MathFest 2014

Prizes and Awards

MATHEMATICAL ASSOCIATION OF AMERICA

Portland, Oregon
11:30am
August 7, 2014

Program for the MAA Prize Session

Opening and Closing Remarks
Bob Devaney, President
Mathematical Association of America

Carl B. Allendoerfer Awards

The Carl B. Allendoerfer Awards, established in 1976, are made to authors of articles of expository excellence published in *Mathematics Magazine*. The Awards are named for Carl B. Allendoerfer, a distinguished mathematician at the University of Washington and President of the Mathematical Association of America, 1959-60.

Sally Cockburn and Joshua Lesperance

"Deranged Socks", *Mathematics Magazine*, Volume 86, Number 2, April 2013, pages 97-109.

How many ways can n people each choose two gloves from a pile of n distinct pairs of gloves, so that nobody gets a matching pair? In this article, authors Sally Cockburn and Joshua Lesperance consider a fun and surprisingly challenging twist on this familiar combinatorics problem, replacing gloves with socks. They ask, "How many ways can *n* people each choose two socks from a pile of n distinct pairs of socks, with no one getting a matching pair?".

The sock problem extends the glove problem by removing the crucial assumption that right- and left-handed gloves are distinguishable. In the glove problem, the matched pairs are effectively sorted in two piles: left-handed gloves in one and right-handed gloves in another, and since each person will take one left-handed and one right-handed glove, the ways to derange gloves are limited. But we do not distinguish between left and right socks, and this allows for a wider range of possibilities. As the authors illustrate, the seemingly innocuous switch from gloves to socks significantly complicates the problem.

The authors begin their discussion with counting derangements, permutations in which every object gets moved. From there, they develop solutions to the more complicated sock problem, starting with a recursive formula. Next they come up with a non-recursive solution, and as the authors develop their ideas, the reader becomes thoroughly engaged by the connections of this problem with other mathematical results. The reader is led on a lively tour of a variety of discrete mathematical tools: partitions, cyclic permutations, recurrence relations, ordinary and exponential generating functions. At the end the authors deliver a final pleasing touch: using complex analysis to show that the fraction of all sock distributions that are deranged in this sense converges to $1/e$.

Response from Sally Cockburn and Joshua Lesperance

We were honored and delighted to learn that our paper had received a Carl B. Allendoerfer Award. Truth to tell, we were honored and delighted when it was accepted for publication in such a popular and respected journal as *Mathematics Magazine*. The MAA makes an immeasurable contribution to the field through their publication of such journals as *The American Mathematical Monthly, Mathematics Magazine*, and *The College Mathematics Journal*. Special thanks also to Walter Stromquist, for his insightful and encouraging feedback throughout the publication process. Finally, we are immensely grateful to the student who first innocently suggested in class the sock variation on the glove problem. At first, we blithely assigned it as an extra credit homework assignment, but then, after nobody (including us) managed to solve it by the next class, or indeed, by the end of the semester, we realized that we had happened upon a gem of a problem.

Biographical Notes

Sally Cockburn was born and raised in Ottawa, Canada. She first fell in love with mathematics at Queen's University, where she completed a Bachelor of Science in 1982 and a Master's of Science in 1984. While at Yale University pursuing a Ph. D., her research in algebraic topology took an unexpected detour into generating functions and combinatorial identities, and she became hooked on discrete mathematics. Since joining the Mathematics Department at Hamilton College in 1991, her teaching and research specialization has been in combinatorics, graph theory and linear optimization, although she also likes to dabble in the philosophy of mathematics. Sally is an avid squash player and helped coach Hamilton's varsity squash teams for ten years. Whenever possible, she escapes to go hiking, biking, kayaking and skiing in the wilds of the Adirondacks.

Joshua Lesperance has a B.S. in applied mathematics from Rochester Institute of Technology and both a M.S. and a Ph.D. from the University of Notre Dame, where he studied algebraic geometry. He has taught mathematics at Hamilton, Oberlin, Skidmore, and Franklin & Marshall colleges. Since leaving Notre Dame, his research interests have shifted back towards his applied mathematics roots, most recently working on applications of spherical harmonics in the understanding of human perception of 3-dimensional shape. Joshua currently lives in Columbus, Ohio with his wife Karilyn and their two Siberian Huskies, Mia and Kai.

Susan Marshall and Donald Smith

"Feedback, Control, and Distribution of Prime Numbers", *Mathematics Magazine*, Volume 86, Number 3, June 2013, pages 189-203.

In this article, Susan Marshall and Donald Smith describe an unusual application of a technique of mathematical modeling, feedback and control, to a classical mystery of number theory, the distribution of primes. In a famous result due to Gauss, the density of primes is (approximately) inversely proportional to the natural logarithm. The differential equation below reasonably models the density of primes. Here f(x) represents the density of primes:

$$f'(x) = \frac{f(x)\, f(\sqrt{x})}{2x}$$

Although this is a known application in differential equation literature, it appears to be largely forgotten in number theory. In the process of deriving this model, the authors give the reader a lively introduction to the theory of feedback and control, complete with a cast of characters representing different feedback phenomena in the face of perturbations. We have the "cool, calm, and collected" responder, the "whimsical" responder, and finally the "panicky and overreacting" responder. The authors note that the distribution of prime numbers has an element of randomness, yet it also stays on track, much like a feedback and control system, with either a "whimsical" or a "cool, calm, and collected" response.

The authors demonstrate how one verifies not only that the differential equation (above) predicts the correct density function, but also that the model is robust. That is, while the true density of primes at times deviates from *1/ ln x*, they show that *1/ ln x* is the ideal path of the true density. For a "perturbed solution" to the differential equation, as *x* increases we see that *f(x)* approaches *1/ ln x*. This represents stability. The mathematics is presented as a beautifully simple (manageable) change of variables. With stability comes the conclusion that the model predicts the prime number theorem. After further computation, the authors show that Littlewood's Theorem is also predicted by the model. For a complete lesson in modeling, the authors also describe the limitations of their model; it is successful as far as gross behavior goes, but most likely fails at the fine scale, as it is incompatible with the Riemann Hypothesis. In this engrossing article, descriptions and arguments are interspersed with history, which serves to round out a satisfying tour through both prime density and mathematical modeling.

Response from Susan Marshall and Donald Smith

We are excited and grateful for the recognition of our work with a Carl B. Allendoerfer Award! Our collaboration (between a professor of Mathematics and a professor of Business) began on a Search Committee on which we both served. Upon learning that Susan's area of research is number theory, Bob (whose training is in Operations Research) shared his own passion for the subject and mentioned a differential equation he had discovered that seemed to model the density of prime numbers. The allure of this equation is that it captures the intuitive idea of self-regulation that appears to be at the heart of the distribution of prime numbers--namely that if there are ``too many" primes in an interval, there will be fewer subsequent primes (and vice-versa). This gives the system of prime numbers the appearance of a feedback and control system. After much digging around, we discovered that Bob was not the first to discover the equation and was in the company of no less than Lord Cherwell, scientific advisor to Churchill during WWII. Given the interesting history, the interplay of different fields of mathematics, and the accessibility of the topic, we felt *Mathematics Magazine* was an appropriate venue to share our story. We are indebted to Editor Walter Stromquist for championing the project through many, many revisions. Thanks also to our colleagues and our families for their support throughout the process.

Biographical Notes

Susan H. Marshall received a BS in Mathematics from Wake Forest University in 1993, with a minor in Psychology. After a brief stint as a data analyst for the Hubble Space Telescope at Goddard Space Flight Center in Maryland, she returned to school and received a PhD in Mathematics from the University of Arizona in 2001. While in graduate school, Susan studied Arithmetic Geometry. She was a postdoctoral fellow at the University of Texas at Austin from 2001-2004. She is currently an Associate Professor of Mathematics at Monmouth University, where she has just completed her 10th year. She lives on the Jersey Shore with her husband (and colleague) David, and their two children Gillian and Dylan.

Donald R. (Bob) Smith received an AB in Physics (magna cum laude) from Cornell in 1969, a MS in Operations Research from Columbia University in 1974 and a PhD in Operations Research from the University of California at Berkeley in 1975. He was an Assistant Professor of Operations Research at Columbia University from 1975-1979, before working at Bell Laboratories as a Member of Technical Staff and a Supervisor from 1980-2001. After leaving Bell Laboratories, he joined the faculty at Monmouth University where he is currently an Associate Professor in the Management and Decision Science Department. Most of his publications are in Operations Research journals in the areas of stochastic processes. Bob has always been fascinated by prime numbers because they are a deterministic system with elements of apparent randomness but hidden control. He and his wife Pat have 3 grown children and two grandchildren. He is an avid cyclist averaging over 11K miles per year.

Trevor Evans Award

The Trevor Evans Award, established by the Board of Governors in 1992 and first awarded in 1996, is made to authors of expository articles accessible to undergraduates and published in *Math Horizons*. The Award is named for Trevor Evans, a distinguished mathematician, teacher, and writer at Emory University.

Jordan Ellenberg

"The Beauty of Bounded Gaps: A Huge Discovery about Prime Numbers and What it Means for the Future of Mathematics", *Math Horizons*, Volume 21, Number 1, September 2013, pages 5-7.

In this engaging article, we learn about Yitang “Tom” Zhang’s breakthrough in proving what the mathematical community long suspected—that even though prime numbers are less common as they get larger, for any positive integer *N* there is a pair of primes bigger than *N* within a certain fixed distance *D* of each other. Jordan Ellenberg enlightens us with details of Zhang’s proof and the distribution of primes. He reveals that the bound does not represent a gravitational attraction between the primes. With jaunts into the dichotomy of structure and randomness, we too understand that “there’s infinite and then there’s *infinite.”*

Response from Jordan Ellenberg

It is a great honor to receive the Trevor Evans award from the MAA, especially since I myself grew up reading MAA publications (though not *Math Horizons* — it started too late for me!) and benefited deeply from the many articles I read there which were designed to be both mathematically rich and accessible to undergraduates. I am also grateful to *Slate*, who published an earlier version of "The Beauty of Bounded Gaps" in their own magazine. Almost uniquely among general-audience magazines, they have always been eager to run articles about advances in pure mathematics, and open to quite advanced ideas as long as they can be expressed in a widely accessible way. I thank the MAA for recognizing my work and *Math Horizons* for publishing it.

Biographical Note

Jordan Ellenberg grew up in Potomac, Maryland, the son of two statisticians. He got undergraduate (1993) and doctoral (1998) degrees at Harvard with a master's degree in creative writing in between. Since 2005 he has been at the University of Wisconsin, where he is now the Vilas Distinguished Achievement Professor of Mathematics. His research areas center on number theory and algebraic geometry, with recent excursions into algebraic topology and representation theory. He has held a Sloan Foundation Fellowship and an NSF-CAREER award and is a Fellow of the American Mathematical Society. He has also written articles for the general public for newspapers and magazines including *Slate, The New York Times, The Wall Street Journal, Wired*, and *The Believer*, and is the author of the 2014 book *How Not to Be Wrong: The Power of Mathematical Thinking*, a *New York Times* best seller.

Paul R. Halmos - Lester R. Ford Awards

The Paul R. Halmos-Lester R. Ford Awards recognize authors of articles of expository excellence published in *The American Mathematical Monthly.* The awards were established in 1964 as the Ford awards, named for Lester R. Ford, Sr., a distinguished mathematician, editor of *The American Mathematical Monthly,* 1942-1946, and President of the Mathematical Association of America, 1947-1948. In 2012, the Board of Governors designated these awards as the Paul R. Halmos-Lester R. Ford Awards to recognize the support for the awards provided by the Halmos family and to recognize Paul R. Halmos, a distinguished mathematician and editor of *The Monthly,* 1982-1986.

William Traves

"From Pascal's Theorem to *d*-Constructable Curves", *The American Mathematical Monthly*, Volume 120, Number 10, December 2013, pages 901-915.

Beginning with the history of the word *syzygy*, the author of this paper turns to Pascal's Theorem: if six distinct points *A, B, C, a, b, c* lie on a conic then the lines *Ab, Bc,* and *Ca* meet the lines *aB, bC,* and *cA* in three new *collinear* points. Pascal's Theorem leads to deep but very natural questions about *d*-constructible curves. A curve *S* of degree *t* is *d*-constructible if there exist *k = d+t* red lines and *k* blue lines so that: the red lines meet the blue lines in *k2* distinct points and *dk* of these points lie on a curve *C* of degree *d* and the remaining *tk* points lie on the curve *S*.

Traves grounds the reader firmly in the history and motivation of the problems in this area of algebraic geometry and leads us to an understanding of *d*-constructible curves and of the dimensions in which *d*-construction is dense. In a lucid and comprehensive exposition of the ideas stemming from Pappus' Theorem on line arrangements, to its generalization to 6 points on a conic by Pascal, to a converse of Pascal's Theorem by Braikenridge and Maclaurin, to Möbius's generalization of Pascal's theorem, the reader is introduced to work by Eisenbud, Green and Harris on the Cayley-Bacharach Theorem. Traves includes an introduction to projective geometry with exercises for the beginner, Bézout's Theorem and the Zariski topology. This is material that can be technical and off-putting to the uninitiated. However, Traves embeds each idea in historical contexts that highlight connections and expose the underlying structure without trivializing or glossing over difficulties.

Response from William Traves

I am deeply grateful to the prize selection committee and the Mathematical Association of America for this wonderful honor. The inspiration for the paper came from Pappus' Theorem in *The Synagogue*, a collection of mathematical gems that Pappus believed would spur mathematical research. I hope that this paper inspires others to continue to mine this rich vein of beautiful ideas.

Biographical Notes

Will Traves was born in Toronto, Canada and completed an undergraduate degree at Queen's University. He received his Ph.D. from the University of Toronto under the supervision of Karen Smith and Mark Spivakovsky, neither of whom were on the faculty at Toronto at the time. After a short post-doc at U.C. Berkeley with Bernd Sturmfels, he joined the faculty at the U.S. Naval Academy in 1999, where he is currently the chair of the Mathematics Department. Will is a brown dot Project NExT fellow and helped found Section NExT, the faculty development program of the MD/DC/VA section of the MAA. Will's mathematical interests are very broad and include pure and applied mathematics, operations research, and statistics. He enjoys games of all kinds, including chess and backgammon.

Tadashi Tokieda

“Roll Models”, *The American Mathematical Monthly,* Volume 120, Number 3, March 2013, pages 265-282.

Paul Halmos claimed that the heart of mathematics is problem solving. This article exemplifies Halmos’ thesis by presenting 19 problems---but not problems of the usual variety! “Which way will it roll? … Problem 1: Make a guess. Have you made a guess? Now try the experiment.” The author invites the reader to participate with pens and pot lids and golf balls and spools of thread as lab materials. Along the way, the reader delights in the numerous asides, such as the claim that the number 7 = 2 + 5 rarely appears in mechanics except in the context of the dimensionless moment of inertia (2/5) of a solid ball. Memorable wordings like “did they telephone each other” or “non-*Drosophila* biology” or “the time the ball takes to adjust to the shock” or “unprobable” decorate the chatty informal text. The article illustrates that applied mathematics begins with surprising phenomena that lead to surprisingly simple principles (e.g., conserved quantities) which lead to more investigations. This paper fully realizes the goals of the *Monthly*: to “inform, stimulate, challenge, enlighten, and even entertain” its readers.

Response from Tadashi Tokieda

Thank you.

Tadashi Tokieda

Biographical Note

Tadashi Tokieda is the Director of Studies in Mathematics at Trinity Hall, Cambridge. He was a painter, then a classical philologist, before becoming a mathematician (Ph.D. Princeton under W. Browder). He works mostly in geometry and macroscopic physical modeling; he also collects, invents, studies toys. Through the African Institute for Mathematical Sciences, among others, he is active in outreach. For 2013-2014 he is a Radcliffe Fellow at Harvard.

Jaques Lévy Véhel and Franklin Mendivil

"Christiane's Hair", *The American Mathematical Monthly,* Volume 120, Number 9, November 2013, pages 771-786.

Beginning with a striking visualization of stacked Cantor sets that reminded the first author of his wife Christiane's braided hair, Lévy Véhel and Mendivil guide the reader through an exploration of the geometric and measure-theoretic properties of these fractal sets. The authors describe the constructions from different perspectives, using iterated function systems as well as ternary (and more general) expansions. While the horizontal cross-sections of their constructions are Cantor sets generated from the interval *[0,1]* with continuously changing gap parameters, the vertical view consists of many smooth strands, thus producing an appearance of a woman's hair. They prove that not only is each strand a smooth curve, it is in fact real analytic. While these strands emanate from the points of *[0,1]*, their structure is more complicated—the strands can be indexed by infinite binary sequences. For instance, the point *x=1/2* has two binary representations, corresponding to two different strands that originate from *x=1/2*. The authors explore various properties of these intriguing sets, such as the area between the strands and the Hausdorff dimension of the original set and generalizations of it, in a clear and accessible manner. The article also has a wonderful mix of calculations that a calculus student can understand along with deeper analysis to satisfy an inquiring mathematical audience.

Response from Jaques Lévy Véhel

I am deeply honored to receive the Halmos-Ford award for this joint article with F. Mendivil. This work has a special significance for me: roughly twenty years ago, I met and fell in love with Christiane, who then became my wife. At approximately the same time, I became very much attracted to the topic of fractal analysis, which has since occupied most of my professional activities. I am glad that the meeting of these two parts of my life has resulted, thanks to the skills of my co-author, in an awarded article.

Response from Franklin Mendivil

It is a great honour to be recognized with this award from the MAA, especially since the MAA excels in promoting exposition in mathematical writing. We are very grateful that the MAA exists to provide this important service. It is our hope that our article will provide an entry point into a beautiful and fascinating area of mathematics.

Biographical Notes

Jacques Lévy Véhel is a Research Director at Inria, France. He studied at Ecole Polytechnique and received his Ph.D. in Applied Mathematics at Orsay University. His research interests lie in probability theory, statistics, harmonic analysis, and fractal geometry. He is also working in various applied areas, such as signal processing and financial modelling.

Franklin Mendivil is a Professor in the Department of Mathematics and Statistics at Acadia University in Nova Scotia, Canada. He started his studies by obtaining a BS in Civil Engineering but then switched to mathematics for his PhD (both at Georgia Tech). His research interests include general topology, applied probability, evolutionary optimization algorithms, and fractal geometry.

Susan Marshall and Alexander Perlis

"Heronian Tetrahedra are Lattice Tetrahedra", *The American Mathematical Monthly,* Volume 120, Number 2, February 2013, pages 140-149.

Heronian triangles are those whose side lengths and area are integer-valued. These seemingly simple objects have long been studied and written about, including a result from this journal by P. Yiu that they can be placed in the plane so the vertices have integer coordinates. In this paper by Marshall and Perlis, the authors bring Yiu's result to three-dimensions by considering Heronian tetrahedra, those tetrahedra with integer side lengths, face areas and volume. The authors begin by reviewing an alternate proof to Yiu's result by J. Fricke that represents the locations of the vertices of the triangle as complex numbers and uses the arithmetic of Gaussian integers to find a rotation that moves the vertices onto the integer lattice. Their review is organized in a straightforward manner, which then provides for a clear transition to the tetrahedron. By considering the vertices of the tetrahedron as quaternions and using various arithmetic results on Lipschitz-integral quaternions, the authors show that the previous argument can be adapted to yield the same result on the Heronian tetrahedron: that there is a rotation that moves the vertices onto the integer lattice. Especially nice are the concrete examples provided of this method to an explicit Heronian triangle and Heronian tetrahedron, letting the reader solidify his or her understanding in a very enjoyable way.

Response from Susan Marshall and Alexander Perlis

That *a triangle with integer sides and integer area can always be positioned so as to have its three corners lying at integer coordinates* seems like a classical concern, yet is a theorem by Paul Yiu from 2001! We learned of it from Susan's spouse David, and during a summer reunion visit commemorating the three of us having attended graduate school together, Susan and Alexander worked on generalizing the result. Our computer searches led us to believe a corresponding statement in three dimensions might hold, and so we looked for a proof. Where Yiu had manipulated Heron's formula for the area of a triangle, we tried to similarly manipulate a formula for the volume of a tetrahedron but were unable to replicate that method. We then discovered notes by Jan Fricke, who had a different proof of Yiu's theorem. Think of a triangle with integer sides as an arbitrary finite set of points whose mutual distances are integers. Fricke shows: if such an *integer distance set* can be positioned to have rational coordinates (which is true for the triangle when the area is an integer), then the set can be rotated to have integer coordinates. The rotation eliminates denominators, and is constructed from the prime factors of those denominators one prime p at a time in terms of a number $a+bi$ where $p=a^2+b^2$. From seeing Gaussian integers appear in Fricke's proof of Yiu's result on triangles, and from Susan's stint as a data analyst with the Hubble Telescope where three-dimensional rotations are represented as quaternions, we suspected some type of quaternionic integer might be the key to proving something similar about tetrahedra. Fortunately Gordon Pall had published results on the arithmetic of quaternions, and that provided the necessary tools to prove the three-dimensional analogue of Fricke's result: *integer distance sets in space, if rationally positioned, can be rotated onto the three-dimensional integer lattice*. Particularly satisfying was formulating the statements and proofs so that the three-dimensional ones could collapse almost word for word into the two-dimensional ones, and we had high hopes of seeing this appear in the *Monthly*. Working with editor Scott Chapman to follow the sage advice from an anonymous referee, we reworked our terse and technical submission with concrete examples and familiar language. We were quite proud of the final manuscript, and its acceptance by the *Monthly* was the icing on the cake. And now, receiving the Paul Halmos---Lester Ford award is the cherry on top, and we are grateful to the MAA for the recognition!

Biographical Notes

Susan H. Marshall received her B.S. from Wake Forest University in 1993 and her Ph.D. from The University of Arizona in 2001. She currently teaches at Monmouth University and enjoys the beaches and boardwalks of the Jersey Shore with her spouse David and their children Gillian and Dylan.

Alexander R. Perlis received his B.S. from Louisiana State University in 1992 and his Ph.D. from The University of Arizona in 2004. He is currently a systems administrator at Louisiana State University. His interests include nonprofit community bicycle education and community radio, and he enjoys going on walks and listening to Cajun music with his spouse Heather and their child Astrid.

Annie and John Selden Prize

In November 2004, the MAA Board of Governors approved the Mathematical Association of America's Annie and John Selden Prize for Research in Undergraduate Mathematics Education honoring a researcher who has established a significant record of published research in undergraduate mathematics education and who has been in the field at most ten years. The prize is designed to be an encouragement to such researchers and at most one is awarded every other year.

Matthew Inglis

Dr. Matthew Inglis completed his PhD in mathematics education in 2007. His first publication in undergraduate mathematics education was in 2005 – "La fuerza de la aserción y el poder persuasivo en la argumentación en matemáticas" – published in *Revista EMA: Investigación e Innovación en Educación Matemática.* In 2003, during his first year as a doctoral student, he published an essay – "Three Worlds and the Imaginary Sphere", in *For the Learning of Mathematics.* In the past nine years, Dr. Inglis has published an astounding number of papers (33) in peer-reviewed journals, and has an additional 2 papers in press. His publications include 3 in the *Journal for Research in Mathematics Education* and 5 in *Educational Studies in Mathematics*, widely acknowledged as the two elite journals in the discipline. Some of his other publications appear in equally prestigious general education and cognitive psychology journals.

Dr. Inglis has advanced our thinking of mathematical argumentation by integrating theories from mathematics education, psychology and philosophy. In a 2008 paper for *Educational Studies in Mathematics,* he explored the complexity of what it means to be persuaded by an argument using student interviews to illustrate how an individual's judgment on the persuasiveness of an argument depends on the context in which the question was asked, a crucial point for those investigating students' proof schemes. In three papers for the *Journal for Research in Mathematics Education* he used a method from cognitive psychology – eye-tracking – to explore how mathematics majors and mathematicians read proofs.

Dr. Inglis has notably contributed to the field by drawing on a wide range of sources for his theories and methodologies, including psychology and philosophy. Further, he is recognized for insisting on rigorously testing the hypotheses that he and others generate, and was publically recognized by the editorial team of the *Journal for Research in Mathematics Education* for his and his co-authors' conduct as a model for how the field should share data and contest data interpretations.

Response From Matthew Inglis

Given the high esteem in which I hold earlier winners, I am honoured and delighted to be awarded this year's Selden Prize. I would like to thank those colleagues who supported me during the early stages of my career, notably Adrian Simpson and Derrick Watson at Warwick, and Charles Crook and Mike Sharples at Nottingham. I am also extremely grateful to my collaborators and students in the MEC's Mathematical Cognition Group, especially Lara Alcock, Camilla Gilmore and Ian Jones, who have made Loughborough such an enjoyable place to work. Finally, I would like to offer my appreciation to the whole US-based RUME community for running such stimulating and friendly conferences, and for being so welcoming to outsiders like myself.

Biographical Note

Matthew Inglis is a Senior Lecturer and Royal Society Worshipful Company of Actuaries Research Fellow in the Mathematics Education Centre at Loughborough University in the UK. He was educated at the University of Warwick, where he was awarded a BSc, MSc and PhD. During his doctoral work he investigated undergraduate students' understanding of conditional logic, and was supervised by Eddie Gray and Adrian Simpson. After graduating, Dr Inglis took up a postdoctoral fellowship at the Learning Sciences Research Institute at the University of Nottingham, where he remains an Honorary Research Fellow. In 2008 he moved to Loughborough University, where he conducts research on a variety of topics in mathematical cognition. Dr Inglis has received a number of grants to support his work from funding bodies including the Royal Society, the Economic and Social Research Council, the Nuffield Foundation and the British Academy.

George Pólya Awards

The George Pólya Awards, established in 1976, are made to authors of articles of expository excellence published in the *College Mathematics Journal*. The Awards are named for George Pólya, who was a distinguished mathematician, well-known author, and professor at Stanford University.

Adam Parker

“Who Solved the Bernoulli Differential Equation and How Did They Do It?”, *The College Mathematics Journal*, Volume 44, Number 2, March 2013, pages 89-97.

We mathematicians are so focused on the theory and techniques of our subject that we virtually ignore its history. Even when we attach a name to a topic, such as the Bernoulli Differential Equation, the modern reader cannot be confident that it is the correct name. Adam Parker takes us on a mystery tour to seek to identify who was the first to actually solve Bernoulli’s Equation.

You might think this entails nothing more than a careful search of very old publications seeking to find the first published solution, but there is much more to the story than that. Parker transports us to the 1690s, a world very different than the one we know today. Leibnitz and the Bernoulli brothers, Jacob and Johann, relate to one another as mentors, mentees, friends, and sometimes fierce competitors. Jacob poses the equation in print as a challenge problem. All three present solutions using a variety of techniques including reduction to a linear differential equation, separation of variables, and variation of parameters. Leibnitz’s claim is described deliberately vague, apparently to hide special insights and to hold on to the competitive advantage. Does it really matter who was first? Do we want to judge who solved it best? Parker’s engaging article, like any good math article, raises more questions than it answers.

But Parker doesn't stop with reporting the early history. He observes that all the modern textbook authors follow like sheep, presenting Jacob's substitution. This solves the problem easily enough, but leaves the student to memorize a specific substitution that doesn't generalize to other problems. Is this the best pedagogy? Parker lobbies for using this problem to introduce variation of parameters. Whether you agree or not with the teaching philosophy, Adam Parker has written an article that is enjoyable to read, informative, and thought provoking.

Response from Adam Parker

I am deeply grateful to receive the Polya Award. This paper is part of an ongoing professional and pedagogical project of integrating primary sources into my teaching – a project that started at an Ohio MAA Summer Short Course presented by Danny Otero and David Pengelley in 2008. I am grateful to them for showing me how history and primary sources can enrich the classroom experience for my students and myself. I also thank my various classes and Wittenberg University for the opportunity and encouragement to try new things in my classes. I am indebted to the many people that greatly improved this manuscript. But most of all, I must thank the prize selection committee for this honor.

Biographical Note

Adam Parker received B.S. degrees in Mathematics and Psychology from the University of Michigan in 1999, followed by his Ph.D. in Algebraic Geometry from the University of Texas at Austin in 2005. For the past 9 years he has been at Wittenberg University in Springfield, Ohio. A sepia dot (2006-07 Project NExT Fellow) he has been involved in several parts of the MAA, particularly the Ohio Section. He teaches a wide range of courses and often incorporates primary sources in his teaching. In his spare time, he enjoys sports, cooking, repairing old watches and spending time with his wife, Bernadette.

Christianne Rousseau

"How Inge Lehmann Discovered the Inner Core of the Earth", *The College Mathematics Journal,* Volume 44, Number 5, November 2013, pages 399-408.

How can we determine what lies deep within the earth when we cannot travel there ourselves and cannot obtain direct measurements beyond a certain depth? As Christiane Rousseau points out, we can use our "*mathematical eyes*" to see. Her paper in the Mathematics of Planet Earth issue of *The College Mathematics Journal* provides a lesson in such mathematical sight of otherwise invisible geological features.

Rousseau starts by exploring what we can learn about the earth using just a few concepts, including Newton's gravitational law and a spherical model of earth. Quickly, she shows that assuming a homogeneous interior for this simplified earth leads to a mismatch with data on seismic waves following earthquakes. She then uses geometric and trigonometric ideas to describe refraction and reflection. These concepts become necessary when we change the model of a homogeneous earth to consider an earth with concentric layers with differing properties. At each stage of extending the model of earth's interior, Rousseau connects scientific principles, mathematical properties, and known data. Diagrams and explanations make clear how each model works, yet there remain exercises for readers who would like to try for themselves to complete some of the computations.

Interspersed with the modeling, we meet Inge Lehmann, the Danish seismologist who first determined that the earth's core had more than one layer. Lehmann lived and worked in Denmark. As a child, she experienced an education that saw girls as equal to boys, yet when she was an adult, her workplace did not credit the ideas of women as readily as those of men. Lehmann used modeling similar to that described by Rousseau to support her claim of the earth's inner core. Her claim directly contradicted the conventional wisdom of the time, that the earth's core was entirely liquid, and took a few years to gain acceptance.

This article combines history, the thrill of discovery, and explication of how to build a meaningful model from basic principles. It engages the reader and epitomizes the theme of Mathematics of Planet Earth.

Response from Christianne Rousseau

I would like to thank the MAA for receiving this prize: this is a great honor for me! One of my greatest pleasures when working for MPE2013 has been to learn new applications of mathematics on an almost daily basis, and to share many of them through the MPE2013 blog and by writing this article. I have been fascinated by the way Inge Lehmann has untangled quite complicated, incomplete, and sometimes not very accurate data to produce her toy model. I am happy to share this fascination with other mathematicians.

Biographical Note

Christiane Rousseau studied at University of Montreal where she got her PhD in 1977. After postdoctoral studies at McGill she came back to University of Montreal where she became professor. She was Chair of her department from 1993 to1997. During her whole career, she led in parallel research activities and outreach activities: lectures in the schools, organization of mathematical camps, and articles in mathematical magazines. She has specialized her teaching to future high school teachers. From 2002 to 2004, she was President of the Canadian Mathematical Society and she organized a Canada School Mathematics Forum in 2003. She is a fellow of the American Mathematical Society. Since 2011, she is Vice-president of the International Mathematical Union. When she was Director of Centre de Recherches Mathématiques in 2009, she initiated and coordinated the initiative "Mathematics of Planet Earth 2013" (MPE2013), which became an international year under the patronage of UNESCO.

The 74th William Lowell Putnam Mathematical Competition
December, 2013

The William Lowell Putnam Mathematical Competition is an annual contest of the Mathematical Association of America for college students established in 1938 in memory of its namesake. Each year on the first Saturday in December, over 2000 students spend six hours (in two sittings) trying to solve twelve problems.

The Five Highest Ranking Individuals

1. Mitchell M. Lee, *Massachusetts Institute of Technology*
2. Zipei Nie, *Massachusetts Institute of Technology*
3. Evan M. O'Dorney, *Harvard University*
4. Bobby C. Shen, *Massachusetts Institute of Technology*
5. David H. Yang, *Massachusetts Institute of Technology*

Team Winners

1. Massachusetts Institute of Technology
   Benjamin P. Gunby, Mitchell M. Lee, and Zipei Nie
2. Carnegie Mellon University
   Michael Druggan, Linus U. Hamilton, and Thomas E. Swayze
3. Stanford University
   Vishal Arul, Ravi Fernando, and Sam G. Keller
4. Harvard University
   Octav I Dragoi, Evan M. O'Dorney, and Allen Yuan
5. California Institute of Technology
   Xiangyi Huang, Zhaorong Jim, and Tian Nie

The ***Elizabeth Lowell Putnam Prize***, established in 1992, is awarded periodically to a woman whose performance on the Putnam Exam is deemed particularly meritorious. The prize this year goes to:

Xiao Wu, *Yale University*

The United States of America Mathematical Olympiad

The USAMO (United States of America Mathematics Olympiad) provides a means of identifying and encouraging the most creative secondary mathematics students in the country. It serves to indicate the talent of those who may become leaders in the mathematical sciences of the next generation. The USAMO is part of a worldwide system of national mathematics competitions, a movement in which both educators and research mathematicians are engaged in recognizing and celebrating the imagination and resourcefulness of our youth. The USAMO is a six-question, two-day, nine-hour essay/proof examination. This year it was held June 2, 2014.

Winners (in alphabetical order)

- Joshua Brakensiek, Home School (Arizona College Prep-Erie), AZ
- Evan Chen, Irvington High School, CA
- Ravi Jagadeesan, Phillips Exeter Academy, NH
- Allen Liu, Penfield Senior High School, NY
- Nipun Pitimanaaree, Pomfret School, CT
- Mark Selke, William Harrison High School, IN
- Zhou Qun (Alex) Song, Phillips Exeter Academy, NH
- David Stoner, South Aiken High School, SC
- Kevin Sun, Phillips Exeter Academy, NH
- James Tao, Illinois Math & Science Academy, TX
- Alexander Whatley, North Houston Academy of Science & Math, TX
- Scott Wu, Baton Rouge Magnet High School, LA

Henry L. Alder Awards for Distinguished Teaching by a Beginning College or University Mathematics Faculty Member

The Alder awards were established in January 2003 to honor beginning college or university faculty whose teaching has been extraordinarily successful and whose effectiveness in teaching undergraduate mathematics is shown to have influence beyond their own classrooms. An awardee must 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 the Ph.D. Henry Alder was MAA President in 1977 and 1978 and served as MAA Secretary from 1960 to 1974.

Dominic Klyve

Dominic Klyve is a teacher who inspires a lasting love of mathematics in his students, by continuously connecting his lecture topics to interesting bits of history, art, and science. He created a Math 101 class for music majors that studied regression and correlation using published research on the lengths of sections in Mozart's sonata-allegro forms. His enthusiasm for mathematics is infectious, even among those who have self-identified as finding mathematics either terrifying or boring. Dr. Klyve is also talented at guiding undergraduate student research and pioneered a one-week “speed research” summer program that has had remarkable success. He has co-authored a number of papers with his undergraduate students, and has helped several of his mentees to pursue their graduate studies. Dr. Klyve makes an impact in his community as well by teaching Upward Bound courses for underrepresented teenagers and by incorporating community needs as service learning opportunities. For example, he structured a statistical concepts and methods course around analyzing a dataset about food insecurity for the local County

Board of Public Health. Dr. Klyve serves as a counselor on the Council on Undergraduate Research, and he is responsible for the proposed Special Interest Group of the MAA on undergraduate research. He influences the scholarship of teaching and learning by publishing pedagogical research on quantitative reasoning drawn directly from his classroom experiences.

Response from Dominic Klyve

Wow – thanks!

I have been guided by so many people in my professional journey that I can't possibly thank everyone that I should. I am grateful to my wife, Allyson, and my children, Liam and Emery, for all their love and support. I am thankful for my mentors at Dartmouth College – notably Marcia Groszek, Ken Bogart, and Carl Pomerance, who spent so much time helping me learn to teach and to write effectively.

I work every day at a special university, in a department which in both word and practice values teaching as a faculty member's most important job. They have taught me a great deal about both the practice and scholarship of teaching. I am rewarded every day by the students who surely give me more than I can give them. Their energy, enthusiasm, and efforts in the realm of learning mathematics revitalize me every time I step into the classroom, and serve as a regular reward for this important job.

The MAA is a wonderful organization, and I am proud that this award increases my connection with its ongoing work of advancing mathematics and education.

Biographical Note

Dominic Klyve teaches at Central Washington University, where he founded and directs the Math Honors Program, a program designed to introduce students to advanced mathematical ideas and promote undergraduate research. He received his Ph.D. from Dartmouth College in 2007 under the direction of Carl Pomerance. While in graduate school, he co-founded (with Lee Stemkoski) the Euler Archive, now housed at the MAA. Both number theory and the history of mathematics continue to play an important role in his research, teaching, and work with students. He is a popular speaker, and has been invited to speak about Euler's life and work around the country. He recently taught a five-week course on Euler's mathematics at the University of Canterbury, New Zealand.

Klyve has been involved with the MAA in many ways; he serves as the Undergraduate Program Coordinator for the Pacific-Northwest Section, and has served on the Basic Library List Committee. He currently sits on the editorial boards of the *College Math Journal* and the *Spectrum* book series.

Lara Pudwell

Lara Pudwell is cited as the faculty member with the leading performance in teaching at all levels, the most prolific faculty member publishing undergraduate research with student co-authors, and the faculty member with the most contact and impact on student learning outside of class at Valparaiso University. Her students describe her as one of the most approachable, effective, patient, inspiring, engaging, and amazing teachers they have ever had. One of her colleagues describes her as "wonderful in her effectiveness, organization, ability to motivate, and in her concern for students." She has made a significant impact within her department, as many of her colleagues have adopted her creative "homework check" quizzes, and also at the university-level, as the *Experimental Mathematics* course she designed has been added to the official university catalog. Dr. Pudwell has led many undergraduate research projects with Valparaiso students, and her students have regularly presented their work at the Valparaiso Celebration of Undergraduate Scholarship, the Indiana Section MAA meeting, and the Joint Mathematics Meetings. Students in her summer REU programs have published their work in significant peer-reviewed journals, and Dr. Pudwell was one of three national recipients of the 2013

Faculty Mentoring Award from the Mathematics and Computer Science Division of the Council on Undergraduate Research. In addition, Dr. Pudwell mentors for *Discoveries Unlimited,* encouraging middle school girls to pursue interest in STEM fields.

Response From Lara Pudwell

Over the past decade the Alder award has celebrated the teaching of many exceptional faculty I admire, and I am humbled to be added to the list of recipients. I know my teaching has been strengthened by having wonderful teaching role models (Nancy Gates at White Station High School in Memphis, TN; Stephen Greenfield and Doron Zeilberger at Rutgers University, to name a few). I have learned a great deal through dialogue with outstanding colleagues at Valparaiso University, in Project NExT, and more. I am also fortunate to work with inquisitive and hard-working students, who make my job a joy from day to day. Finally, I am thankful to my friends and to my parents, Rick and Kris, and my brother Ryan for their constant support.

Biographical Note

Lara Pudwell received her Ph.D. in mathematics from Rutgers University in 2008. That same year, she joined the Department of Mathematics and Computer Science at her undergraduate alma mater, Valparaiso University, where she is now an Associate Professor. Pudwell is a Dolciani Red08 Project NExT fellow and served as chair of Indiana Section NExT for 2012-2014. She is passionate about undergraduate research, serving as a 2014-2017 CUR Councilor, and as co-PI for the 2010-2015 NSF-funded Valparaiso Research Experience for Undergraduates summer program. In her 6 years at Valparaiso she has mentored 9 teams of undergraduate students on various research projects. To date, she has published 19 papers, 4 with undergraduate coauthors, and she has used her research in enumerative combinatorics to infuse her teaching with interesting applications and open problems, especially in the Experimental Mathematics course she developed at Valparaiso. She is also a member of the steering committee for the International Conference on Permutation Patterns.

Mary P. Dolciani Award

The Mary P. Dolciani Award recognizes a pure or applied mathematician who is making a distinguished contribution to the mathematical education of K-16 students in the United States or Canada. The award is named for Mary P. Dolciani Halloran (1923-1985), a gifted mathematician, educator, and author, who devoted her life to developing excellence in mathematics education. A leading author in the field of mathematical textbooks at the college and secondary school levels, she published under her professional name Dr. Mary P. Dolciani. This award is made possible by a gift from the Mary P. Dolciani Halloran Foundation.

Alan Schoenfeld

The 2014 Mary P. Dolciani Award is presented to Alan H. Schoenfeld, the Elizabeth and Edward Conner Professor of Education and Affiliated Professor of Mathematics at the University of California at Berkeley, for his extensive and extraordinary work in mathematics education.

After an early career as a research mathematician, Professor Schoenfeld began thinking critically and deeply about how mathematics is actually done, how it is learned, and how it might best be taught. His early work on mathematical problem solving is fundamental to our current understanding of what it means to think mathematically. A focus on students doing "real mathematics" and in developing in both students and teachers patterns of productive mathematical thought has been central to his research. His continuing work over the past 30 years has moved that early research forward by developing ground-breaking theory and connecting that theory to actual classroom daily practice. Throughout his career, Professor Schoenfeld's research has drawn together the rich and distinct perspectives of mathematics and education in ways that have deepened and enriched our understanding and improved our practice.

Professor Schoenfeld has, quite literally, changed the conversation in mathematics education, where discussions of meta-cognition and self-regulation, of heuristics and mathematical practices, of goals and beliefs, are now common. Many of these concepts were introduced and others expanded upon by Professor Schoenfeld, most notably in his books *Mathematical Problem Solving* (1985) and *How We Think* (2010), in the volumes he edited, and his often-cited paper in the 1992 Handbook for Research on Mathematics Teaching and Learning, *Learning to Think Mathematically: Problem Solving, Metacognition, and Sense-Making in Mathematics*. His insights through more than 30 years of exemplary research have had real and lasting effects on research methodology, teacher education, mathematics curriculum and the assessment of mathematical understandings.

In 2011, Professor Schoenfeld was awarded the Felix Klein Medal by the International Commission on Mathematical Instruction (ICMI) for his "outstanding lifetime achievements in mathematics education research and development." As was noted at that time, "His work is internationally acclaimed across disciplines with more than 200 highly-cited publications in mathematics education, mathematics, educational research, and educational psychology. His scholarship is of the highest quality, reflected in esteemed recognition from mathematical, scientific, teaching, and educational organizations over the years."

Response From Alan Schoenfeld

I am most grateful for the existence of the Mary P. Dolciani award, which celebrates the contributions of mathematicians to K-16 mathematics education, and to the nominators and selection panel for my having been nominated and chosen to receive it. Over the course of my career it has been a great privilege to work with numerous mathematicians and mathematics educators in trying to enrich the mathematical lives of students at all grade levels. I feel deeply honored and grateful.

Biographical Note

Alan Schoenfeld is the Elizabeth and Edward Conner Professor of Education and Affiliated Professor of Mathematics at the University of California at Berkeley. He is a Fellow of AAAS and AERA, and a Laureate of the education honor society Kappa Delta Pi; he has served as President of AERA and vice President of the National Academy of Education. Schoenfeld has received ICMI's Klein Medal and AERA's Distinguished Contributions to Research in Education award.

Early in his mathematical career Schoenfeld read George Pólya's *How to Solve it*, which motivated him to explore issues of mathematical thinking, teaching, and learning; that has kept him busy ever since. He has served on a range of AMS, MAA, NCTM, and AERA committees, with the goal of helping to bring together the extended mathematical and educational communities in the quest to provide enriched mathematical instruction for all students.

Index of Award Recipients

(Alphabetically)