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On the cover: The prizewinner and the presidents. Left to right: AMS President David Eisenbud, Melanie Wood, MAA President Ron Graham, and SIAM President James Hyman. Photograph courtesy of Fernando Gouvêa.

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Melanie Wood Wins Morgan Prize

By Joe Gallian

Melanie Wood was named recipient of the 2003 The AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student at the January Joint Mathematics Meetings in Phoenix. Wood received a $1000 cash prize and a certificate at the meetings. Wood is the first woman to win the prize since its inception in 1995. The selection committee cited Melanie's honors thesis at Duke on combinatorial structures associated with algebraic curves defined over number fields, done under the supervision of Richard Hain, and her work on algebraic number theory, done at the Duluth REU in 2000. Her work on algebraic curves yields important insights into the action of the absolute Galois group on fundamental groups. This research has attracted the attention and admiration of the specialists working in this field. Wood's results in number theory generalize the usual factorial function and expand on ideas introduced by Manjul Bhargava, for which he received the Morgan Prize in 1996. The Prize committee called her work "deep and original."

Melanie is well known for her success in math competitions. In 1998 she was the first woman ever to be named to the United States team for the International Mathematical Olympiad. In 2002 she was the second female to be named a Putnam Fellow. In 2003 she was an instructor in the Mathematical Olympiad Program and she accompanied the US team to the International Mathematical Olympiad in Japan.

Wood's historic participation in the IMO caused a media stir. The June 2000 issue of the science magazine *Discover* ran a six page profile about her and the IMO (see http://www.findarticles.com/m1511/6_21/62277745/p1/article.jhtml). The table of contents was printed over a full page photo of her doing a headstand in front of a blackboard. In 2002 she appeared on the television program *To Tell the Truth*, in which four panelists and the audience tried to determine which of three contestants was the real Melanie Wood. (Only one panelist succeeded, perhaps because Melanie had taught the other contestants some "math talk.")

Melanie Wood

Karen Yeats.

Having received Fulbright and Gates Scholarships, Wood is currently studying mathematics at Cambridge University. In the fall of 2004 she will begin graduate school in mathematics at Princeton.

Melanie also enjoys acting, especially classical acting and voice work, directing, dancing, and philosophy.

The Morgan Prize committee awarded Honorable Mention to Karen Yeats of the University of Waterloo for a series of three papers making outstanding contributions on topics ranging from asymptotics and number theory to mathematical logic. Her work expands on results of Schur and results of Dedekind. Karen was a member of the Waterloo 2002 Putnam team that finished in the top 10. She spent three summers as an NSERC (Natural Sciences and Engineering Research Council of Canada) undergraduate research assistant at Waterloo. She graduated in 2003 with honors in Pure Math and a Governor General's Sil-

Melanie Wood presenting her talk at the Joint Mathematics Meetings in Phoenix, AZ.

ver Medal. She is currently a graduate student in mathematics at Boston University.

Karen is an accomplished recorder player, and also enjoys playing clarinet and singing in choirs, as well as the occasional foray into making teddy-animals and working on free software.

Both Wood and Yeats gave talks on their research at the Phoenix meeting. Although most of the recipients of the Morgan Prize have yet to finish a Ph.D. degree, winners of the early prizes have already begun to make their mark. Indeed, three of the first four winners and one who was named honorable mention have received the Clay Mathematics Institute or American Institute of Mathematics Long Term (five years) Prize Fellowships for researchers at the beginning of their careers. The first Morgan prize winner in 1995, Kannan Soundararajan, received the 2003 Salem Prize given to young researchers for outstanding contributions to the field of analysis and the 1996 winner, Manjul Bhargava, is a tenured full Professor at Princeton.

Abstract of Melanie Wood's Morgan Prize Talk

The absolute Galois group, G_Q, is the group of automorphisms of the algebraic numbers which fix the rational numbers. Though this group is an important object in number theory, little is known about it. Grothendieck proposed studying G_Q by considering its faithful action on combinatorial structures called *dessins d'enfants* (children's drawings). A dessin is a bipartite graph with a fixed 2-coloring and cyclic edge orderings at each vertex. The eventual goal of studying the action of G_Q on dessins is a complete list of G_Q invariants computable from the combinatorial structure of the dessins. Such a list would allow us to check whether two dessins are in the same G_Q-orbit by checking whether they agree on the list of invariants. Some invariants are known, and the present work develops a method for constructing new invariants from old ones. We give an example of two dessins whose orbits are distinguished by one of our new invariants but were previously undistinguished. The action of G_Q on dessins comes from an action on the fundamental group of the Riemann sphere minus three points, which gives an injection of G_Q into Aut($\hat{F}_2$), the automorphisms of the profinite completion of the free group on two generators. Our method for finding new dessin invariants extends to a method for finding relations on the injection of G_Q into Aut($\hat{F}_2$).

"Great Internet Mersenne Prime Search" Locates Another One

"It was just a matter of time," said Michigan State University graduate student Michael Shafer, about identifying the largest prime number to date. In late November, 2003, the number was found: It is 2 to the 20,996,011th power minus 1. The number contains 6,320,430 digits — 2 million digits more than the previous largest known prime number.

Mersenne primes are prime numbers of the form $2^n - 1$. It is easy to see that in order for this number to be prime, n must also be prime, but of course this condition is far from sufficient. It is conjectured that there exist infinitely many such primes, so the search has the potential to go on forever. Mersenne primes are closely related to perfect numbers: if $2^n - 1$ is prime, then $2^{n-1}(2^n - 1)$ is a perfect number. (This result can be found in Euclid's *Elements*; Euler proved that in fact any even perfect number is of this form.) They are named after Marin Mersenne (1588–1648), a French friar who is best known for his correspondence with many scientists and mathematicians. By passing along results, questions, and ideas, Mersenne hoped to get scholars to build on each other's work. One of his areas of interest was perfect numbers, which is why his name became attached to the primes involved in the factorization of even perfect numbers.

Shafer, who is 26 and studying chemical engineering, helped find the number — using a Dell computer — as a volunteer member on the eight-year-old project called the "Great Internet Mersenne Prime Search" (GIMPS). This is a world-wide effort that involves thousands of people and more than 200,000 computers — in effect a supercomputer that could do 9 trillion calculations per second. As for his standing in the world of mathematics, "I don't think I'm going to be recognized as I go down the street," he said. "Somebody else could have found the number… You install the program on the computer and it takes care of itself." But, he continued, "I get the credit, along with the people that developed the software."

The home page for GIMPS can be found at http://www.mersenne.org, where one can find more information about Mersenne primes, the GIMPS project and its latest discovery. One can even download software to join the search.

Things I Learned in School Last Year

By Jim Loats

Be at work by 8:00 a.m., every day. Observe the dress code. (Dress code!?) Have a cubicle as an office, but be out in the schools most of the time. Update my phone message every day. Carry a cell phone. This is definitely not the life of an academic. But it was my life during the year I spent, away from my job as a mathematics professor, as a Mathematics Coordinator for the Denver Public Schools (DPS).

The district's decision to move towards standards-based curricula in grades 4–8 increased my desire to step out of my comfortable academic routine. *Everyday Mathematics* and *Connected Mathematics Program* are well designed, field-tested, sophisticated standards-based curricula. When they are used effectively, students will gain a broad, deep, and connected understanding of mathematics. To use them well, teachers must have a solid understanding of the important mathematical concepts and be prepared to take on different roles in the classroom. I had changed my own teaching methodology in most of my college courses and was excited to help others make similar transitions.

During the mid-1990's at Metropolitan State, I was co-P.I. and Mathematics Team Leader of our NSF-funded Rocky Mountain Teacher Education Collaborative. In this role I helped to hire middle and high school teachers to work on-campus side-by-side with college math and science faculty on curricular revisions. I became a good friend of one of these Teachers-in-Residence, Rosanne Fulton, who had since become Director of Curriculum and Instruction at DPS. One July evening last year she phoned. "Why don't you take a year's leave from Metro and park your car over here at DPS where the real work is?" I decided it would be a great opportunity, and my department chair and dean concurred. DPS could benefit from my expertise and I'd learn a lot about public schools… really fast!

My coworker, Debbie Hearty, had been doing this job for several years and was an expert. I studied her closely while I hastily learned a whole new culture. As Mathematics Coordinators we directed the Math Team, a group of nine teachers who had been newly chosen to be district Mathematics Specialists. Together with the Team, we designed and presented curriculum implementation workshops for over 300 fourth to eighth grade mathematics teachers. Debbie and I regularly worked on math problems with the specialists and supported them in the work with their teachers. We created curriculum pacing guides and visited classrooms with school principals.

We had additional tasks. We conveyed the district's new vision of mathematics instruction to various stakeholders: superintendents, principals, parents, school board members, the press, vendors, professors at various local colleges and universities, and colleagues on national grants. We explained the new curricula at meetings with administrators and teachers from special education, gifted and talented programs, counselors, technology, summer school, English language acquisition, career education, alternative schools, and student records. I had no idea how much effort was required just to inform all the non-teaching staff of the implications that came with the changes in mathematics curricula.

What I Learned About the Schools

I learned that helping schools to improve requires very sophisticated thinking and excellent management skills. The problems are complex and resistance to change is huge. Successful interventions took time to plan.Carrying them out required the right people in the right places making good decisions.There are no easy solutions.

Everyday Mathematics and *Connected Mathematics Program* places enormous demands on teachers, both in terms of their content knowledge and their pedagogical flexibility. Providing adequate support for them in both areas will require a significant effort for all of us for years to come.

I learned that mobility of teachers is a problem, especially in urban districts like ours. The teacher turnover within a single building can be quite large from year to year. This underlying fluidity is very different from my experience in higher education. It cuts both ways in the schools. On one hand, school change efforts can lose momentum when the players change. On the other, it can help, because some of the troupe may be different next year.

I learned that the schools are not in charge of themselves. Many stakeholders know best about what should happen. What happens inside schools is often defined outside of the schools. For example, I talked with parents who did not want mathematics instruction to change despite admitting that their own school math experiences were not particularly effective.

Each school exudes a unique culture and individual personality. You can feel it the moment you walk into a building. This culture influences the nature and amount of learning that takes place. While this culture has considerable inertia, a strong principal can impact a school and change the learning/teaching experience for teachers and children.

The daily workload of K-12 teachers is "impossible." Almost no one has enough time to do their job really thoroughly, although most do outstanding jobs. Their work schedules, the conflicting push-pulls, and the slow pace of change conspire to divert their attention from the business of teaching children. Administrators must be as wise and thoughtful as they can be, considering their hectic schedule and breadth of responsibilities. After working with them for a year, I have profound respect for all of these people and the work they do.

Tracking

I was most disturbed by the consequences of tracking students. It may seem like common-sense for a third grade teacher to group children based on how fast they read. Small, seemingly obvious decisions like this one lead, over time, to a situation I observed across this diverse urban district: AP classes were composed mostly of white and affluent students, while regular and low track classes had mostly poor students of color. I was (and remain) very troubled to learn about this reality in our schools, not just in Denver, but all across our country.

The issue is the balance between serving the needs of the whole classroom with what is best for any particular child. There is good news. Schools that adopt these new sophisticated curricula acquire a tool that has been specifically designed to address this and other equity issues while teaching good mathematics, all without discriminating against whole groups of kids. These Standards-based curricula work especially well in classrooms that contain a broad spectrum of students. They rely on the rich variations of student experiences to provide multiple means to view and understand the mathematics that arises. They have multiple entry points to provide access for students with different backgrounds and learning styles.

What I Learned About Me

I enjoyed spending time with teachers, both in their classrooms and at the workshops. I loved helping principals and other administrators understand the design of these new curricula. I felt like I was making a difference. I liked working closely with a team and pulling off nearly impossible missions. My work life as a professor is usually more isolated.

I valued being personally challenged in a series of workshops on equity. Using protocols from the National Center for Equity in Education, forty of us started facing our biases around race, gender, class, and sexual preference and became close friends.

I was proud to be working for leaders who were smart and pushed the system to change as fast as it could. I respect the district's administrative team, especially the Superintendent, Jerry Wartgow, the

Denver middle school teachers, Kelly Babcock and Nathan Pruss, solving a math problem together at a workshop.

Chief Academic Officer, Sally Mentor Hay, and my supervisor, Rosanne Fulton. I trusted that they were making wise, strategic decisions even if the details of implementation at my level occasionally seemed hurried or impractical.

I truly fell in love with the people of the Denver Public School system. They love the children and give their best, often in less than optimal situations. Our mission was to provide excellent schooling to "Every Child Every Day." It was truly inspirational and compelling to be working with people who took that to heart day in, day out.

I often felt ineffective because very few things changed directly or immediately as a result of my work. Back on campus, the feedback from students was always more immediate and direct.

Coming from the classroom, I was caught off guard by the work life of an administrator. I was not in charge of my time. I was always on-call and accountable to my boss, my fellow curriculum teammates, and the public. My schedule for the day was fluid and unpredictable. There was always something new to do. The tasks could not be done as fast as needed. Any decision inevitably led to unforeseen consequences. I missed the structure, predictability, and freedom of my academic routine.

What This Means for Our Work as Mathematics Professors

First, I urge all of us to continue rethinking our mathematics courses so that our students finish them with in-depth conceptual understanding that makes sense to them and sticks with them long after the final examination. Further, in each of our classes, we must regularly take time to examine with our students how learning happens in the class. For example, take brief moments away from the content to make public and explicit what we are doing to help them learn.

I write this after observing over 100 middle and high school classroom teachers who have been teaching for many years. Many "facts and skills" they learned in their college mathematics classes have probably faded away. Nevertheless they model their own classes on recollections of their experiences in college mathematics classes. For most, that meant listening and taking notes, answering — not asking — questions, working alone and mistrusting opportunities for collaboration. It meant memorizing "how" to do a problem and not worrying "why" it works; and, importantly, rarely being asked to write cogent explanations of their own understanding of the important ideas of the class.

Imagine it is a year after one of your classes. Wouldn't it be cool if the students could explain the central big ideas in the class and understand how they fit together? Even better if they had an explicit understanding of what you did as their teacher to help them learn. For all of our students, but especially the future teachers, it would send a strong message that mathematics is about understanding and making sense; and that their task as students is to build, with our help, their own coherent, connected structure of the fundamental ideas.

Data from the recent Third International Mathematics and Science Study (TIMSS) video study show that teachers in the United States, unlike every other country, always convert problem-solving opportunities into procedural tasks and teach their students to do them that way. Somehow, in our college and university courses perhaps, these teachers have learned that mathematics is about recalling, and performing procedures to the exclusion of thinking, conjecturing and problem solving.

These new school curricula require teachers to have the habit of asking, "Why does this work?" not just "How does it work?" Most of the teachers I observed had difficulty leading discussions about why things work. The prospective teachers in our classes need to see these types of discussions modeled in their college and university classrooms by "real" mathematicians.

Second, it is important that we as members of higher education mathematics community work to understand the important, difficult work of the K–12 teachers and then be public with our support and respect for them. Too often we are silent while less informed voices get the sound bites and column inches.

Third, I urge each of you to find a way to help raise the math content knowledge of our public school teachers. Many teachers would really appreciate the attention of a mathematician who would support them in asking and answering the questions they have about the mathematics they are teaching. Enjoy the opportunity to share the mathematics you know and value so deeply. Initiate a relationship with them. You can find them just down the street.

The author is once again professor in the Department of Mathematical and Computer Sciences at Metropolitan State College of Denver. He is an avid sailor, skier, musician, and co-author of Algebra Unplugged *and* Calculus For Cats. *He'd enjoy responding to inquiries at* loatsj@mscd.edu.

The 2004 IAS/Park City Mathematics Institute: The Undergraduate Faculty Program

By William Barker

A unique mathematics event takes place each July in Utah: the Park City Mathematics Institute, sponsored since 1994 by the Institute for Advanced Study in Princeton. For three intense weeks mathematics researchers, scholars, and students at the post-secondary level as well as mathematics educators at the secondary and post-secondary level gather for research and study in Park City, Utah, a setting of breathtaking mountain scenery and abundant hiking and outdoor opportunities.

This year's PCMI Summer Session will be held from July 11 to July 31, 2004, with the research theme of *Geometric Combinatorics* and the education theme of *From Policy to Practice: Partnerships with School Districts.*

The central themes of PCMI are developed in six separate but connected programs, each centered on a different component of the mathematics community:

The research program components: mathematics researchers (Research Program), for graduate students (Graduate Summer School), and for undergraduate students (Undergraduate Program). The education program also has three parts: for mathematics education researchers (Mathematics Education Research Program), for undergraduate college faculty (Undergraduate Faculty Program), and for high school teachers (High School Teacher Program).

At the Summer Session these groups meet simultaneously, each following an individual program of research and study. However, considerable interaction takes place between the groups due to the fundamental structure of PCMI: lectures and courses in each Summer Session program are open to *all* participants and, in addition to the activities specific to each group, there are daily events of general interest designed for the full Institute. Further opportunities for informal and social interaction are also available, ranging from organized cross-program activities to informal conversations over meals. Cross-program mentoring is also encouraged and nurtured to further enhance the sense of community among participants.

Andrew Bernhoff leads a session at the 2003 Undergraduate Faculty Program at the Park City Mathematics Institute.

The rich mathematical experience combined with interaction among groups with different backgrounds and professional concerns results in greatly increased understanding and awareness of the issues confronting contemporary mathematics and mathematics education.

Each of these programs will be attractive and appropriate for many members of the MAA. However, the *Undergraduate Faculty Program* (UFP), with its focus on collegiate mathematicians with a strong interest in undergraduate education, is of relevance to a particularly large portion of the MAA. Co-sponsored by NSF's Chautauqua Program, the UFP offers opportunities for broad professional growth and engagement with the excitement of mathematics by working with peers on new approaches to teaching, tackling research questions, and interacting with the broader mathematical community. Each year the theme of the UFP bridges the research and education themes of the Summer Session. This year's UFP theme is:

Combinatorics in Concert: for Teaching, Research, Outreach, and Recreation

The workshop leader will be Francis Su, Associate Professor of Mathematics at Harvey Mudd College.

The program will use geometric combinatorics to weave together many aspects of a faculty member's professional life — teaching, research, outreach, and recreation — into a harmonious whole.

The many beautiful yet accessible ideas in geometric combinatorics make this topic perfect for: enriching a wide variety of undergraduate courses with examples from this field; providing a source of research problems (for undergraduates or oneself); generating topics for general lectures in the community or local high schools; and sustaining recreation opportunities such as puzzle solving.

Geometric combinatorics refers to a growing body of mathematics concerned with counting properties of geometric objects described by a finite set of building blocks. Primary examples include polytopes (which are bounded polyhedra and the convex hulls of finite sets of points) and complexes built up from them. Other examples include arrangements and intersections of points, lines, and planes. There are many connections to linear algebra, discrete mathematics, analysis, and topology, and there are many exciting applications to economics, game theory, robotics, and biology.

The UFP "concert" will feature two concurrent parts, the Baseline and Melody. Each will generally last one hour per day. The *Baseline* hour will be a course on selected topics in geometric combinatorics, open both to undergraduate faculty as well as other PCMI participants.

The *Melody* hour will build on the Baseline material to address issues of particular interest to faculty in highly interactive and participatory ways. For example, one topic will be how the Baseline material can enrich one's own undergraduate courses (such as discrete mathematics, linear algebra, geometry, and topology) or how to teach a standalone course in the subject.

Not only does the UFP Program explore both the content and pedagogy of one undergraduate topic per year, it also helps encourage and facilitate interaction among PCMI's constituent groups and programs. For example, some UFP participants like to attend the Graduate Summer School courses. Some also work actively with the High School Teachers program, particularly concerning pedagogical, curricular, or articulation issues. A large number are attracted to the Undergraduate Program, both for the interesting mathematics in the courses and for the kind of research experiences for undergraduates that are often available. The UG courses for 2004 are *From Polytopes to Enumeration*, taught by Edward Swartz of Cornell University, and *Groebner Bases and Polytopes*, taught by Rekha Thomas of the University of Washington.

This summer's UFP workshop leader, Francis Su, earned his Ph.D in Mathematics from Harvard University in 1995, and is now an Associate Professor of Mathematics at Harvey Mudd College. His research interests lie presently in geometric combinatorics and applications to mathematical economics. He has a dual passion for mathematics education, and has won several teaching awards, authored a popular *Math Fun Facts* website, and serves on the editorial board of *Math Horizons*. In 2001 the Mathematical Association of America awarded him the Merten M. Hasse Prize for excellence in expository writing.

The Coordinator of PCMI's Undergraduate Faculty Program, Daniel Goroff, is Professor of the Practice of Mathematics at Harvard University and Associate Director of the Derek Bok Center for Teaching and Learning. He is a member of the PCMI Steering Committee, chaired by Herb Clemens of the Ohio State University.

For more information and application instructions for the Undergraduate Faculty Program, consult the UFP web page at http://www.admin.ias.edu/ma/program/ufp2004.html. Reviewing of applications begins February 15, 2004, and financial support is available for participants in all the programs. For more general information on all aspects of the 2004 Summer Session consult the PCMI web page at http://www.admin.ias.edu/ma/.

Student Paper Contest in the History of Mathematics

HOMSIGMAA, the History of Mathematics Special Interest Group within the MAA, has recently announced a student paper contest. The contest is open to all undergraduate students. Its purpose is to increase awareness of and interest in the history of mathematics among undergraduates. A grand prize and two runner-ups will be chosen. All three will receive a one year student membership to the MAA; the grand prize winner will also receive a $25 dollar gift certificate to the MAA bookstore.

Topics for the paper can be drawn from any field of mathematics. Papers may address a single person, topic, or period, or may survey the history of a broader topic or a school of thought. They should be approximately 5000 words (12 double-spaced 12pt pages) long, should include a full citation list, should not draw too heavily from internet sources (except for web sites that give access to printed material, such as JSTOR or Gallica). Papers will be judged by a panel of specialists for content, presentation, and grammar.

The deadline for submissions is March 15, 2004. Submitted papers should include the student's name, institution, their email and postal address, and the name of the supervising instructor if applicable. Submissions and questions should be directed to Amy Shell-Gellasch at amy.shellgellasch@us.army.mil or by post at Dr. Amy Shell-Gellasch, CMR 415, Box 3161, APO AE 09114. Results will be announced via email and on the HOMSIGMAA website in May 2004.

Information on the contest can also be found at the HOMSIGMAA web site at http://home.adelphi.edu/~bradley/HOMSIGMAA.

AAAS Elects Fellows in Mathematics

In September, the Council of the AAAS (American Association for the Advancement of Science) elected 348 members as Fellows of the AAAS. These individuals will be recognized for their contributions to science at the Fellows Forum to be held on 14 February 2004 during the AAAS Annual Meeting in Seattle. The new Fellows will receive a certificate and a blue and gold rosette pin as a symbol of their distinguished accomplishments. The new Fellows in the Mathematics Section are Donald Ludwig of the University of British Columbia, David W. McLaughlin of New York University, Maxine L. Rockoff of the New York Academy of Medicine, Annie Selden of New Mexico State University, Las Cruces, and Victor L. Shapiro of the University of California, Riverside. Both Shapiro and Selden are members of the MAA, and Selden is also a member of the FOCUS editorial board.

Mathematics and Operations Research in Industry

By Dennis E. Blumenfeld, Debra A. Elkins, and Jeffrey M. Alden

Students majoring in mathematics might wonder whether they will ever use the mathematics they are learning, once they graduate and get a job. Is any of the analysis, calculus, algebra, numerical methods, combinatorics, math programming, etc. really going to be of value in the real world?

An exciting area of applied mathematics called *Operations Research* combines mathematics, statistics, computer science, physics, engineering, economics, and social sciences to solve real-world business problems. Numerous companies in industry require Operations Research professionals to apply mathematical techniques to a wide range of challenging questions.

Operations Research can be defined as the science of decision-making. It has been successful in providing a systematic and scientific approach to all kinds of government, military, manufacturing, and service operations. Operations Research is a splendid area for graduates of mathematics to use their knowledge and skills in creative ways to solve complex problems and have an impact on critical decisions.

The term 'Operations Research' is known as "Operational Research" in Britain and other parts of Europe. Other terms used are "Management Science," "Industrial Engineering," and "Decision Sciences." The multiplicity of names comes primarily from the different academic departments that have hosted courses in this field. The subject is frequently referred to simply as "OR", and includes both the application of past research results and new research to develop improved solution methods.

Some key steps in OR that are needed for effective decision-making are:

Problem Formulation (motivation, short- and long-term objectives, decision variables, control parameters, constraints);

Mathematical Modeling (representation of complex systems by analytical or numerical models, relationships between variables, performance metrics);

Data Collection (model inputs, system observations, validation, tracking of performance metrics);

Solution Methods (optimization, stochastic processes, simulation, heuristics, and other mathematical techniques);

Validation and Analysis (model testing, calibration, sensitivity analysis, model robustness); and

Interpretation and Implementation (solution ranges, trade-offs, visual or graphical representation of results, decision support systems).

These steps all require a solid background in mathematics and familiarity with other disciplines (such as physics, economics, and engineering), as well as clear thinking and intuition. The mathematical sciences prepare students to apply tools and techniques and use a logical process to analyze and solve problems.

OR became an established discipline during World War II, when the British government recruited scientists to solve problems in critical military operations. Mathematical methods were developed to determine the most effective use of radar and other new defense technologies at the time. OR groups were later formed in the U.S. to meet needs of wartime operations, such as the optimal movement of troops, supplies, and equipment.

Following the end of World War II, interest in OR turned to peacetime applications. There are now many OR departments in industry, government, and academia throughout the world. Examples of where OR has been successful in recent years are the following:

Airline Industry (routing and flight plans, crew scheduling, revenue management);

Telecommunications (network routing, queue control);

Manufacturing Industry (system throughput and bottleneck analysis, inventory control, production scheduling, capacity planning);

Healthcare (hospital management, facility design); and

Transportation (traffic control, logistics, network flow, airport terminal layout, location planning).

There are many mathematical techniques that were developed specifically for OR applications. These techniques arose from basic mathematical ideas and became major areas of expertise for industrial operations.

One important area of such techniques is *optimization.* Many problems in industry require finding the maximum or minimum of an objective function of a set of decision variables, subject to a set of constraints on those variables. Typical objectives are maximum profit, minimum cost, or minimum delay. Frequently there are many decision variables and the solution is not obvious. Techniques of mathematical programming for optimization include linear programming (optimization where both the objective function and constraints depend linearly on the decision variables), non-linear programming (non-linear objective function or constraints), integer programming (decision variables restricted to integer solutions), stochastic programming (uncertainty in model parameter values) and dynamic programming (stage-wise, nested, and periodic decision-making).

Another area is the *analysis of stochastic processes* (i.e., processes with random variability), which relies on results from applied probability and statistical modeling. Many real-world problems involve uncertainty, and mathematics has been extremely useful in identifying ways to manage it. Modeling uncertainty is important in risk analysis for complex systems, such as space shuttle flights, large dam operations, or nuclear power generation.

Related to the topic of stochastic processes is *queueing theory* (i.e., the analysis of waiting lines). A common example is the single-server queue in which customer arrivals and service times are random. Figure 1 illustrates the queue, and the curve shows how sensitive the average queue length becomes under high traffic intensity conditions. Mathematical analysis has been essential in understanding queue behavior and quantifying impacts of decisions. Equations have been derived for the queue length, waiting times, and probability of no delay, and other measures. The results have applications in many types of queues, such as customers at a bank or supermarket checkout, orders waiting for production, ships docking at a harbor, users of the internet, and customers served at a restaurant. Examples of decisions in managing queues are how much space to allocate for waiting customers, what lead times to promise for production orders, and what server count to assign to ensure short waiting times.

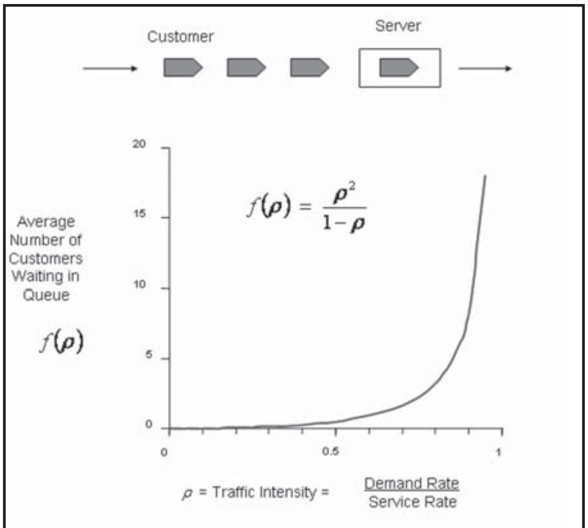

Figure 1: Single-Server Queueing System

An important mathematical problem in manufacturing is the performance analysis of a production line. A typical production line consists of a series of workstations that perform different operations. Jobs flow through the line to be processed at each station. Buffers between stations hold the output of one station and allow it to wait as input to the next. A finite buffer can fill and block output from an upstream station or can empty and starve a downstream station for input. Blocking and starving are key mechanisms of the complex interactions between queues that form in the line. A critical measure of performance is throughput, defined as number of jobs per unit time that can flow through the line. Throughput is reduced when stations experience random machine failures, a common practical situation. Mathematical modeling is needed to capture the impact on throughput of station reliabilities, as well as processing rates and buffer sizes. A model can support operating decisions, such as how to improve a line to meet a throughput target, how to identify bottlenecks, and how much buffer space to allocate in line design.

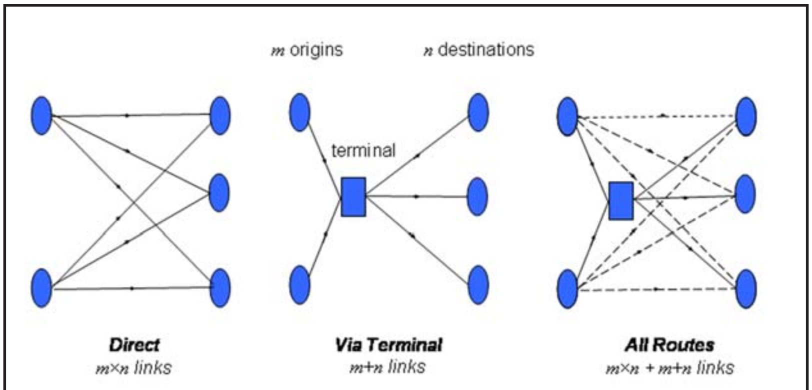

Figure 2: Network Routing Options

Another real-world mathematical problem, common to many industries, is the distribution of material and products from plants to customers. For a network of origins and destinations, there are many shipping alternatives, including choices of transportation mode (e.g., road, rail, air) and geographical routes. Some key decisions are routing options over the network, and shipping frequencies on network links. As shown in Figure 2, routing options involve shipping direct, via a terminal or distribution center, and by a combination of routes. These options affect distances traveled and times in transit, which in turn affect transportation and inventory costs. Shipping frequency decisions also affect these costs. Transportation costs favor large infrequent shipments, while inventory costs favor small frequent shipments. Trade-offs between these costs are complex for large networks, and finding the optimal solution is a challenging mathematical problem. In addition to decisions for operations of a given network, there are major strategic decisions, such as the selection and location of distribution centers.

Other OR topics requiring mathematical analysis are inventory control (when to reorder material to avoid shortages under demand uncertainty), manufacturing operations (what size of production run will minimize sum of inventory and production setup costs), location planning (where to locate the hub to serve markets with minimal travel distances), and facility layout (how to design airport terminals to minimize walking distances, maximize number of gates, allow for future expansion, and conform to government regulations).

OR analysts can model difficult practical problems and offer valuable solutions and policy guidance for decision-makers. Constraints involving budgets, capital investments, and organizational considerations can make the successful implementation of results as challenging as the development of mathematical models and solution methods.

In general, Operations Research requires use of mathematics to model complex systems, analyze trade-offs between key system variables, identify robust solutions, and develop decision support tools. Students of mathematics can be sure there are plenty of uses for the knowledge and skills they are developing. As the world becomes more complex and more dependent on new technology, mathematics applied to business problems is likely to play an increasingly important role in decision-making in industry.

On a personal note…

All three of us developed an interest in the mathematical sciences early on, and took undergraduate degrees in math, or math and physics. We each got into the field of Operations Research as a result of looking for practical ways to use our math training. Below, we each answer the question: "How did you decide on a career in math and decide to join GM?"

Dennis Blumenfeld: *The math courses I liked best were the ones on applied topics. I found Operations Research an especially appealing subject, since it uses basic mathematical principles in clever ways to solve all kinds of complex problems in everyday life — such as queueing, reliability, scheduling, and optimization. I was intrigued by applications of OR models to traffic flow and congestion, and as a graduate student at University College London I focused on modeling of transportation systems. I continued research on this topic in engineering school faculty positions at Princeton University and University College London. I knew of the traffic studies and other research at GM R & D through meetings and their publications, and was interested to gain experience of applied research in industry. I joined GM R & D, where I have had the opportunity to work in a variety of research areas, including traffic safety, logistics, inventory control, and production system design, and to see results used in practice. It always impresses me how powerful even simple mathematical models can be in providing insight into system behavior.*

Debra Elkins: *I took a lot of classes in math, computer science, physics, and chemistry, and finally realized I liked sport computing and slick mathematics applied to real world industrial problems. I ended up in Operations Research, which lets me combine my interests in probability, super computing and high performance computing, simulation, and so forth. As a graduate student in the Industrial Engineering/ Operations Research Program at Texas A&M University, I found out about working at GM R&D when I was at a technical conference. I decided to interview out of curiosity. I was really surprised and delighted with the people and the caliber of research going on within GM. My first major research project was to explore financial implications of agile machining systems for GM. While working on that project, I was poking around in risk analysis work, and connected with GM Corporate Risk Management, a group that wanted some help with probabilistic modeling of risks. Now I'm working on strategic supply chain risk analysis. I'm examining how to model the GM manufacturing enterprise, exploring the frequency and severity of business interruption events—anything that interrupts production operations—and considering strategic mitigation options that can reduce GM's risk exposure. What excites me about my research is combining ideas from different subject areas, like math, computer science, statistics, and operations research, to develop novel modeling approaches and solutions for large-scale problems.*

Jeff Alden: *I basically pursued areas that I liked, excelled in, and seemed good for a future career. Since I really enjoy problem solving, math modeling, and helping people make better decisions, I naturally migrated to Operations Research. So I was sure what I wanted to do, but not sure where to work. Well, I attended a presentation about the research opportunities at GM R &D given by Larry Burns (now a VP at GM). It seemed like an ideal place to work, so I gave him my resume and soon accepted a research position at GM R&D. For the next decade, I researched production systems looking at throughput, maintenance, leveling, stability, agility, and cost-drivers. I'm now on a two-year rotation in GM Engineering managing development of decision-support tools and methods for engineering in a variety of areas that include test-scheduling, warranty cost drivers, and work load planning.*

We wish to thank Dr. Devadatta Kulkarni at General Motors R&D Center for valuable comments and suggestions.

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Prizes and Awards at the Phoenix Joint Mathematics Meetings

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

Thomas Garrity

Thomas Garrity was one of three winners of the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics. In his acceptance, Garrity described himself as "the William Shatner of mathematics: a smidgeon of talent and a huge number of lucky breaks."

Andy Liu

Andrew Chiang-Fung Liu was one of three winners of the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics. He began his response by saying "I think I'm entitled to a rebuttal." For more on the Haimo Award winners, see the November issue of FOCUS.

Olympia Nicodemi

Olympia Nicodemi was one of three winners of the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics. In her response, Nicodemi thanked her students "who have put up with all this nonsense." She also observed that MAA President Ron Graham has (so far) failed to teach her how to juggle.

Section Certificates of Meritorious Service

Underwood Dudley

Underwood (Woody) Dudley received a Certificate of Meritorious Service from the Indiana Section of the MAA. The citation noted his many years of service to the Section and to the Association at a national level. In his response, Dudley said, "I turned in my first set of grades in December 1957 (Calculus I) and my last set in May 2003 (Calculus II). Not much progress!"

Stephen Ligh

Stephen Ligh received a Certificate of Meritorious Service from the Louisiana-Mississippi Section of the MAA. The citation noted, in particular, Ligh's work in establishing the Student Team Competition in 1988 and running it until his retirement in 1997. Ligh has also received his section's Distinguished Teaching Award.

Richard Barlow

Richard Barlow received a Certificate of Meritorious Service from the Nebraska-Southeast South Dakota Section of the MAA. The citation noted his many years of service as Section officer, chair, meeting host, and newsletter editor.

Section Certificates of Meritorious Service

Thomas A. Hern

Thomas A. Hern received a Certificate of Meritorious Service from the Ohio Section of the MAA. The citation noted his work as Section President, his work on many committees, his work on the section web site, and finally as Governor. It also pointed out that Hern was a member of an MAA Delegation to the People's Republic of China in 1983.

John W. Kenelly

John W. Kenelly received a Certificate of Meritorious Service from the Southeastern Section of the MAA. Currently the Treasurer of the Association, Kenelly has served both his Section and the MAA in many ways: as a leader in the reform of teaching and the use of technology in the classroom, as a fund raiser, and by his work as an officer and a member of many committees.

Levi L. Conant Prize

Noam Elkies

Noam Elkies received the Levi L. Conant Prize from the AMS for his two-part article "Lattices, Linear Codes, and Invariants," which appeared in the October and November 2000 issues of the *Notices of the AMS*. In his response, Elkies expressed the hope that the prize would encourage more people to actually read the article.

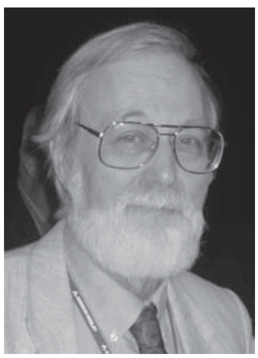
Leroy P. Steele Prize for Seminal Contribution to Research

Lawrence C. Evans

Lawrence C. Evans (pictured) and Nicolai V. Krylov (who was unable to attend) jointly received the Leroy P. Steele Prize for Seminal Contribution to Research for their work on the Evans-Krylov Theorem. The citation added that "while the Steele Prize for Seminal Research is explicitly awarded for the named works, it is noted that both recipients have made a variety of distinguished contributions to the theory of nonlinear partial differential equations."

Leroy P. Steele Prize for Mathematical Exposition

John W. Milnor



John W. Milnor was the winner of the Leroy P. Steele Prize for Mathematical Exposition, awarded by the AMS "in recognition of a lifetime of expository contributions." In his response, Milnor said that he has "always suspected that the key to the most interesting exposition is the choice of a subject that the author doesn't understand too well. I have the unfortunate difficulty that it is almost impossible for me to understand a complicated argument unless I try to write it down."

Leroy P. Steele Prize for Lifetime Achievement

Cathleen Synge Morawetz

Cathleen Synge Morawetz received the Leroy P. Steele Prize for Lifetime Achievement from the AMS. She was honored for her research on partial differential equations and applied mathematics, for offering "guidance and inspiration" to many graduate students, visitors, and post-docs, and for her leadership within the mathematics community, which included a term as president of the AMS. In her response, Morawetz thanked, among others, her high school mathematics teacher, "Buckshot" Reynolds.

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

T. Christine Stevens received the Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service for Mathematics, the highest honor offered by the MAA, to a standing ovation from NExT fellows old and new. Stevens has had a long and productive career that included many forms of service to mathematics, but it is as co-creator and director of Project NExT that she has had the most impact. In her acceptance, Stevens noted that her advisor, Andrew Gleason, had also received this award (in 1996), making them the only advisor-advisee pair to have received the award (so far!). A fuller account of Stevens' work and influence will appear in the *American Mathematical Monthly.*

T. Christine Stevens

Norbert Wiener Prize in Applied Mathematics

James A. Sethian received the Norbert Wiener Prize in Applied Mathematics, sponsored jointly by SIAM and the AMS, "for his seminal work on the computer representation of the motion of curves, surfaces, interfaces, and wave fronts, and for his brilliant applications of mathematical and computational ideas to problems in science and engineering." In his response, Sethian mentioned that his high school teacher once called him aside to point out that he was pretty good at mathematics, almost as good as the kid sitting next to him. This other kid was Eric Schmidt, currently the CEO of *Google*. He also pointed out that "there are closet mathematicians everywhere" and urged his hearers to speak to them. Indeed, the citation noted that Sethian's work is noteworthy in that it goes all the way from the formulation of a mathematical model to concrete applications in laboratory and industrial settings.

James A.Sethian

AMS Award for Distinguished Public Service

Richard A. Tapia received the AMS Award for Distinguished Public Service "for inspiring thousands of people (from elementary school students to senior citizens) to study and appreciate the mathematical sciences" and for his dedication to "opening doors for underrepresented minorities and women." In his response, Tapia noted that he often visits elementary school classrooms full of bright and interested students, and is saddened to think that a great proportion of those who are African-American or Latino will never graduate from high school. He argued that this statistic should be a call to action.

Richard A. Tapia

Louise Hay Award for Contributions to Mathematics Education

Bozenna Pasik-Duncan

Bozenna Pasik-Duncan received the Louise Hay Award for Contributions to Mathematics Education from the AWM. The award recognizes outstanding achievement in any area of mathematics education. Pasik-Duncan was honored for a wide range of education-related activities, from teaching elementary school students to working with undergraduates on research projects. She dedicated her award to those research mathematicians who teach honors introductory courses in mathematics.

E. H. Moore Research Article Prize

Mark Haiman

Mark Haiman received the E. H. Moore Research Article Prize from the AMS for his paper on "Hilbert Schemes, Polygraphs, and the Macdonald Positivity Conjecture," which appeared in the *Journal of the AMS* **14** (2001), 941–1006. The prize is for an outstanding research article appearing in one of the AMS journals over a six-year period.

Alice T. Shafer Prize for Excellence in Mathematics by an Undergraduate Woman

Kimberly Spears

Kimberly Spears received the Alice T. Shafer Prize for Excellence in Mathematics by an Undergraduate Woman from the AWM. Spears is a senior at the University of California, Santa Barbara. In addition to performing brilliantly in her classes, she has done two significant research projects: a generalization of the Quadratic Reciprocity Law to non-abelian groups and a result showing that assuming standard conjectures about the connection of zeros of zeta and L-functions to the Grand Unitary Ensemble allows one to classify discriminants *d* whose corresponding quadratic number fields have one ideal class per genus.

Oswald Veblen Prize in Geometry

David Gabai

David Gabai received the Oswald Veblen Prize in Geometry from the AMS for his work in geometric topology, in particular the topology of three-dimensional manifolds. In his response, Gabai noted that much of his work was based on and inspired by the work of former winners of a Veblen Prize, and said that "It is humbling to be the recipient of the 2004 Veblen Prize."

NSF Beat
Mentoring Through Critical Transition Points

By Sharon Cutler Ross

The transition points of a student's mathematical career have long been recognized as critical junctures and have been a topic of concern and conversation in the mathematical community. Whether from high school to college, two-year college to four-year institution, undergraduate to graduate school, or even graduate school to a post-doc fellowship or first job, each transition is known to be critical to the development practitioners in the mathematical sciences. Statistics on the loss of students at these points are well known. Other more subtle transitions need scrutiny as well; these include the move from computational courses to proof-focused courses in the undergraduate years and the change from course-taker to independent researcher in graduate school.

A previous column (September 2003) described briefly a new NSF initiative, *Mentoring through Critical Transition Points* (MCTP). The first round of MCTP proposals were reviewed in December 2003, and these give some indications about current thinking for dealing with the transitions listed above. For a variety of reasons, the step from undergraduate to graduate school seems to be the easiest on which to get a handle and generated the most proposals. Developing a program to help students through one of the other points may be more challenging. Proposals may address one or more transitions either within a single institution or in a consortium. With some funding also available from the Directorate for Education and Human Resources for MCTP projects, the area of engaging talented high school students in mathematical research and thus attracting them to major in mathematics as undergraduates is appropriate for proposals.

It should be noted that of the three segments of *Enhancing the Mathematical Sciences in the 21st Century, Vertical Integration of Research and Education* (VIGRE), *Research Training Groups* (RTG), and MCTP, only MCTP accepts proposals from four-year colleges. The NSF hopes to see more proposals in the second round as the program becomes better known. Both the Foundation and the U. S. Congress are committed to increasing the number and quality of Americans in the mathematical sciences. The deadline for new MCTP proposals is mid-September.

MCTP is intended to generate community-wide best practices in promoting successful careers in the mathematical sciences for more students, in particular for U.S. citizens, national, and permanent residents. Because relatively modest efforts have been undertaken for dealing with the critical transition points, much remains to be done. Further discussion is called for. The MAA, with NSF-funding, will host a conference in Washington, D.C., April 30–May 1, Dialogue 2004: The Division of Mathematical Sciences and the Mathematical Sciences Community. The conference will be a forum for the discussion of all three components of *Enhancing the Mathematical Sciences in the 21st Century.*

Correction

The mathematics education team at University of Michigan–Dearborn is pleased that MAA has noted our recent award of an NSF CCLI Adaptation and Implementation grant. (NSF Beat, December 2003 issue of FOCUS). There is, however, a misprint in the title of our project. It should be "A Problem and Reasoning Based Curriculum for Preservice Elementary Educators." (In the article "reasoning" has been replaced with "research.") While our work certainly is "research-based" that is not part of our title. Also, please note that our affiliation is University of Michigan–Dearborn. Thank you.

Rheta Rubenstein
Department of Mathematics
and Statistics
University of Michigan–Dearborn

Eileen Poiani Receives Several Awards

Eileen L. Poiani, Vice President for Student Affairs and Professor of Mathematics at Saint Peter's College and a longtime member of the MAA, received one of New Jersey's top honors when she was honored with the New Jersey Woman of Achievement Award by the New Jersey Federation of Women's Clubs. The presentation was made on April 6, 2003, at Drumthwacket, the New Jersey Governor's residence in Princeton. On May 3, she received the Alumnae Recognition Award for outstanding service to Douglass College, her *alma mater*. Later that same month, on May 13, the National Conference for Community and Justice (NCCJ), New Jersey Region, Hudson County Chapter, bestowed upon Dr. Poiani its Humanitarian Award. The award recognized her work with diverse groups to build harmony and respect. The year culminated with Dr. Poiani's induction into the inaugural Nutley Hall of Fame. Induction is based on an individual's extensive contributions outside of the Township of Nutley, New Jersey. She is a graduate of Nutley High School and a third generation Nutleyite.

Within the MAA, Poiani has most recently served on the Education Council. She was the founding director of the MAA's Women and Mathematics Program and served as the Governor of the New Jersey Section. She received the MAA New Jersey Section Award for Distinguished College Teaching in 1993.

Note from the Editor

Because the Joint Mathematics Meetings were held early in January, we have been able to include some material on the meetings (mainly prize winners) in this issue. Expect much more Joint Meetings coverage, including a photo spread, in the March issue.

Octagon Feedback

By Fernando Q. Gouvêa

My article "The Texas Octagon Massacre" in the December issue of FOCUS produced (as expected) many reactions. Here is a selection of what we received. My comments are in italics.

Which is the Radius?

In the article *The Texas Octagon Massacre*, the author used the term "radius" to describe the segment from the center to a vertex of a polygon. This is probably not a good idea. The definition of a radius should be a segment from the center of a regular n-gon *perpendicular* to a side of the regular n-gon. If we take a circle as the limit of a regular n-gon when n tends to infinity, this definition of the radius of a regular n-gon would extend naturally to a circle.

Fat Lam
Gallaudet University

It's a matter of convention, of course. The segment from the center to a vertex also converges to the radius of the circle, after all. I used "radius" because I was too lazy to say "radius of the circumscribed circle," which was what I meant. I think the standard name for the length of the radius of the inscribed *circle is "apothem," leaving "radius" to mean the radius of the circumscribed circle. See, for example,* http://mathworld.wolfram.com/Apothem.html.

Another Article

I also read the NASSMC Briefing and wrote an article about the Octagon problem. I thought you might be interested in reading it: http://learn.sdstate.edu/dwight_galster/Issues/TAKS8.htm

Dwight Galster
South Dakota State University

Thanks for letting me know. I thought readers of FOCUS might want to take a look at it too.

Other Methods

I got a kick out of your "massacre" article even if the story is very depressing. When I tried to work it out for myself, I came to the same conclusion that you did. Not having a calculator or tables available I got the 26.5 answer by simpler methods. I pass the idea along for your interest.

A circumscribed square will have four edges of length 4 + 4 = 8 for a perimeter of 32 so clearly the octagon has less perimeter, since it uses one side rather than two of the "ears" which are part of the square but not of the octagon. That makes the 27 answer look about right; the 18 seems too low.

A more careful analysis shows that each edge of the square consists of one octagon edge, x, and two edges, y, from the ears at the corners. We get $x + 2y = 8$ and also $x = y\sqrt{2}$, leading to $x = 8/\left(1+\sqrt{2}\right) = 3.3137\ldots$ With 8 edges the octagon has perimeter 26.5097.

I think this problem, which is clearly a "wrong problem," could be an interesting exercise for students, teaching them to be willing to question the correctness of claims that seem to lead to contradiction.

Carroll Zahn
Retired, San Diego

I read with interest your write-up in the December 2003 issue of FOCUS. You might find it interesting I too instantly got *both* answers, trying my best to take a second look at the problem as though it were a new problem!

Initially, I used the Pythagorean Theorem, did the math, and arrived at an answer of 36.3 cm. Fine: check "36 cm" and move on.

Then I looked at the problem again, and, seeing the placement of the point in the center of the regular octagon. Not being told "drawing is not to scale", it's easy to see the outer circle of radius 4.6 cm (perimeter 28.9 cm) and the inner circle of radius 4.0 cm (perimeter 25.1 cm), with the average of these two perimeters approximating the perimeter of the regular octagon equal to 27.0 cm.

Remember, the question asked for an answer "to the nearest centimeter," so it's not unreasonable to use the averaging above to approximate the answer.

Michael Round
Overland Park, KS

Missing Assumptions

There *is* an octagon with the measurements shown in the illustration for your article in FOCUS, but it's not a regular octagon. The horizontal and vertical sides have length $2\sqrt{5.16}$ cm and the diagonal sides have length $\sqrt{2}\left(4-\sqrt{5.16}\right)$ cm. Its perimeter comes to about 27.95 cm. The test taker is thus forced to round down, and select 27 cm as the answer.

George Kangas
University of Kansas

Sure. The problem, however, did specify that it was a regular *octagon (as noted in the January issue). Unfortunately, I failed to state that in my article.*

You, along with those students who got the answer wrong (by failing to select the single correct answer of 36 centimeters), fell into a trap.

You are incorrect when you state that "no octagon with those measurements exists." If the octagon is regular, there is only one. Where you (and those students who used trigonometry to "solve" the problem) went wrong was in assuming that the apex of the triangles (where the sides of lengths 4.6 cm and 4 cm meet) was the center of the octagon. Nothing in the information given (aside from a poorly drawn figure) suggests such a conclusion. In any geometry course a student is repeatedly advised to NOT draw conclusions from a diagram, but to use only the given information. (Of course, sometimes a diagram might contain the information through symbols, such as the right-angle symbol in this example.)

I take issue with your penultimate sentence also: "The truth is just that there was a wrong problem." A problem can be ambiguous (this one wasn't), or unsolvable (this one wasn't), or misleading (this one was). But the only students who fell into the trap and used trigonometry were those who made an unwarranted assumption.

Was it a good question? Of course not, unless its goal was to identify those students who would assume a fact from a diagram when that fact could easily be disproved by using the given information. But the identification of such students could be done with other much-better questions.

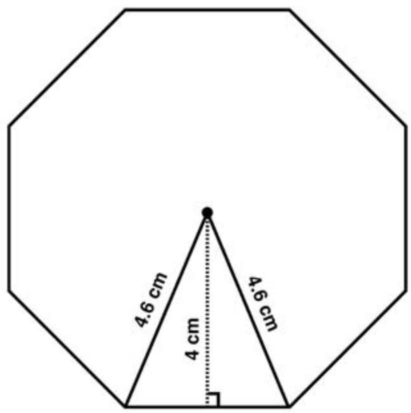
But I do agree with you that is was nonsense for the test makers to say that "there were two right answers."

Harry Baldwin
Author of *Essential Geometry*

You are certainly correct. Looking at the problem, I don't see any explicit statement that the apex of the triangle is the center. If we drop that assumption, then of course the only correct answer to the problem is 36 (but the picture is very far from being correctly drawn in that case, since the apothem of an octagon with perimeter 36 is about 5.4).

The result is a problem that will confuse the better students, unless they are really good *students. I kind of doubt that this was intended, but it's hard to tell. Of course, as you point out, this reading of the problem seems to have been missed by the test makers themselves!*

What is the perimeter to the nearest centimeter of the regular octagon drawn below?



How Often Does It Happen?

In regards to your question: "how often does this happen?" in your article "The Texas Octagon Masssacre," I note that there were 5 errors in the NYS Regents Math A Exam from June 2003. One of these errors forced the state to adjust the scores on the exam. I think [such errors are] very common. I am hoping soon to complete an analysis of all the past Math A Exams.

David W. Henderson
Cornell University

David enclosed an article analyzing the June 2003 Regents Exam. Most of the errors he finds are of the "missing assumption" kind. For example, students are given the total number of voters in an election and the votes for candidate A. They are then asked to compute the percentage of people who voted for candidate B. The missing assumption, of course, is that there was no third candidate.

I'd like to address the question with which you ended your article in the recent issue of FOCUS: "How often does this happen?" You're not going to like my answer.

Speaking as a competent math teacher (I have an M.S. in mathematics) with 18 years' experience, it is my unhappy duty to inform you that in every high-stakes multiple-choice test I have had the unpleasant job of administering there have been several — not one, several — obvious howlers of the type you noted this month.

Every year you hope that the powers that be have a reasonably howler-free test; every year you are disappointed. For peace of mind in the last couple of years I've stopped reading the tests. No matter: within a day my colleagues are talking about the latest boo-boo in the teacher's lounge.

Look, the people who write the tests are not math teachers. The people who order the tests are bureaucrats in the state Department of Education: they're not math teachers. Neither the people who write them nor the people who order them value the services of math teachers; the result is predictable.

Michael Meo
Benson Polytechnic High School
Portland Oregon

Well, if you're right then this is an unfortunate state of affairs. The question we should pose ourselves is how we can help make the tests more effective. It seems very reasonable to me that those who pay for public education should want to see whether they are getting the education they are paying for, so I don't object to testing per se.

But if the tests are going to give useful information they should be designed well, and good mathematics teachers can and should do what they can to help that happen. I don't know enough about how these tests are designed to make concrete suggestions about how that might be achieved. I am pretty *sure, however, that if we just stay on the sidelines and criticize we won't achieve all that much.*

Call for Papers
Contributed Paper Sessions at MathFest 2004

The Mathematical Association of America will hold its annual MathFest, Thursday, August 12 through Saturday, August 14, 2004 in Providence, Rhode Island.

The complete meetings program will appear in the April 2004 issue of FOCUS. This announcement is designed to alert participants about the contributed paper sessions and their deadlines. Please note that the days scheduled for these sessions remain tentative.

The organizers listed below, indicated with an (*), solicit contributed papers pertinent to their sessions. Sessions generally limit presentations to ten or fifteen minutes. Each session room contains an overhead projector and screen. Persons needing additional equipment should contact the organizer of their session as soon as possible, but prior to Tuesday, May 4, 2004.

Submission Procedures for Contributed Paper Proposals

Send the name(s) and address(es) of the author(s), and a one-page summary of your paper directly to the organizer indicated with an (*). In order to enable the organizer(s) to evaluate the appropriateness of your paper, include as much detailed information as possible within the one-page limitation.

A proposal should not be sent to more than one organizer. If your paper cannot be accommodated in the session it was submitted, it will be automatically considered for the general contributed paper session. E-mail submissions are preferred.

Your summary must reach the designated organizer by Tuesday, May 4, 2004. Early submissions are encouraged. The organizer will acknowledge receipt of all summaries. If your paper is accepted, the organizer will provide you with an e-mail template and directions on how to submit an abstract for your presentation.

Contributed Paper Sessions

MAA CP A1 Uses of the WWW that Enrich and Promote Learning
Thursday and Friday afternoons

This session seeks to highlight uses of the Web and its tools that engage students in the learning process. Tools such as course management systems, digital resources, tutorial systems, and hybrids that combine these functions on the Web can make a difference in student engagement, understanding, and performance. Talks should demonstrate how these technologies are being integrated into the learning process. The session is sponsored by WebSIGMAA and the MAA Committee on Computers in Mathematics Education (CCIME).

Roger Nelson*
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Marcelle Bessman, Jacksonville University Kirby Baker, UCLA

MAA CP B1 Extracurricular Mathematics
Thursday afternoon

Most MAA sessions are focused on different ideas and strategies to incorporate into various classes. On the other hand, some of the most creative and diverse aspects of our work with students are the ways in which we incorporate mathematics outside the classroom. This session invites presentations of mathematical activities outside of the classroom. This includes, but is not limited to, MAA student chapters' activities, field trips, activities with schools and in the general community, presentations and workshops. Submissions are encouraged not only from faculty, but also from students who have organized extracurricular mathematical activities.

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Melissa Sutherland, SUNY Geneseo

MAA CP C1 Putting Some Analysis Into Introductory Real Analysis
Thursday afternoon

Introductory Real Analysis is a required course for most mathematics majors. As such, it offers unique opportunities to generate real student interest in advanced mathematics by challenging their intuition and pushing them to think at a higher level. All too often this goal is not reached and the course ends up as one that presents the theory behind the results in first year calculus—essentially a course in epsilons and deltas. Papers submitted for this session should present approaches that generate student interest and encourage them to explore mathematics further while at the same time focusing on the key theoretical components underlying first year calculus

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MAA CP D1 Cooperative Projects Between the Mathematical Sciences and the Life Sciences
Saturday afternoon

Emerging areas in the life science are opening up new careers for biology and mathematical sciences majors. Both groups of students need preparatory undergraduate experiences. This session will consist of talks by faculty who, within the existing structures of their departments and schools, have developed such experiences with colleagues in the life sciences. The presentations will describe the type of experience, how it was initiated, how it has evolved and, most importantly, evidence of its impact on students. This session is sponsored by the Subcommittee on Mathematics Across the Curriculum.

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Bill Marion, Valparaiso University

MAA CP E1 Innovative Approaches in Mathematics Education
Thursday afternoon

This session invites papers dealing with innovations in mathematics education courses for both pre-service and in-service teachers K–12. Topics of interest might include: new courses; use of technology or web-based modules; online tools and activities; courses aligned to national or state standards; courses for master's of arts in teaching programs; relevant assessment techniques; interactions with local school districts; usefulness of such topics as history of mathematics or collaborative learning strategies; difficulties encountered in teaching math ed courses. We look forward to interesting responses and hope that discussion will enhance our future teaching.

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Carol Vobach, University of Houston-Downtown

MAA CP F1 Advances in Recreational Mathematics
Friday afternoon

There have been many recent advances in recreational mathematics, some of which have involved the use of computers. This session is designed to give you an opportunity to explain your recent work in the field. While the organizer encourages submissions that involve computers, that is not essential for consideration. For the purposes of this session, the definition of recreational mathematics will be a broad one. The primary guideline used to determine suitability of subject will be the understandability of the mathematics. For example, if the mathematics in the paper is commonly found in graduate programs, then it would generally be considered unacceptable. Supplemental computer programs can be written in any language, however they must be clean and WELL documented. Any source code used to create the paper must also be submitted for verification. Papers where existing programs such as Mathematica® were used will also be considered.

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MAA CP G1 Model Lessons from First-Year Calculus
Friday afternoon

This session will explore best practices in teaching first-year calculus. In their book, *The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom*, education researchers James W. Stigler and James Hiebert point to "lesson-study" as the driving force behind educational reform in Japan. Lesson-study is a "research-and-development system" in which teachers collaborate to design, implement, and refine mathematics lessons. The premise is that continual teaching improvement results from understanding how the daily lesson promotes student understanding and learning. This session invites presenters to contribute to the scholarship of teaching by sharing a lesson given in the last three years on a single topic from first-year calculus. Presenters should describe their student profile and address these questions: What is the topic of your lesson? What is (are) the main idea(s) behind the topic? How do you present the topic? How do students learn the topic? What are the student mistakes and confusions in learning this topic? Where do the teaching difficulties lie? How did your lesson evolve over time? How did you measure the success of this lesson in promoting student learning?

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MAA GP H1 Mathematical Modeling Modules and Materials
Saturday afternoon

Courses in mathematical modeling have grown in popularity in recent years, encompassing a diverse range of offerings. The interdisciplinary nature of modeling courses allows for the creative use of a wide range of materials ranging from writing and reading in the curriculum to innovative uses of technology. Modules, self-contained instructional lessons, have been popularized by the Consortium for Mathematics and its Applications (COMAP) and have been disseminated in several publications. This session will focus on modules and other materials that would be useful for a modeling class.

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Laurie J. Heyer, Davidson College

MAA CP I1 Theory and Applications of Graph Theory
Saturday afternoon

This session solicits papers on the teaching of undergraduate courses in graph theory as well as papers on research in the field of graph theory. Research papers should be accessible to a reasonably wide audience. Both papers in theoretical and applied graph theory are welcome. Papers on teaching should present new and innovative methods of teaching the course.

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Carol G. Crawford, United States Naval Academy
T. S. Michael, United States Naval Academy

MAA CP J1 Getting Students To Explore Concepts Through Writing In Mathematics
Friday afternoon

This session invites papers about assignments/projects that require students to write about mathematical concepts, to express concepts and to interpret symbolic mathematics in their own words, and to write about mathematics, in general. These assignments can include conceptual papers such as having the students explain a concept in their own words as an answer to a question, in the form of a letter to a friend, a poem, or even a short story, project reports that require students to explain fully all concepts used as if to someone who knows little or nothing about the mathematics used in solving the project problem, assignments that require students to express theorems in *plain English* so that one of their friends could understand, or even simple assignments that require students to explain the meaning and the use of the variables and notations that they use.

Each presenter is encouraged to discuss how the use of the assignment/project helped students to improve their understanding of course concepts and how the use of writing in the course helped students to understand and to learn mathematics. Of particular interest is the effect of such projects/assignments throughout the semester on the students' understanding of course concepts and notations, the ability of students to communicate mathematics using words and symbols, and the attitude of students toward mathematics.

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MAA CP K1 Strategies for Teaching Multiple Audiences in One Class
Saturday afternoon

Mathematics classes across the curriculum are often populated by students who have different levels of preparation, widely diverse mathematical goals, or both. Providing a meaningful and appropriate learning experience to multiple audiences simultaneously presents a unique challenge to the instructor. One example is an Abstract Algebra class with traditional graduate school bound students as well as prospective high school teachers. Another example is College Algebra whose students typically have a very wide range of preparations as well as diverse goals varying from general education credit to preparation for a long sequence of mathematics classes.

This session solicits presentations that address how multiple student audiences can be served in one class. Presentations might include: details of particular courses that have dealt with diverse student audiences, descriptions of programs targeted to meet the needs of different groups of students in the same class, or examples of tactics or approaches that can be used in a variety of mathematics classes. Presentations that include assessment of desired outcomes (whether successful or not) are strongly encouraged.

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Christopher Goff, University of the Pacific

MAA CP L1 General Contributed Paper Session
Thursday, Friday, and Saturday afternoons

This session is designed for papers that do not fit into one of the other sessions. Papers may be presented on any mathematically related topic. Papers that fit into one of the other sessions should be sent to that organizer, not to this session.

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CALL FOR STUDENT PAPERS
Students who wish to present a paper at MathFest 2004 in Providence, Rhode Island, must be nominated by a faculty advisor familiar with the work to be presented. To propose a paper for presentation, the student must complete a form and obtain the signature of a faculty sponsor.

Nomination forms for the MAA Student Paper Sessions are located on MAA Online at www.maa.org under STUDENTS, or can be obtained from Dr. Thomas Kelley (tkelley@hfcc.net) at Henry Ford Community College (313) 845-6492.

Students who make presentations at the MathFest, and who are also members of MAA Student Chapters, are eligible for partial travel reimbursement. Travel funds are limited this year so early application is encouraged. The deadline for receipt of applications is July 2, 2004.

PME student speakers must be nominated by their chapter advisors. Application forms for PME student speakers can be found on the PME web site www.pme.math.org or can be obtained from PME Secretary/Treasurer, Dr. Leo Schneider (leo@jcu.edu). Students making presentations at the Annual Meeting of PME are eligible for partial travel reimbursement. The deadline for receipt of abstracts is July 2, 2004.

Employment Opportunities

WASHINGTON, DC

TRINITY COLLEGE
Clare Boothe Luce Assistant Professor in Mathematics
Trinity College, Washington, DC is one of thirteen institutions named in Clare Boothe Luce's bequest to receive funds in perpetuity to support women in Math, Science and Engineering through scholarships and professorships. Trinity College is a comprehensive University emphasizing the education of women in its undergraduate programs. The college invites applications from outstanding women committed to teaching mathematics at the undergraduate level for a tenure-track position at the assistant professor level, beginning Fall 2004. The search for the position is restricted by the Luce Foundation to women who are U.S. citizens or U.S. permanent residents.

In addition to a competitive salary, the successful candidate will have access to discretionary funds for professional activities. Doctorate in Mathematics required. Review of applications will begin February 1, 2004 and continue until the position is filled. Send cover letter, resume, transcripts, a statement of teaching philosophy in a liberal arts setting, and three letters of recommendation to: Carole King, Trinity College, 125 Michigan Ave, NE, Washington, DC 20017; email: humanresources@trinitydc.edu; or fax to 202-884-9123. Trinity College is an EEO employer.

MONTANA

Montana State University
Mathematics – Assistant Professor. The Department of Mathematics of Montana State University-Billings invites applications for a tenure track position beginning Fall Semester 2004 (August 2004). A doctorate in the mathematical sciences is required, but ABD will be considered if the completion of a doctorate is imminent. The successful candidate will be expected to teach a wide variety of undergraduate mathematical sciences courses, pursue a research agenda, and contribute to the department and the University through service. Excellence in teaching is expected, both in the classroom and in mentoring students outside the classroom. The qualifications and ability to teach statistics or computer science as well as mathematics is desirable. Preference review given to applications received by March 1, 2004; however, the position is open until filled. Submit a Letter of Application describing teaching and research interest, Curriculum Vita, Copies of Graduate Transcripts, and Three Letters of Reference to: Search #2004-10, Human Resources, MSU-Billings, 1500 University Drive, Billings, MT 59101. Phone: (406) 657-2278; Fax: (406) 657-2120; http://www.msubillings.edu/humres. **EEO/AA/ADA.**