the theme of this great prize and I am utterly delighted to be chosen as a recipient. Early on, I became a wanderer-by-choice between the disciplines, and between theory and applications. Electing to live as a constant maverick, I allowed my interests to move in and out of mathematics, in and out of physics, of economics, or diverse other fields of physical and social sciences, and even music and art. I showed that very simple formulas can generate objects that exhibit an extraordinary wealth of structure. Lately, I have also been very active in college and high school education. I feel extraordinarily privileged that my professional life has continued long enough to allow me to merge every one of my activities into a reasonable beginning of a science of roughness."

James Yorke has been called "Dr. Chaos," that is, the one who found the universal mechanism underlying nonlinear phenomena, naming it chaos.

Early in his academic career, James Yorke quickly earned a reputation as a man with an unpredictable mind. "He thinks very unconventionally," says Edward Ott, a professor of physics and electrical engineering at the University of Maryland, who has collaborated with Yorke. "When I'm talking to him in the hall sometimes, he'll say something that seems completely bizarre to me. Then I'll go away and I'll think, 'Hey, that was very good."


James Yorke

In 1975, Yorke published the math paper that made him famous. It was called "Period Three Implies Chaos," and it gave a name to the emerging new field that was thereafter known as chaos theory.

In his best-selling 1987 book, *Chaos: Making a New Science*, author James Gleick summed up the revolutionary effect of Yorke's paper: "Yorke had offered more than mathematical result. He had sent a message to physicists: Chaos is ubiquitous; it is stable; it is structured."

More information about the award and this year's winners can be found at http://www.japanprize.jp/English.htm.

MathFest 2003: Call For Papers

MAA CP L1 Innovations in Teaching Upper Level Mathematics Courses
Saturday afternoon

This session offers a forum for faculty to disseminate innovative teaching techniques they have employed in upper level undergraduate courses —typically those beyond the calculus and differential equations sequences. Such techniques as student journals, guided reading assignments, and creative projects can potentially benefit mathematics teachers seeking to improve student learning in traditionally difficult classes. The calculus reform and statistics reform movements, together, have initiated a lively and continuing discussion about teaching approaches to freshman and sophomore level mathematics courses. While mathematicians disagree about specifics, most agree that the discussion has either led to experimenting with new techniques or else re-evaluating a time-tested approach. This level of innovation and discussion is just as needed in upper division mathematics courses. Many mathematics majors have little difficulty in their mathematics courses until they reach the junior and senior year. Proof courses, such as algebra and analysis, often provide difficult hurdles. Many mathematics teachers have made a great deal of progress in incorporating innovative techniques in such classes without sacrificing rigor. Now is an especially opportune time to share such techniques.

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Email: dmazur@wnec.edu

Michael Axtell, Wabash College
Crista Coles, Elon University

Other special sessions were listed in the February issue of FOCUS.

PMET: Preparing Mathematicians to Educate Teachers

By Victor J. Katz and Alan Tucker

The MAA has received funding to initiate a multifaceted project entitled Preparing Mathematicians to Educate Teachers (PMET) in response to numerous national reports calling for better preparation of the nation's mathematics teachers. These reports are sparking growing interest among college and university mathematicians to do more to help improve school mathematics teaching. The PMET project, directed by Alan Tucker and Bernie Madison, will help nurture and support this interest by providing a broad array of educational, organizational, and financial assistance to mathematicians.

The major report stimulating action for improving school mathematics teaching was *Before It's Too Late: A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century*, more commonly known as the Glenn report, after the chairman of the commission, former Senator John Glenn. (The report is online at http://www.ed.gov/americacounts/glenn/report.pdf). The Comission, which was appointed by then Secretary of Education Richard Riley on July 20, 1999, issued this report on September 27, 2000. Among the representatives of the mathematics community on the commission were Deborah Ball, Professor of Mathematics Education at the University of Michigan; Diane Briars, Mathematics Director of the Pittsburgh Public Schools; and Javier Gonzalez, a mathematics teacher from Pioneer High School in California. The commission's Executive Director was Linda Rosen, formerly the Executive Director of the National Council of Teachers of Mathematics.

The Glenn Report made only a few straightforward points, but it made them urgently and insistently. In particular, the report concluded that "the most powerful instrument for change, and therefore the place to begin, lies at the very core of education — with teaching itself." It suggested three specific goals, each accompanied by several strategies to accomplish the goal.

Goal 1: Establish an ongoing system to improve the quality of mathematics and science teaching in grades K-12.

1. Each state must undertake a needs assessment.
2. Summer Institutes must be established for professional development.
3. Inquiry groups should be established, both building-wide and district-wide.
4. Leadership training must be made available for facilitators for Summer Institutes and Inquiry groups.
5. There should be a Dedicated Internet Portal for teachers.
6. A Nongovernmental Coordinating Council must be established to bring together the above.
7. Reward and incentive programs should be set up in each state and local district.

Goal 2: Increase significantly the number of mathematics and science teachers and improve the quality of their preparation.

1. Identify exemplary models of teacher preparation whose success can be widely replicated.
2. Find ways to attract additional qualified candidates into teaching.
3. Create 15 competitively selected Mathematics and Science Teaching Academies to train annually 3000 Academy Fellows on effective teaching methods in science and mathematics.

Goal 3: Improve the working environment and make the teaching profession more attractive for K-12 mathematics and science teachers.

1. Establish focused induction programs to help acclimate beginning teachers.
2. Develop district/business partnerships to provide support for a broad range of efforts to help create professional working environments for teachers.
3. Establish incentives to encourage deserving mathematics and science teachers to remain in teaching and improve their skills.
4. Make salaries of all teachers more competitive, especially for mathematics and science teachers.

Certainly, the achievement of these goals requires political leadership from Congress and the President, not to mention the state governments and the local boards of education, but the MAA, through the PMET program, is attempting to play a significant role toward the achievement of goal 2. This goal is also the focus of the 2001 report from the Conference Board of the Mathematical Sciences (CBMS) on *The Mathematical Education of Teachers* (usually called the *MET* report; it can be found online at http://www.cbmsweb.org/MET_Document/index.htm). That report stresses two general themes: the intellectual substance in school mathematics and the special nature of the mathematical knowledge needed for teaching. Mathematicians often assume, the report points out, that because the topics covered in school mathematics are so basic, they must be easy to teach. But recent mathematics education research has shown that substantial mathematical understanding is necessary even to teach whole number arithmetic well. Liping Ma's widely read 1999 book, *Knowing and Teaching Elementary Mathematics* has numerous examples of the differences between a group of American teachers and a group of Chinese teachers in their understanding of certain "elementary" concepts and how those differences impact on the teaching of these concepts.

The authors of the *MET* report made nine basic recommendations, some of which form the basis for the PMET project. Among these recommendations are:

1. Prospective teachers need mathematics courses that develop a deep understanding of the mathematics they will teach.

2. Mathematics courses for prospective teachers should develop the habits of mind of a mathematical thinker and demonstrate flexible, interactive styles of teaching.
3. Teacher education must be recognized as an important part of the mathematics department's mission at institutions that educate teachers. More mathematicians should consider becoming deeply involved in K-12 mathematics education.
4. Teachers need the opportunity to develop their understanding of mathematics and its teaching throughout their careers.

One major thrust of the recommendations in the Glenn Report and the *MET* report, at least insofar as the MAA is concerned, is that mathematics departments need to be more involved in K-12 education. Although, historically, the college and university mathematics community was always deeply involved in school mathematics and teacher preparation, in recent years this interest has been in decline. As the 1999 AMS report *Towards Excellence* (available online at http://www.ams.org/towardsexcellence) notes, "If K-12 mathematics education in the U.S. deserves criticism (and it surely has received a lot of criticism in the wake of the TIMSS reports), then a share of the blame falls to those university mathematicians who should be playing an important role in the preparation of teachers but are not." The report further notes that in many institutions, a department's increased attention to this part of the university's mission will provide benefits for all aspects of departmental life.

Some universities, of course, already have a substantial involvement in K-12 mathematics education. Among these is the University of Chicago, where Paul Sally, the director of undergraduate studies, has for years insisted that the department commit itself to work with school mathematics teachers and even with their students. In his address at the Joint Mathematics Meetings in January, Sally reiterated that mathematicians must work seriously with educators and teachers at every level by, for example, creating problems that could span the grades from kindergarten to graduate school. Similarly, at Oklahoma State University, the mathematics department faculty is significantly involved in instructional programs, centered in the College of Education, in the preparation of elementary and high school teachers. Interestingly, undergraduates majoring in mathematics education consider the Department of Mathematics their "home," not the College of Education, and look to mathematics faculty as mentors and advisors.

Although there are numerous other examples of university and college mathematics departments being heavily involved in the preparation of K-12 teachers, the majority of college and university mathematicians still need assistance in finding appropriate instructional strategies for helping future teachers connect their college mathematics to the mathematics they will teach and also need better information about the mathematical issues that arise in K-12 classroom lessons. It is the goal of the PMET project to provide that assistance and information.

The PMET project will have three major components:

1. *Faculty Training:* Summer workshops of various lengths and mini-courses at professional meetings.

2. *Information and Resources:* Articles in professional journals, panels at meetings, multi-media websites, and hard-copy material dissemination to support faculty instruction for teachers.

3. *Mini-grants and Regional Networks:* to nurture and support grassroots innovation in teacher education on individual campuses. These grants and networks will be concentrated in five states: New York, California, Ohio, Nebraska, and North Carolina.

Component 1 will begin this summer with three faculty workshops on teaching elementary school teachers and one workshop for teaching high school teachers. In 2004 and 2005, the number of workshops will increase; some of the workshops will extend over two summers with activities in the intervening academic year. Workshop activities will include (1) connecting content of college mathematics courses to school mathematics and discussing how those college courses should be taught; (2) demonstration college classes by master teachers, both live and video; (3) discussions of demonstration classes; (4) discussions of school standards, both state and those of the National Council of Teachers of Mathematics (NCTM); (5) individual course development projects by participants: (6) guest lectures by visiting experts, including learning theory researchers; (7) discussion of curricular materials; (8) discussion of reports such as the *MET* report; (9) use of technology; and (10) networking with others. Each workshop will be led by a team including a mathematician and a mathematics educator, with at least one member (or possibly a third person) having had several years of experience teaching school. There will also be introductory minicourses at national and sectional meetings, whose aim is to get more faculty interested in teaching prospective teachers.

As part of component 2, PMET will organize talks and panel discussions about the mathematical education of teachers at national and regional meetings of the MAA, the American Mathematical Association of Two Year Colleges (AMATYC), the American Statistical Association (ASA), and the NCTM. Presentations will be made to national education organizations in order to coordinate PMET's agenda with their goals. Furthermore, PMET will encourage articles on ways to support school mathematics in such publications as FOCUS, the *AMS Notices*, and ASA's *Amstat News*. Finally, PMET intends to develop a website with information and resources about the mathematical education of teachers. This site will offer extensive guidance for getting started in various situations; for example, it will provide a discussion of differing ways to teach a geometry course for teachers using available technology such as *Cabri* or *Geometer's Sketchpad*.

As part of component 3, PMET will provide mini-grants of approximately $3000 to help faculty at individual campuses rework mathematics courses for teachers, bring speakers into their department to raise faculty consciousness about teacher education, and send proposals to funding agencies for more extensive course and materials development. PMET will also support networking of those receiving these minigrants.

Most of the workshops, mini-grants, and networks will be concentrated in five states: California, Nebraska, New York, North Carolina, and Ohio. This focus will help the project develop a critical mass of activities in a given area for maximum impact. It will also help PMET secure local funding of further projects. The networks in each of the five selected states will connect the faculty involved in PMET with various state education initiatives and help them participate in local and state policy-making about teacher education and K-12 mathematics. For example, the PMET project directors have already been in touch with leaders of the State of California's Mathematics Professional Development Institutes who look to the PMET initiative to train more California mathematics faculty to teach in their institutes.

For the long-term health of K-12 mathematics education, it is essential that collegiate mathematics faculty reclaim a central role in the training and support of classroom teachers. Through PMET, the MAA's members have an opportunity to contribute to this process.

For more information on PMET and on how to participate, follow the links to the PMET project on MAA Online.

Victor Katz is Professor of Mathematics at the University of the District of Columbia. He is the author of an introductory textbook and many other books and papers on the history of mathematics. He is currently a visiting mathematician at the MAA.

MAA to Use Electronic Voting in National Election

The Board of Governors has voted to allow electronic voting in the upcoming national election of officers of the MAA. In the spring 2003 election, members will elect the President-Elect, and the First and Second Vice Presidents. Paper informational brochures will be sent to every member of the Association on April 1, as required by the Bylaws. This will contain information on all the candidates and a paper ballot for those who opt to use the U.S. mail instead of the web to cast their vote. Voting online will be easy, secure, and fun! There will be a link on the MAA website to Intelliscan, Inc. for a replica of the paper brochure and specific instructions on how to vote online. You simply click on your choices as you would in any approval voting procedure and hit a button to register your vote. That's all there is to it!

MAA National Elections Coming Up in April

A new MAA President has just taken office; how can it be time for elections again? The reason is the MAA's system of allowing future Presidents a full year of President-Elect status, during which they participate in the governance of the Association and get ready for their two years as President. So it's time to elect the person who will serve as President-Elect in 2004 and then as President in 2005 and 2006. It's also time to choose new MAA Vice-Presidents who will serve in 2004 and 2005.

Election booklets and ballots will be sent out in April. Members will be able to vote either electronically or using paper ballots. See above for information on electronic voting.

The candidates for the MAA national elections are:

President:

Carl C. Cowen
Purdue University, West Lafayette, IN

Wade Ellis, Jr.
West Valley College, Saratoga, CA

Doris Schattschneider
Moravian College, Bethlehem, PA

First Vice-President

Amy Cohen
Rutgers University, Piscataway, NJ

Barbara T. Faires
Westminister College
New Wilmington, PA

William Yslas Velez
University of Arizona, Tucson, AZ

Second Vice-President

Charles C. Alexander
University of Mississippi
University, MS

Jean Bee Chan
Sonoma State University
Rohnert Park, CA

William A. Hawkins, Jr.
Unieristy of the District of Columbia
Washington, DC

The Curriculum Foundations Workshop in Biology

By Anita Salem and Judith Dilts

Ten biologists met at Macalester College November 2-5, 2000 for the MAA *Curriculum Foundations* Workshop in Biology. Among the biologists were Lou Gross from the University of Tennessee, who holds a joint appointment in ecology and mathematics, and John Jungck, who was the original developer of BioQUEST, a reform undergraduate curriculum in biology. The biologists' charge was to provide advice for the planning and teaching of the mathematics curriculum as it affects biology majors. Nine mathematicians were present to answer questions and probe for clarification. Five of the mathematicians (Fred Adler, Danny Kaplan, Eric Marland, Claudia Neuhauser, and Dan Tranchina) have research interests in the biological sciences. This article highlights the major findings of the workshop participants. The summary report is available at the Bowdoin website at http://academic.bowdoin.edu/faculty/B/barker/dissemination/Curriculum_Foundations/CF_Biology.doc.

Understanding and Content

Surveys of quantitative skills needed for biologists frequently include college algebra, introductory calculus and statistics. Among these three areas of mathematics, statistics is the most commonly mentioned and the most extensively used. Other content areas that are mentioned include mathematical modeling, discrete mathematics, and matrix algebra. What follows are topics, organized by course, that the workshop participants identified as important in the study of biology.

College Algebra or Precalculus: Biology students need to understand the meaning and use of variables, parameters, functions and relations. They need to know how to formulate linear, exponential, and logarithmic functions from data or from general principles. They must also understand the basic periodic nature of the sine and cosine functions. It is fundamentally important that students are familiar with the graphical representation of data in a variety of formats (histograms, scatter plots, pie charts, log-log, and semi-log graphs.)

Introductory Calculus: The topics from introductory calculus that were mentioned at the workshop included integration for the purpose of calculating areas and average value, rates of change, optimization, and gradients for the purpose of understanding contour maps.

Statistics: It is here where the list of necessary topics is the longest and encompassed descriptive statistics, conditional probability, regression analysis, multivariate statistics, probability distributions, simulations, significance, and error analysis.

Discrete Mathematics and Matrix Algebra: The topics most frequently mentioned were qualitative graphs (trees, networks, flowcharts, digraphs), matrices (Leslie, Markov chains), and discrete time difference equations. Other topics included equilibria, stability and counting techniques.

Technology

The pervasive presence of computers, together with their ever-increasing computational power, encourages biologists to apply statistical methods to analyze data that is collected in the laboratory or the field. One important software application used by biologists is the spreadsheet. Increasingly, spreadsheet applications contain sophisticated statistical tools sufficient for use with undergraduate biology majors. The panelists were unanimous in their observation that *the graphing calculator is not the tool of choice* for biology students. Technological tools must be capable of producing graphs that can be incorporated into printed and presentation documents. They must allow students to apply modeling techniques to large data sets and they must also support simulation of models that are stochastic, discrete or continuous.

Implementation

The biologists generally agreed that current research areas in biology are more quantitatively oriented. At the same time, they also recognized that the quantitative needs of undergraduate students enrolled in biology courses are diverse and depend largely upon the student audience (e.g., majors versus non-majors) and the variety of disciplinary tracks, ranging from molecular biology to ecology, that students choose to explore. In an already crowded biology curriculum, the biologists agreed that the issue of increasing quantitative emphasis would call for innovative solutions. They suggested solutions ranging from the creation of mathematical courses designed specifically for biology majors to the creation of mathematical modules that could be incorporated into existing biology courses.

One particular challenge facing biology educators is the range of mathematical backgrounds of professors of biology. Many biology educators have completed only calculus and one course in statistics. The limited mathematical background of most biologists is clearly reflected in the correspondingly limited quantitative components of both biology textbooks and curricula. As we begin to expand the quantitative backgrounds of biology students we will also have to provide opportunities for the biology faculty to increase their own facility with mathematics.

To build and require more quantitatively oriented biology courses would be a major, but important, undertaking and would necessitate increased cooperation among biologists and mathematicians. The biologists viewed the proposed actions of the MAA in assisting their partner colleagues with possible changes and emphasis in the mathematics curriculum as a catalyst for needed changes in the undergraduate biology curriculum.

Anita Salem is Professor of Mathematics and Interim Dean, College of Arts & Sciences at Rockhurst University. Judith Dilts is the Dr. Burnell Landers Chair in Biology and Department Chair of Biology at William Jewell College.

Short Takes

By Fernando Q. Gouvêa

What Actually Happens in Classrooms

The Manhattan Institute for Policy Research recently released a report, written by Christopher Barnes of the University of Connecticut, entitled *What Do Teachers Teach?* The report is based on a survey of 4th-grade and 8th-grade teachers and tries to describe their actual classroom practice. The report focuses especially on assessment issues. The overall thrust is that teachers aren't holding their students to a high enough standard. The full report can be found online at http://www.manhattan-institute.org/html/cr_28.htm.

American Institute of Mathematics Research Conference Center

The American Institute of Mathematics (AIM) Research Conference Center will be hosting focused workshops in all areas of the mathematical sciences. The workshops are intended to focus on a specific mathematical goal by bringing together active researchers in a particular area. See http://www.aimath.org/ARCC/ for the workshops that are already scheduled, and also for information on how to organize workshops. For more about AIM itself, check http://www.aimath.org.

Studying the Mathematical Reviews Database

In an article published in the November 2002 issue of *SIAM News*, MAA governor Jerrold W. Grossman reports on a statistical analysis of the *Mathematical Reviews* database. It turns out that 42.7% of the authors represented in the database have written only one paper. About 16% have written ten or more papers. The mean number of papers per author is 6.87, with a standard deviation of 15.34.

Grossman highlights the growth in the number of collaborations over the last few decades. In the 1960s, 81% of the papers had only one author, as compared with only 54% in the 1990s. Papers with three or more authors represented only 3% of the papers reviewed in the 1960s, as compared with 13% in the 1990s.

Grossman includes a careful study of the collaboration graph, with vertices corresponding to the 337,454 mathematicians in the database and edges corresponding to joint papers. There are 84,115 isolated vertices, 16,883 small components having between 2 and 39 vertices, and one giant component representing everyone else. The average distance between two vertices in this component is between 7 and 8, and Grossman suggests that "the appropriate buzz phrase for mathematicians should be 'eight degrees of separation'. See http://www.siam.org/siamnews/11-02/collaboration.pdf or the November 2002 issue of *SIAM News* for the details.

National Academy Announces Honors

In January, the National Academy of Sciences announced several awards for significant contributions to research. Among those honored were David A. Freedman of the Berkeley Department of Statistics, who received the *John J. Carty Award for the Advancement of Science*, and David R. Karger of the Massachusetts Institute of Technology, who received the *NAS Award for Initiatives in Research* for his work on algorithms for network flow, graph coloring, minimum trees and minimum cuts. For a complete list of those honored, see http://www4.nationalacademies.org/news.nsf/isbn/01102003?OpenDocument.

A Matched Pair of Teaching Awards

Barbara Faires was the winner of the 2002 Distinguished Teaching Award from the Allegheny Section of the MAA. Her husband, Douglas Faires, won the same award from the Ohio Section in 1996. It seems likely that this makes them the only couple with a matched pair of teaching awards.

Education Schools Under Pressure

According to the *Washington Post*, traditional schools of education "are under increasing pressure to change the way they train teachers." The article gives several examples of schools that are changing their programs in response to the No Child Left Behind Act. See http://www.washingtonpost.com/wp-dyn/articles/A52358-2003Jan13.html for the article.

CUPM Curriculum Guide Draft Available

Look for draft 4.0 of "Undergraduate Programs and Courses in the Mathematical Sciences: A CUPM Curriculum Guide" to appear on MAA Online early in March. CUPM is looking for suggestions and comments. Send suggestions of additional examples for the "Illustrative Resources" section to Kathi Snook at kathleen.snook@verizon.net. All other comments on this draft should go to Harriet Pollatsek, the chair of CUPM, at hpollats@mtholyoke.edu. Comments will be most helpful if received before May 1, 2003. CUPM plans to have a final draft ready for approval at MathFest 2003, with publication in time for the January 2004 meetings.

The Decidable and the Undecidable in Mathematics Education

The Mathematics Education into the 21st Century project will be holding its next conference in Brno, Czech Republic, from September 19-25, 2003. The title of the conference is "The Decidable and the Undecidable in Mathematics Education," a tribute to Kurt Godel who was born and educated in Brno. Plenary Speakers will include Nicolina Malara and Filippo Spagnolo. Contact arogerson@vsg.edu.au for more information.

Board of Governors Decides on Substitution Policy

After much discussion, the MAA Board of Governors has settled on a policy about how to handle cases in which governors are unable to attend meetings. The Board approved a bylaws change that would allow designated substitutes to be seated and to have the right to vote. Substitutes must be selected among past governors for the section (or for the constituency) represented by the absent governors. See the May issue of FOCUS for details on this and other bylaws changes.

Courts Recognize "Math Phobia"

According to a news item in *USA Today*, an Italian court has ruled that a teenage girl should be excused from her high school mathematics requirements because she has an "irreversible psychological pathology," namely math phobia. The court asked the school to allow the student to be promoted to a higher grade despite having failed her mathematics course. According to the article, Johnny Lott, president of the National Council of Teachers of Mathematics, suggested that the school "should have tried putting Viviana in a substitute course such as economics, computer science or physics that might have been easier for her while still maintaining what he called the 'intellectual honesty' of the curriculum."

The article goes on to quote Lott as saying that "Students should be taking more math classes, not fewer. If a student has some kind of block against math, that means the school should try harder to reach that student; simply allowing the student to pass without a sufficient score in math is not an alternative I can recommend. We all need a certain amount of math literacy to function in the world, and that must come from the schools." See http://www.usatoday.com/usatonline/20030121/4795963s.htm for the article.

More and More SIGMAAs

There are now six SIGMAAs (Special Interest Groups within the MAA), focused on Philosophy of Mathematics, Environmental Mathematics, Statistics Education, History of Mathematics, Research on Undergraduate Mathematics Education, and Mathematics in Business, Industry and Government. The SIGMAA on RUME is the largest, with 1264 members. Some of the older SIGMAAs are very active, sponsoring special sessions at MAA meetings and other activities. Others are just starting out. MAA members can become members of a SIGMAA by calling up the MAA Service Center and making the request. See http://www.maa.org/sigmaa/sigmaa.html for more information and links to the home pages of the various SIGMAAs.

Cora and Baley Price Donate Papers to Archive

G. Baley Price, professor emeritus of mathematics at the University of Kansas, and Cora Lee Beers Price, retired assistant professor of classics at KU, have donated their professional papers to the University Archives. Baley Price played an important role in the development of the "new math" in the 1960s. The couple was honored at a reception at the University of Kansas Kenneth Spencer Research Library on the eve of Baley Price's 97th birthday. More information, and some interesting samples from the collection, can be found online at http://www2.lib.ukans.edu/~public/spencerlib/exhibits/price/index.htm.

MET Summit II

The Benjamin Banneker Association and the National Association of Mathematicians, in cooperation with other member societies of the Conference Board of the Mathematical Sciences, will be sponsoring a national conference on the mathematical education of teachers, MET Summit II. The meeting will be held October 11 and 12, 2003, in the Washington, D.C. area. The conference will emphasize the participation of historically black colleges and universities and other institutions serving minorities that are involved in the mathematical education of teachers. For more information, visit the BBA website at http://www.math.msu.edu/banneker or the NAM web site at http://jewel.morgan.edu/~nam.

Baltimore Talk Gets Press Attention

One of the plenary talks at the Baltimore joint meetings got the attention of the press even before it was given. The University of Chicago distributed in advance a press release on Paul Sally's talk, which discussed the trend towards offering liberal arts students "courses about mathematics" instead of mathematics courses. Sally described such courses as full of "beautiful pictures and imprecise ideas," and argued that we should be offering these students some real mathematics. The story was picked up by UPI (see"http://www.upi.com/view.cfm?StoryID=20030116-012039-1511r) and the *Chicago Sun-Times*.

Robert Lewand Presents Ohio Section Summer Short Course

Robert Lewand of Goucher College will present the Ohio Section's summer short course, entitled "Cryptography," on July 16-18. This course, designed for those with no experience in the subject, will investigate techniques of encryption and decipherment along with the mathematical underpinnings of these systems. Anyone with a background in elementary number theory and at least a rudimentary familiarity with computing (a programming language, or Maple, or even Excel) will be sufficiently prepared to understand the material in this course. The course will be held at Capital University in Columbus, Ohio. Details can be found at the section's web site http://www.maa.org/Ohio.

Sources. What actually happens: *Washington Post*, December 17, 2002, Manhattan Institute website. AIM Research Conference Center: AIM web page. Patterns of collaboration: Ann Watkins, *SIAM News* (November 2002). NAS honors: NAS website. Matched pair: Leo Schneider, section web pages. Education schools: *Washington Post*, January 14, 2003, and NASSMC Briefing Service. Missing governors: Martha Siegel. Math phobia: *USA Today*, January 21, 2003, NASSMC Briefing Service. SIGMAAs: president's report to the Board. Price papers: KU alumni magazine, KU website. MET Summit: BBA press release. Paul Sally's talk: University of Chicago press release, UPI website, *Chicago Sun-Times*. Ohio section: email communication.

NSF Announces New Solicitation

The Teacher Professional Continuum (TPC) program at the National Science Foundation (NSF) announces new funding opportunities to conduct research studies, as well as research and development projects for K-12 science, technology, and mathematics (STM) education. This professional continuum includes K-12 experiences, teacher preparation programs, instructional practice, professional development, leadership development, and other life and professional experiences.

The principal mission of the TPC program is to promote quality K-12 STM teaching through (1) the production of resources, (2) the development of infrastructure, and (3) the advancement of knowledge. To fulfill its mission, the TPC program set the following goals to:

- Improve the quality and coherence of the learning experiences that prepare and enhance STM teachers;
- Develop innovative curricula, materials, tools, ideas, and information resources that prepare and support STM teachers and administrators;
- Research, develop, and identify models, organizational structures, and systems that support the teacher professional continuum;
- Research teacher learning throughout the teacher professional continuum and its impact on teaching practice using scientifically-based investigations;
- Advance the knowledge base on the preparation, enhancement, and retention of STM teachers, and on the strategies that strengthen and diversify the STM teaching profession; and
- Disseminate this knowledge and research, as well as innovative models and resources, to a national audience.

Research studies from first-time Principal Investigators are especially encouraged. The deadline for required preliminary proposals is May 19, 2003. For more information and the TPC program solicitation visit the NSF website at: www.ehr.nsf.gov/esie/programs/te/te.asp.

Other programs in the Division of Elementary, Secondary and Informal Education (ESIE) include the following.

Centers for Learning and Teaching - www.ehr.nsf.gov/esie/programs/clt/clt.asp

Informal Science Education - www.ehr.nsf.gov/esie/programs/ise/ise.asp

Instructional Materials Development - www.ehr.nsf.gov/esie/programs/imd/imd.asp

Presidential Awards – www.ehr.nsf.gov/pres_awards.

Tensor Grants for Women and Mathematics Projects

The MAA plans to award grants for projects designed to encourage college and university women or high school and middle school girls to study mathematics. The Tensor Foundation, working through the MAA, is soliciting college, university and secondary mathematics faculty (in conjunction with college or university faculty) and their departments and institutions to submit proposals. Projects may replicate existing successful projects, adapt components of such projects, or be innovative. **The deadline for proposals is March 3, 2003.** For more information on these grants go to: http://www.maa.org/projects/solic_99.html.

Letters to the Editor

Still on Heron

It may be of interest to note that Hersh's proof of Heron's formula (FOCUS, Nov. 2002, pg. 22) exactly works for Brahmagupta's formula for the area of cyclic quadrilaterals.

Pete Gilmore
Northeastern University

Textbook Reviews

Congratulations to the MAA on the reviews project outlined on p. 3 of the latest issue of FOCUS. When I get back to teaching, I'll be glad to both use and contribute to it.

Robert Thomas
Editor, Philosophia Mathematica
University of Manitoba

I agree that this has the potential to be an extremely useful resource. In order to get there, we need to get more reviews of more books. Please visit MathDL at http://www.mathdl.org and click on the Commercial Products link to see the listing and to contribute your own reviews.

Past-Presidential Correction

I made a mistake in cutting and pasting in "A Year in the Life of the MAA" in the January issue of FOCUS. The number of full-time graduate students in mathematics is not 26,168 as reported there. That is the number of four-year college mathematics faculty from the 2000 CBMS survey. The number of graduate students in mathematics is 12,127, according to the latest Annual Survey of the Mathematical Sciences, published in the *Notices* in September 2002. Thanks to Jim Maxwell for pointing this out.

Ann Watkins
MAA Past President
California State University Northridge

Employment Opportunities

INDIANA

INDIANA UNIVERSITY PURDUE UNIVERSITY INDIANAPOLIS
Endowed Chair in Mathematics Education
The Department of Mathematical Sciences at Indiana University Purdue University Indianapolis, invites applications and nominations for the Marvin L. Bittinger Endowed Chair Professorship in the area of Mathematics Education.

Located in the heart of Indianapolis, IUPUI is an urban doctoral/research intensive university with 29,000 students. The Department of Mathematical Sciences, with a faculty of 42 members, houses the mathematics and statistics disciplines and offers a range of undergraduate and graduate programs, leading to Purdue University B.S, M.S., and Ph.D. degrees in mathematics and applied mathematics as well as Masters degrees in applied statistics and mathematics education.

We seek a well-established colleague with national/international recognition and with strong interests in mathematics education at the university level. The person holding this position is expected to be a leader in the Department, in terms of teaching, scholarship and curricular development. In particular, the person will have demonstrated a commitment to working on the forefront of efforts to advance the teaching and learning of developmental and university-level undergraduate mathematics.

Applicants must have a Ph.D. degree in the mathematical sciences with academic and scholarly accomplishments adequate for appointment to Full Professor. The successful candidate must have record of teaching excellence. The Bittinger Chair offers a competitive salary commensurate with background, experience, and record of professional achievements, and an excellent fringe benefit package.

All application materials, including a letter of interest, a detailed curriculum vita and the names and contact information of at least four references should be mailed to:

The Bittinger Chair Search CommitteeDepartment of Mathematical SciencesIndiana University Purdue University Indianapolis402 N. Blackford St., LD Suite 270 Indianapolis, IN 46202-3216

Screening of applications will begin on March 1, 2003, and will continue until the position is filled.

IUPUI is an Equal Opportunity/Affirmative Action Employer and strongly encourages applications from women and underrepresented minorities. Additional information about IUPUI and the Department is available at www.iupui.edu and www.math.iupui.edu.

NEW YORK

BRONX COMMUNITY COLLEGE OF CUNY
The Department of Mathematics & Computer Science invites applications for one anticipated tenure track position starting in September 2003. A Ph.D. in mathematics or computer science is preferred; enrollment in a doctoral program is desirable in its absence. Candidates must have a record of and commitment to excellence in teaching and continued scholarly activity. The department has 23 full-time and 55 part-time faculty members. Courses offered range from developmental to upper level mathematics and computer science. Bronx Community College encourages applications from women and minority candidates and is an AA/EOE. Send a letter of application, a statement of teaching philosophy, resume, graduate transcript(s) and three recent letters of reference, (at least one should address teaching), no later than March 15, 2003, to: Prof. Germana Glier, Chair Department of Mathematics & Computer Science, Bronx Community College/CUNY, University Avenue & West 181 Street, Bronx, NY 10453.

OHIO

THE OHIO STATE UNIVERSITY
VISITING ASSISTANT PROFESSOR IN MATHEMATICS
The Ohio State University at Newark is seeking a one-year Visiting Assistant Professor in Mathematics to begin Autumn Quarter 2003. The Newark Campus is an extended campus in The Ohio State University system that serves around 1800 students and is located 30 miles east of the central Columbus campus.

DUTIES:
Teaching load is negotiable and will consist of first-year and second-year undergraduate courses.

QUALIFICATIONS: Ph.D. in mathematics required by start date, with research interests in commutative rings, differential geometry, homotopy theory, optimization, and representation theory preferred. Applicants should have an active research program, be able to demonstrate the ability to communicate effectively in the classroom, and have a record of outstanding college teaching.

TERMS: Full-time, non-tenure track one-year appointment.

SALARY:
$38,000 - $42,000 per year.

APPLICATION PROCEDURE: To assure consideration, submit a research description, curriculum vitae and three letters of professional reference to The Ohio State University at Newark, Search #02-83, 1179 University Drive, Newark, Ohio 43055 by March 28, 2003. The Ohio State University at Newark is an Equal Opportunity/Affirmative Action employer. Women, minorities, veterans, and individuals with disabilities are encouraged to apply.

UNIVERSITY OF CINCINNATI
OMI College of Applied Science,
Assistant Professor of Mathematics
The OMI College of Applied Science at the University of Cincinnati invites applications for a full-time tenure-track Faculty position in Mathematics to begin in September, 2003. The OMI College of Applied Science is a fully accredited baccalaureate college with an international reputation in delivering innovative education in science and technology. The Department of Mathematics, Physics and Computing Technology presently has twelve full-time Faculty, offers BS and AS degrees in Computer Science Technology, Information Engineering Technology, and Information Technology as well as support courses in Mathematics, Physics and Computing Technology. This position is contingent on availability of funding.

This is a nine-month appointment with possible opportunity to teach during alternate summers. The position requires a minimum of a master's degree in Mathematics and experience in teaching Mathematics in higher education. The candidate must be able to teach a full range of undergraduate mathematics offerings from algebra through differential equations and discrete mathematics. The candidate should be familiar with the use of modern technology in the classroom. The candidate must be willing to teach classes in both day and evening as part of the regular load. Since this is a full-time teaching position, an ability to demonstrate teaching excellence will be required. Ability to work with other Faculty Members in offering common courses is necessary. Excellent oral and

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Contact the MAA Advertising Department toll free at 1-866-821-1221, fax: (703) 528-0019. Ads may be sent via email to ads@catalystcom.com.

Nominations Sought for 2004 Gung-Hu Award

Nominations are now being accepted for the 2004 Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics, the most prestigious award given by the Association. It is to be made for service to mathematics that has been widely recognized as extraordinarily successful. The period of service may be long or short, and the award may be made on the basis of one or several activities. The contribution should be such as to influence the field of mathematics or mathematics education in a significant and positive way on a national scale. Nominations should be sent to Robert Megginson, Deputy Director, Mathematical Sciences Research Institute, 17 Gauss Way, Berkeley CA 94720-5070, or via email meggin@msri.org, to arrive no later than April 1.

MAA Section Meeting Schedule 2003

ALLEGHENY MOUNTAIN

April 4-5, 2003-Penn State University DuBois, PA

EASTERN PA & DELAWARE

April 12, 2003-Wilkes University Wilkes-Barre, PA

FLORIDA

February 21-22, 2003-Jacksonville University, Jacksonville, Florida

ILLINOIS

March 28-29, 2003-Illinois College Jacksonville, IL

INDIANA

March 28-29, 2003-Butler University Indianapolis, IN

INTERMOUNTAIN

March 19-20, 2003, Weber State University, Ogden, UT

IOWA

April 4-5, 2003-University of Northern Iowa, Cedar Falls, IA

KANSAS
April 4-5, 2003-Hays, KS

KENTUCKY

April 4-5, 2003-Bellarmine University Louisville, KY

LOUISIANA-MISSISSIPPI

February 21-22, 2003-Mississippi College, Clinton, MS

MD-DC-VA

April 11-12, 2003-Norfolk State University, Norfolk, VA

METRO. NEW YORK

May 3, 2003-La Guardia Community College (CUNY)

MICHIGAN

May 2-3, 2003-Saginaw Valley State University, University Center, MI

MISSOURI

April 4-5, 2003-Washington University St. Louis, MO

NEBRASKA-SOUTHEAST SOUTH DAKOTA

March 28-29, 2003-University of South Dakota at Vermillion, Vermillion, SD

NEW JERSEY

April 5, 2003-Kean University, Union, NJ

November 8, 2003-Raritan Valley Community College, North Branch, NJ

NORTH CENTRAL

April 25-26, 2003- Malcalester College St. Paul, MN

Fall 2003-University of Sioux Falls Sioux Falls, SD

NORTHEASTERN

June 13-14, 2003-Massachusetts College of the Liberal Arts, North Adams, MA

NORTHERN CALIFORNIA, NEVADA, HAWAII

February 22, 2003-College of Marin Kentfield Campus, Kentfield, CA

OHIO

April 4-5, 2003-Ohio State University Columbus, OH

October 17-18, 2003- Ohio Northern University, Ada, OH

OKLAHOMA-ARKANSAS

March 28-29, 2003-The University of Tulsa, Tulsa, OK

PACIFIC NORTHWEST

June 20-21, 2003-Whitman College

ROCKY MOUNTAIN

April 2003-United States Air Force Academy, Colorado Springs, CO

SOUTHEASTERN

March 21-22, 2003-Joint Meeting with Atlantic Section of SIAM, Clemson, SC

SOUTHERN CALIFORNIA

March 8, 2003-Harvey Mudd College Claremont, CA

SOUTHWESTERN

April 5-6, 2003-New Mexico Institute of Mining and Technology, Socorro, NM

SEAWAY

April 4-5, 2003 Alfred University Alfred, NY.

November 7-8, 2003-Rochester Institute of Technology, Rochester, NY

TEXAS

April 3-5, 2003-Sam Houston State University, Huntsville, TX

WISCONSIN

April 25-26, 2003-University of Wisconsin-Marathon County Wausau, WI

September 26-28, 2003 (Meeting for Project NExT Wisconsin) Bundy Hall Conference Center, Menomonie, WI