



# MathFest

## 2005

MAA  PI MU EPSILON

Student Paper Sessions

August 4-6, 2005

**PI MU EPSILON**

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Fairfield University

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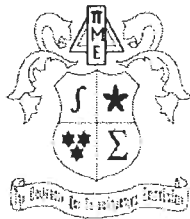
Robert Smith, *ex officio*  
Miami University

James Tattersall, *ex officio*  
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## MAA Student Chapters

The MAA Student Chapters program was launched in January 1989 to encourage students to continue study in the mathematical sciences, provide opportunities to meet with other students interested in mathematics at national meetings, and provide career information in the mathematical sciences. The primary criterion for membership in an MAA Student Chapter is "interest in the mathematical sciences." Thus, the Student Chapter program supplements, but does not compete with, the chapters of Pi Mu Epsilon. Currently there are approximately 225 active Student Chapters on college and university campuses nationwide. Students are also members of the MAA Sections in their geographic region. Many of the MAA Sections provide special activities for students at their regularly scheduled meetings.



## Pi Mu Epsilon

Pi Mu Epsilon is a National Mathematics Honor Society with over 300 chapters throughout the nation. Established in 1914, Pi Mu Epsilon is a non-secret organization whose purpose is the promotion of scholarly activity in mathematics among students in academic institutions and among staffs of qualified non-academic institutions. It seeks to do this by electing members on an honorary basis according to their proficiency in mathematics, and by engaging in activities designed to provide for the mathematical and scholarly development of its members. Pi Mu Epsilon regularly engages students in scholarly activity through its *Journal*, which has published student and faculty articles since 1949. In addition, the society awards monetary prizes for mathematics contests and awards established by chapters. Since 1952, Pi Mu Epsilon has been holding its annual National Meeting in conjunction with the summer meetings of the Mathematical Association of America.

## Schedule of Student Activities

Except where noted, events are in the Albuquerque Convention Center

### Wednesday, August 3

5:30 pm - 6:30 pm MAA/PME Student Reception Fiesta 1, Hyatt Hotel

### Thursday, August 4

8:00 am - 11:30 am PME Council Meeting Fiesta 1, Hyatt Hotel  
9:00 am - 5:00 pm Student Hospitality Center Ballroom A  
1:00 pm - 2:57 pm MAA Session #1 Taos Room  
1:00 pm - 2:35 pm PME Session #1 Picuris Room  
1:00 pm - 2:57 pm MAA Session #2 Cochiti Room  
1:00 pm - 2:35 pm PME Session #2 Santa Ana Room  
3:00 pm - 5:35 pm MAA Session #3 Taos Room  
3:00 pm - 4:35 pm PME Session #3 Picuris Room  
3:00 pm - 5:15 pm MAA Session #4 Cochiti Room  
3:00 pm - 4:35 pm PME Session #4 Santa Ana Room  
5:00 pm - 5:45 pm MAA Special Session on *Math Horizons* Picuris/Santa Ana Rooms

### Friday, August 5

9:00 am - 5:00 pm Student Hospitality Center Ballroom A  
1:00 pm - 2:57 pm MAA Session #5 Taos Room  
1:00 pm - 2:15 pm PME Session #5 Picuris Room  
1:00 pm - 2:55 pm MAA Session #6 Cochiti Room  
1:00 pm - 2:15 pm PME Session #6 Santa Ana Room  
3:00 pm - 4:57 pm MAA Session #7 Taos Room  
3:00 pm - 4:57 pm MAA Session #8 Cochiti Room  
3:00 pm - 4:55 pm MAA Session #9 Picuris Room  
3:00 pm - 4:55 pm MAA Session #10 Santa Ana Room  
6:00 pm - 7:45 pm PME Banquet Grand Pavilion, Hyatt Hotel  
8:00 pm - 9:00 pm J. Sutherland Frame Lecture Grand Pavilion, Hyatt Hotel

### Saturday, August 6

9:00 am - 2:00 pm Student Hospitality Center Ballroom A  
1:00 pm - 2:50 pm MAA Student Workshop Brazos Room  
3:00 pm - 3:50 pm MAA Student Lecture Brazos Room  
4:00 pm - 5:00 pm Student Problem Solving Competition Brazos Room  
5:00 pm - 6:15 pm MAA Modeling Contest Winners Brazos Room

8:00 - 9:00 PM

Friday August 5, 2005

Grand Pavilion, Hyatt Hotel

## **J. Sutherland Frame Lecture**

### **PROOFS THAT REALLY COUNT THE ART OF COMBINATORIAL PROOF**

**Arthur T. Benjamin**  
Harvey Mudd College

Mathematics is the science of patterns, and mathematicians attempt to understand these patterns and discover new ones using various tools. In this talk, we demonstrate that many number patterns, even very complex ones, can be understood by simple counting arguments. You will enjoy the magic of Fibonacci numbers, Lucas numbers, continued fractions, and more. You can count on it! This talk is based on research with Professor Jennifer Quinn and many, many undergraduates.

*The J. Sutherland Frame Lecture is named in honor of the ninth President of Pi Mu Epsilon, who served from 1957 to 1966 and passed away on February 27, 1997. In 1952, Sud Frame initiated the student paper sessions at the annual Pi Mu Epsilon meeting, which is held at the Summer Mathfests. He continually offered insight and inspiration to student mathematicians at these summer meetings.*

**3:00 - 3:50 PM**

**Saturday August 6, 2005**

**Brazos Room**

## **MAA Student Lecture**

### **LIGHTS, CAMERA, FREEZE!**

**Annalisa Crannell**

Franklin & Marshall College

**Marc Frantz**

Indiana University

Director/Producer Stephen "Marc" Frantzberg teams up with the world-famous actress Annalisa Monalisa Cranberry to bring you the new blockbuster hit, Projection. Spanning the centuries between Renaissance perspective painting and modern cinematic special effects, Projection reveals the true secrets behind projecting a 3-dimensional world onto a 2-dimensional canvas (or movie screen). You'll laugh; you'll yawn; you'll cry; you'll reach the vanishing point. The movie includes a cast of thousands (or dozens, depending on how many people are in the audience).

## MAA Student Speakers

Name	School	MAA Session
Asela Acosta	Texas A&M International University	1
Ashley Askew	Clayton State University	2
Kari Barkley	Lafayette College	6
Jessica Bauman	Tufts University	10
Lisa Bishop	Occidental College	4
Jenny Buontempo	St. Peter's College	9
Nicole Casacchia	Youngstown State University	5
John Chatlos	Williams College	7
Carlos Chiquete	University of Arizona	1
Anh Chu	University of Richmond	6
Kimberly Conner	Mercer University	9
Alan Covert	Arizona State University	1
Nicholas Croll	Sam Houston State University	8
Amber De More	Austin Peay State University	2
Elizabeth Eisemann	Augustana College	5
Carl Erickson	Stanford University	4
Sarah Fritsch	Sam Houston State University	9
Justin From	Central College	10
Go Fujita	University of Florida	8
Jesse Gell-Redman	Columbia University	10
John Gemmer	Millersville University of Pennsylvania	2
Ben Gibson	Wake Forest University	2
James Godzik	University of California, Berkeley	7
Sarah Goodpaster	Augustana College	8
Ryan Grady	Colorado School of Mines	6
Andrew Harrell	Texas A&M University	2
Nicholas Johnson	Augustana College	7
Nathan Kaplan	Princeton University	4
Thomas Kindred	Williams College	6
Joesph Kolenick	Youngstown State University	8
Samuel Kolins	Bowdoin College	7
Ross Kravitz	Williams College	1
Marion Kruse	University of Richmond	6

### MAA Student Speakers (Continued)

Name	School	MAA Session
Sean Lee	Pepperdine University	4
Beverly Lytle	Allegheny College	3
Tim Major	Grand Valley State University	3
Melissa Mauck	Sam Houston State University	8
Neil Mendoza	Williams College	4
Benjamin Mitchell	Taos High School	9
Ludguier Montejo	Whitman College	3
Lorena Morales-Paredes	University of Alabama in Huntsville	1
Craig Nicholas	New Mexico Tech	8
Nicole O'Connell	St. Norbert College	5
Nnamdi Oparanozie	Sam Houston State University	8
Samuel Otten	Grand Valley State University	4
Azra Panjwani	University of California, Berkeley	3
Ammon Paquette	Augustana College	3
Mauricio Rivas	Sam Houston State University	9
Siva Sankrithi	University of Washington	5
Mary Servatius	Worcester Polytechnic Institute	3
Todd Shayler	Williams College	4
Brian Simanek	Williams College	7
Chris Smith	Grand Valley State University	9
Nicholas Stucky-Mack	Harvard College	2
Sean Sullivan	University of Texas at Austin	2
Nicholas Toombs	Montclair State University	5
Genevieve-Yvonne Toutain	Simon's Rock College of Bard	1
Timothy Trujillo	New Mexico Institute of Mining and Technology	10
Vladimir Ufimtsev	University of Nebraska at Omaha	3
Daniel Walton	Harvey Mudd College	5
Nathaniel Watson	Washington University in St. Louis	7
Lindsey Webster	Western Oregon University	10
Debbie Witczak	Benedictine University	6
Sherry Wu	Cornell University	7
Nicholas Yates	Williams College	10
Haiyun Zhao	Stevens Institute of Technology	1
Alexander Zupan	Gustavus Adolphus College	3



## Pi Mu Epsilon Delegates

### Speakers

<b>Name</b>	<b>School</b>	<b>Chapter</b>	<b>PME Session</b>
Julian Apelete Allagan	Troy University	AL Eta	3
Chantel C. Blackburn	Andrews University	MI Gamma	3
Dakota Blair	Texas A&M University	TX Eta	1
Jason Brinker	St. Norbert College	WI Delta	1
Angela Brown	Sam Houston State University	TX Epsilon	6
Jennifer L. Carmichael	Western Oregon University	OR Delta	3
Christopher Cicotta	Clarkson University	NY Omicron	6
Tom Cochran	Youngstown State University	OH Xi	2
Stephanie Deacon	University of Texas at San Antonio	TX Omicron	5
Patrick Dixon	Occidental College	CA Theta	4
David Gohlke	Youngstown State University	OH Xi	2
Jeff Goldsmith	Dickinson College	PA Rho	3
Angela Hicks	Furman University	SC Delta	4
Amanda Hoffman	Sam Houston State University	TX Epsilon	4
Alaina Houmard	Mount Union College	OH Omicron	5
Colleen Hughes	Denison University	OH Iota	1
Aubrey Komorowski	Duquesne University	PA Upsilon	2
Mark Lane	Sam Houston State University	TX Epsilon	1
David Martin	Youngstown State University	OH Xi	2
Andrew Matteson	Texas A&M University	TX Eta	4
Tina Smith Mote	McNeese State University	LA Epsilon	3
Phuong Minh Thi Nguyen	Occidental College	CA Theta	6
Maria Salcedo	Youngstown State University	OH Xi	5
Ted Stadnik	Youngstown State University	OH Xi	5
Jennifer Swank	Denison University	OH Iota	2
Carrie Swauger	Duquesne University	PA Upsilon	4
Elizabeth Ann Tiedeman	Duquesne University	PA Upsilon	6
Jackie Van Ryzin	St. Norbert College	WI Delta	1

### Additional Delegates

<b>Name</b>	<b>School</b>	<b>Chapter</b>
Michele J. Kneale	University of Akron	OH Nu
Doyle G. LaCroix, Jr.	Southeastern Louisiana University	LA Delta
Dillon McTernan	Southeastern Louisiana University	LA Delta
Darshit J. Patel	University of South Florida	FL Epsilon
William Paul	University of North Carolina at Charlotte	NC Theta
Margaret Smoot	Texas A&M University	TX Eta

Thursday

Pi Mu Epsilon Session #1

August 4, 2005

Picuris Room

1:00 PM – 2:35 PM

1:00–1:15

**An Introduction to Franklin Squares**

Mark Lane

*Sam Houston State University, Texas Epsilon*

This talk will give an introduction to Franklin Squares. We will determine algebraic relationships that exist among the properties that define a Franklin Square. Finally, we will describe all known symmetry operations on Franklin Squares.

1:20–1:35

**Impossible Paths in Langton's Ant**

Dakota Blair

*Texas A&M University, Texas Eta*

A new characterization of a path (as a word) provides insight into the study of paths produced by many ant-like automata. Impossible words and the construction of a possibility testing algorithm are presented. Additionally, for possible words, this algorithm provides the conditions required for the ant to produce this path.

1:40–1:55

**A New Approach to Multiple Bubble Problems**

Colleen Hughes

*Denison University, Ohio Iota*

It has long been known that a circular fence is the most efficient enclosure of a single quantity of area, and that a spherical bubble has the least surface area among all shapes of a given volume. In the early 1990's, proofs were developed for double or triple bubbles in the plane, three-space, and in other spaces. Here we present research from our REU group which extends this work on multiple bubble problems.

2:00–2:15

**Let Me Do a Little Number**

Jason Brinker

*St. Norbert College, Wisconsin Delta*

The interconnectedness of mathematics and music has long been discussed by professionals in both fields. In the analysis and composition of music, mathematics is used constantly. In fact, in the 20th century, musical set theory and the Twelve-Tone movement utilized mathematics as a foundation. We will examine these two movements as well as discuss a method of composition developed by the speaker himself.

2:20–2:35

**Sumthing Special: The  $n$  Festivals of Whatever**

Jackie Van Ryzin

*St. Norbert College, Wisconsin Delta*

We're all familiar with the song about the Twelve Days of Christmas. We will discuss some efficient ways of determining the total number of gifts given and then generalize to a much wider variety of festive occasions and levels of festivities.

Taos Room

1:00 PM – 2:57 PM

1:00–1:15

**Diophantine Approximation of Real Elements on the Number Line**

Ross Kravitz  
*Williams College*

We start with Dirichlet's Theorem from 1842, the cornerstone of classical Diophantine approximation. From there, we will use the notion of an irrational number's continued fraction expansion to discuss sequences of best approximates and badly approximated numbers. We conclude with new questions involving generalizations of Diophantine analysis to real curves in the plane.

1:17–1:32

**An Epidemic Model of HSV-1 with Vaccination**

Asela Acosta  
*Texas A&M International University*

Recent developments of HSV-1 vaccination on mice motivate this study on the potential impact of a vaccine to control the disease in humans. Recent findings lead one to believe that such a vaccine may become available in the next couple of years. A deterministic epidemiological model of HSV-1 with vaccination will be discussed, along with the stability analysis of the equilibrium states, and the computation of the basic reproductive number.

1:34–1:49

**The Dynamics of Poverty and Crime**

Haiyun Zhao  
*Stevens Institute of Technology*

Poverty and crime are two maladies that plague metropolitan areas. The economic theory of crime (Becker, 1968) demonstrates a direct correlation between poverty and crime. The model seeks to examine the dynamics of the poverty-crime system through stability analysis of a system of Ordinary Differential Equations in order to identify cost-effective strategies to combat crime in metropolises.

1:51–2:06

**Immigration and Policy Change as a Dynamic Model**

Genevieve-Yvonne Toutain  
*Simon's Rock College of Bard*

For the past two centuries, people have emigrated from Mexico to the United States for various reasons. In recent years, changes in the United States immigration policy have drastically altered the flow of people over the border between the United States and Mexico. Modeling this phenomenon as an adapted epidemic model, we explore the dynamics of the Mexican demographic in the United States.

2:08–2:23

**Epidemiology and Evolution of the Influenza Virus**

Lorena Morales-Paredes

*University of Alabama in Huntsville*

The decay of post infection immunity to influenza is known to include mutation of the virus and immune system memory loss, though little has been done to characterize this relationship. We examine dynamical systems at two scales: cellular level interactions between host immune pressures and viral mutations as well as the spread of the mutated strains among heterogeneous susceptible populations. This analysis facilitates understanding of viral evolution and proliferation.

2:25–2:40

**Dispersal and Connectivity in a Stochastic Multi-City Epidemic Model**

Alan Covert

*Arizona State University*

We consider the behavior of moderately infectious and lethal diseases such as SARS over a system of networked cities with SLIR dynamics. We include a disease-induced death rate and stochastic effects on intercity dispersal rates. We compute  $R_0$  for a theoretical system, and study system response to dispersal volumes and number of connections between cities.

2:42–2:57

**Disease Spread as a Function of Population Density**

Carlos Chiquete

*University of Arizona*

Spatial population distributions are key to the spread of many animal diseases. We present a study of human epidemic dynamics as a function of differing spatial population densities and variable contact rates. An epidemic outbreak is applied to both small and comparatively large populations such as New York City and its surrounding communities. Dynamical systems modeling the two scenarios are analyzed qualitatively through numerical methods and computer simulations.

Santa Ana Room

1:00 PM – 2:35 PM

1:00–1:15

**Math with Muscle**

Tom Cochran

*Youngstown State University, Ohio Xi*

Smooth muscles are found throughout our bodies and are extremely important in regulating blood flow in arteries and veins. This talk will touch upon some of the mathematics dealing with the relaxation of smooth muscles. The data was collected during a bio-mathematics summer research program, sponsored by the National Science Foundation, at Youngstown State University.

1:20–1:35

**Modeling Bacterial Growth in the Presence of Toxins**

David Gohlke

*Youngstown State University, Ohio Xi*

Environmental factors such as the amount of available nutrients or the presence of toxins play a large role in bacterial growth. Some strains of bacteria have the ability to survive in environments in which other strains would not. This presentation will focus on modeling growth curves of bacteria in different situations, with the intent of finding accurate mathematical models. This research was undertaken in the NSF-SURE program at Youngstown State University.

1:40–1:55

**An Alternate Demonstration of Euler's Formula**

David Martin

*Youngstown State University, Ohio Xi*

Euler's formula, one of the most intriguing discoveries in the history of mathematics, shows that the exponential and the seemingly unrelated sine and cosine functions are indeed fundamentally linked. One popular method for proving the formula involves power series representations. Another involves differential equations. This presentation will include an alternate demonstration requiring only an understanding of calculus.

2:00–2:15

**The Bus Driver's Sanity Problem**

Jennifer Swank

*Denison University, Ohio Iota*

The Bus Driver's Sanity Problem, introduced by Will (1999), is to determine the best route for the drop off of kids so as to minimize exposure to the children, measured in kid-minutes. Will's solution approach, along with two possible heuristic approaches and continuing research will be presented.

2:20–2:35

**Independence Models, Likelihood Ratio Tests, and a Side of Bacon**

Aubrey Komorowski

*Duquesne University, Pennsylvania Upsilon*

The game PASS THE PIGS requires a player to roll a pair of pig-shaped dice. The configuration of the rolled pigs determines points earned. Data collected from thousands of such rolls from different heights are used in conjunction with multinomial independence models to examine height effect. Likelihood ratio tests are used to compare competing independence models and reveal the most plausible dependence relations.

Cochiti Room

1:00 PM – 2:57 PM

1:00–1:15

**Methods of Solutions for Second Order Equations on Time Scales**

Ashley Askew

*Clayton State University*

In this research, we study different methods of solutions for the second order linear equations on a time scale,  $\mathbb{T}$ , which is a nonempty closed subset of  $\mathbb{R}$ . We compare some examples of the linear equations in the continuous system and in the time scale system, and we also discuss the generalization of methods of solutions in the time scale.

1:17–1:32

**A Probabilistic Approach to the Derivative**

Amber De More

*Austin Peay State University*

We show how various generalized derivatives arise as solutions to linear mean-square estimation problems involving continuous and discrete random variables. These derivatives and their higher-order analogs can be expressed completely in terms of the moment generating function of the corresponding random variable. Alternatively, they can be expressed in terms of orthogonal polynomials.

1:34–1:49

**The General Brachistochrone Problem**

John Gemmer

*Millersville University of Pennsylvania*

Consider a frictionless surface in a gravitational field that need not be uniform. Given two points,  $A$  and  $B$ , on the surface, what curve is traced out by a particle that starts at  $A$  and reaches  $B$  in the shortest time? This project studies this problem for simple surfaces such as surfaces of revolution. We solve this more general problem using the Euler-Lagrange equation and conservation of mechanical energy.

1:51–2:06

**Bounds for Fourth-Order  $[0, 1]$  Difference Equations**

Ben Gibson

*Wake Forest University*

In this talk, we will present new results concerning growth rates for fourth-order difference equations with coefficients restricted to the interval  $[0, 1]$ . Optimality of the bounds will be discussed, as well as some conjectures and open questions.

2:08–2:23

**Error Analysis in Moore-Penrose Interpolation Methods**

Andrew Harrell

*Texas A&M University*

This presentation will demonstrate the power of the Moore-Penrose matrix pseudoinverse as a tool for interpolating data to a wide range of possible functions. Discussion will also include limitations on the method and possible errors in data analysis.

2:25–2:40

**Model Structure Error in Parameter Identification Problems**

Nicholas Stucky-Mack  
*Harvard College*

For most parameter identification problems, the numerical model is not a complete description of the physical system. We investigate the impact of imperfect models on optimization by comparing objective functions generated with correct and incorrect models for a specific problem. We discuss how inadequate models can affect optimization outcomes.

2:42–2:57

**Measurement Error in Parameter Identification Problems**

Sean Sullivan  
*University of Texas at Austin*

When optimization algorithms are applied to parameter identification problems, measurement error is unavoidable. We investigate the impact of noise in the matching data set by comparing objective functions generated with and without spurious noise for a specific problem. We discuss how changes in the objective function can affect optimization outcomes.

Picuris Room

3:00 PM – 4:35 PM

3:00–3:15

**Exploring Groups with Perfect Order Subsets (POS)**

Tina Smith Mote

*McNeese State University, Louisiana Epsilon*

The order subset of an element  $x$  in a group  $G$  is defined to be the set of all elements in  $G$  with the same order as  $x$ . A finite group is said to have POS if the cardinality of each order subset divides the order of the group. Previously established results regarding groups with POS will be discussed and illustrated by examples. In addition, special classes of groups with POS will be characterized.

3:20–3:35

**Finite and Infinite Configurations in the Hausdorff Metric Geometry**

Chantel C. Blackburn

*Andrews University, Michigan Gamma*

The Hausdorff metric provides a way to measure distance between any two non-empty compact subsets of  $n$ -dimensional Euclidean space. A configuration in this space defines two compact sets and the number of sets at each location between the sets. We will focus on finite and infinite configurations and how a small change to a configuration can lead to a drastically different result in the number of sets at each location between sets.

3:40–3:55

**Can You or Can't You Count Cantor?**

Jennifer L. Carmichael

*Western Oregon University, Oregon Delta*

One of the most counterintuitive mathematical objects, the Cantor set, seems riddled with contradictions. This introduction to the Cantor set (a subset of the open interval from 0 to 1) will discuss some of these contradictions, including the ternary-expansion proof that answers whether or not we can count this elusive set.

4:00–4:15

**Convergence Properties of the Riemann Integral**

Jeff Goldsmith

*Dickinson College, Pennsylvania Rho*

We will begin by examining sequences of real numbers and look at what it means for a sequence to converge. This will lead us naturally to a discussion about sequences of functions, and two ways to define convergence for sequences of functions. Because no one can resist integrating a function, we will conclude with the Riemann Integral for the limit of sequences.