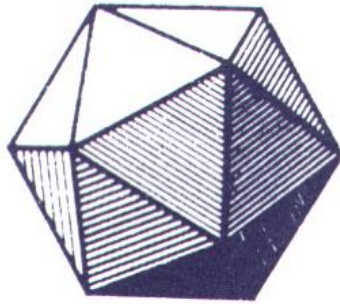


North Central Section (Founded in 1916)

**Mathematical
Association of America**



Fall Meeting • October 14-15, 2016
University of Minnesota-Twin Cities
Minneapolis, Minnesota

Friday, October 14, 2016

Panel for Graduate Students – Blegen Hall 135

4:40 – 5:30 **Getting Your First Job as a Professor at a Teaching-Oriented College or University**
Panelists: **Mike Axtell**, University of St. Thomas, **Su Dorée**, Augsburg College,
Peiyi Zhao, St. Cloud State

6:30 – 8:30 **Registration** – Humphrey Center Atrium
\$15 for all but Students and Invited Speakers

7:00 – 7:05 **Welcome** – Humphrey Center Atrium
Peter Olver, Head – Department of Mathematics

Undergraduate Student Activity I – Blegen Hall 150

7:00 – 8:00 **Shape of Space**
Leaders: **Jonathan Rogness**, **Lauren DeDieu**, **Melissa Lynn**, **Julie Rana**, University of
Minnesota – Twin Cities

7:00 – 8:00 **Banquet** – Humphrey Center Atrium

Invited Lecture

8:00 – 8:45 **Paul Zorn**, St. Olaf College
Treasures from the MAA Attic

Saturday, October 15, 2016

8:15 – 11:00 **Registration** – Blegen Hall 110
8:15 – 11:00, **Book Sales** – Blegen Hall 110
12:00 – 1:45

Section NExT Invited Lecture – Blegen Hall 5

9:05 – 9:45 **Rob Thompson**, Carleton College
Putting Humpty-Dumpty Together Again

9:50 – 10:15 **Wally Sizer**, Minnesota State University-Moorhead
A Brief History of the North Central Section of the MAA

10:15 – 10:40 **Break & Group Photo**

Invited Lecture – Blegen Hall 5

10:45 – 11:10 **Joe Gallian**, University of Minnesota-Duluth
The North Central Section Contributions to the MAA and Mathematics

11:15 – 12:00 **Deanna Haunsperger**, Carleton College
Halving Your Cake

12:00 – 1:15 **Lunch** (on your own)

1:15 – 1:45 **Business Meeting** – Blegen Hall 5, Dr. Co Livingston, Section President Presiding

Undergraduate Student Activity II – Blegen Hall 150

1:15 – 1:40 **Origami Constructions**
Leaders: **Jonathan Rogness**, **Lauren DeDieu**, **Melissa Lynn**, **Julie Rana**, University of Minnesota – Twin Cities

Section NExT Workshop – Blegen Hall 140

1:50 – 3:30 **Activities for the Flipped Classroom**
Leaders: **Kristen Sellke**, St. Mary's University of Minnesota, **Lori Ziegelmeier**, Macalester College

Afternoon Concurrent Session I – Blegen Hall 125, Julie Rana, Presiding

1:50 – 2:10 **Nicholas Stegmeier** (undergraduate), South Dakota State University
A Study of Parallel Implementations of CFD Simulations using PETSc (Portable, Extensible Toolkit for Scientific Computation)

2:15 – 2:35 **María Jesús Muñoz-López** (graduate), University of Minnesota–Twin Cities
Modeling Viral Spread on the Leaf of a Plant

2:40 – 3:00 **Xiao (Marshall) Ma** (undergraduate), Carleton College, **Noah Goldman** (undergraduate), Carleton College, **Jason Zhu** (undergraduate), Carleton College
Assembling Jigsaw Puzzles

3:05 – 3:25 **Hannah Davis** (undergraduate), University of Minnesota–Twin Cities
Symmetry Groups of Multiple Gerechte Designs

Afternoon Concurrent Session II – Blegen Hall 135, Melissa Lynn, Presiding

- 1:50 – 2:10 **Damiano Fulghesu**, Minnesota State University-Moorhead
Necklaces
- 2:15 – 2:35 **Jeremiah Bartz**, University of North Dakota
An Area Formula for Certain Generalized Fibonacci Polygons
- 2:40 – 3:00 **Jessie Lenarz**, St. Catherine University, **Kristine Pelatt**, St. Catherine University,
Matthew Welz, University of Wisconsin-Stevens Point
Extended Symmetric Spaces and θ -Twisted Involution Graphs of S_n
- 3:05 – 3:25 **Harris Ahmed Mohammed Ismail** (graduate), University of Minnesota
An Exposition on the Proof of Dwork's Rationality Theorem

Afternoon Concurrent Session III – Blegen Hall 145, Bert Fristedt, Presiding

- 1:50 – 2:10 **Aaron Wangberg***, Winona State University, **Tisha Hooks** (Winona State University),
Brian Fisher (Lubbock Christian University), **Jason Samuels** (CUNY-BMCC), **Elizabeth Gire**
(Oregon State University)
**Factors Influencing Instructor Use of Student Ideas in the Multivariable Calculus
Classroom**
- 2:15 – 2:35 **Donna Flint**, South Dakota State University
Easy Ways to Engage Real Analysis Students
- 2:40 – 3:00 **Jung-Han Kimn**, South Dakota State University
Experience of Simulation and Analysis REU Sites at South Dakota State University
- 3:05 – 3:25 **Ian Whitehead**, University of Minnesota–Twin Cities
Bite-sized Projects for First-Year Calculus

Afternoon Concurrent Session IV – Blegen Hall 155, Lauren DeDieu, Presiding

- 1:50 – 2:10 **Dick Smith**, University of Dubuque, **Kris Nelson** (graduate student), University of
Dubuque, **Dan Flath**, Macalester College
Curious Area and Volume Ratios
- 2:15 – 2:35 **Jed Yang**, Carleton College
Tiling with Puzzle Pieces is Hard
- 2:40 – 3:00 **Jason Douma**, University of Sioux Falls
Does 3 belong to 17? (and Other Absurd Questions)

Abstracts

Invited Addresses

- **Joe Gallian**, University of Minnesota–Duluth
The North Central Section Contributions to the MAA and Mathematics

North Central Sections members have a rich tradition of service to the MAA and mathematics going back over 90 years. This service includes holding MAA offices, membership on MAA editorial boards, authoring of MAA books, involvement with MAA math competitions, promoting undergraduate research, and hosting summer programs for undergraduate women. We highlight many of these contributions.

Bio: Joe Gallian received a Ph. D. from Notre Dame in 1971. He has been at the University of Minnesota Duluth since 1972. He is the author of the book "Contemporary Abstract Algebra" (9th edition) and coauthor of the book "For All Practical Purposes" (10th edition). His research interests include groups, graphs and combinatorics. He has published more than 100 articles and given over 500 invited lectures at colleges, universities and conferences. He has directed summer research programs for undergraduate students since 1977. He has received the MAA Gung and Hu award for distinguished service, the MAA Haimo award for distinguished teaching, and two MAA awards for exposition. He is a past President of the MAA and an inaugural Fellow of the American Mathematical Society.

- **Deanna Haunsperger**, Carleton College
Halving Your Cake

Here is a problem as old as humanity: given a resource to be shared (water, land, cake), how can it be shared fairly between several people? The answer, in the case of two claimants, is simple and ancient and known to every five-year-old with a sibling: I cut; you choose. Things get much more interesting, and challenging, if one has more than one sibling. How do we make fair divisions?

Bio: Deanna Haunsperger is a professor of mathematics at Carleton College in Minnesota. Since her own undergraduate days at a small liberal arts college in Iowa, Deanna has been interested in increasing the number of students who pursue advanced degrees in mathematics. That passion has guided her as a former co-editor for Math Horizons (the Mathematical Association of America's magazine for undergraduates) and as co-founder and co-director of Carleton's Summer Mathematics Program for Women (a successful, intensive four-week summer program to encourage talented undergraduate women to pursue advanced degrees in the mathematical sciences). She has chaired the MAA's Strategic Planning Committee on Students and the Council on Outreach. Currently Deanna is President-Elect of the MAA. Deanna is married to fellow mathematician Steve Kennedy, and together they have two grown children.

- **Wally Sizer (retired)**, Minnesota State University-Moorhead
A Brief History of the North Central Section of the MAA

Highlights of the history of the Minnesota/North Central Section will be given, in honor of the centennial.

- **Rob Thompson**, Carleton College
Putting Humpty-Dumpty Together Again

All the king's horses and all the king's men couldn't do it, but what about a computer? Inspired by the problem of reassembling a broken egg, we'll visit the mathematical ideas that help us to reassemble broken objects. In particular, we'll examine the idea of an "invariant signature" (a way of encoding the shape of an object while ignoring its position and orientation) and the ways that student researchers have used the signature idea to help assemble flat and curved jigsaw puzzles.

Bio: Rob Thompson is an Assistant Professor at Carleton College, where he joined the faculty in 2015. Before that, he had postdoctoral positions at Macalester College and Harvey Mudd College, preceded by a Ph.D. in Mathematics at the University of Minnesota supervised by Peter Olver. His research is in applied math of various kinds. Rob lives with his wife Rita (also a mathematician and teacher) and children Luisa (3) and Hugo (0) in Northfield. In his spare time, he likes to play the double bass and take care of chickens.

- **Paul Zorn**, St. Olaf College
Treasures from the MAA Attic

Over its 100 years of life the MAA has accumulated a bursting metaphorical attic, stuffed with reports, books, articles, journal problems, Putnam Exam problems, journals, curricular recommendations, and much more.

Most centenarians' collections contain some things that should have gone to Goodwill decades ago. Conceivably there is some of this in the MAA attic, too, but surely not much. The MAA's 100-year collection is full of wise, interesting, surprising, and sometimes quirky mathematical and pedagogical treasures. I'll dust off and describe some of my personal favorites, some old, some new, and some with North Central roots.

Bio: Born and raised in India, Paul Zorn is a professor of mathematics at St. Olaf College. His professional interests include complex analysis, mathematical exposition, textbook writing, and the role of mathematics among the liberal arts. His 1986 paper "The Bieberbach Conjecture" was awarded the 1987 Carl B. Allendoerfer Award for mathematical exposition. He has co-authored several calculus textbooks with his St. Olaf colleague, Arnold Ostebee. His most recent book is *Understanding Real Analysis* (AK Peters, 2010). From 1996 to 2000, he was editor of *Mathematics Magazine*, and also served a hitch (2011-12) as President of the Mathematical Association of America.

Workshops and Panel Discussions

- **Panel for Graduate Students**
Getting Your First Job as a Professor at a Teaching-Oriented College or University
Panelists: **Mike Axtell**, University of St. Thomas, **Su Dorée**, Augsburg College,
Peiyi Zhao, St. Cloud State

What is it like to teach at a teaching-oriented college or university? How does the hiring process work? What do search committees look for in job candidates? What makes for a good application? What should I do while I'm still in graduate school if I want a teaching-oriented position? What's a "liberal arts" college? What's the difference between tenure-track, visiting, or permanent non-tenure track jobs?

- **Section NExT Workshop**
Activities for the Flipped Classroom
Leaders: **Kristen Sellke**, St. Mary's University of Minnesota, **Lori Ziegelmeier**, Macalester College

What happens when introduction of new material and routine examples are moved outside of class time and thus significant class time is freed up for richer mathematically-engaging activities? In this workshop we will look at classroom activities from two different colleges and several flipped courses, reflect on what makes an activity successful, and discuss the student learning and other benefits of the flipped classroom. This, and all, Section NExT workshops are open to anyone interested in thinking about new ideas for the classroom.

- **Undergraduate Student Activity I**
Shape of Space
Leaders: **Jonathan Rogness**, **Lauren DeDieu**, **Melissa Lynn**, **Julie Rana**, University of Minnesota – Twin Cities
Learn what board games and video games can teach us about the shape of the universe.

- **Undergraduate Student Activity II**
Origami Constructions
Leaders: **Jonathan Rogness**, **Lauren DeDieu**, **Melissa Lynn**, **Julie Rana**, University of Minnesota – Twin Cities

Discover some of the deep mathematics behind origami, the art of paper folding, and learn how to create your own modular origami model of a cube, stellated octahedron, and more.

Contributed Talks

- **Jeremiah Bartz**, University of North Dakota
An Area Formula for Certain Generalized Fibonacci Polygons

A compact formula is presented which computes the area of polygons whose vertices are comprised of certain types of subsequences of the Fibonacci numbers, Lucas numbers, and the generalized Fibonacci numbers.

- **Hannah Davis** (undergraduate), University of Minnesota-Twin Cities
Symmetry Groups of Multiple Gerechte Designs

A gerechte design is an n -by- n Latin square and a partition of the square into n regions, each containing n distinct symbols. Sudoku is a gerechte design with a partition consisting of nine 3-by-3 squares. The symmetry groups and corresponding equivalence classes of Sudoku and certain other designs have been well studied for their use in agricultural experiments and as a method of counting unique solutions. We extend these results to designs with congruent non-square regions by examining the relationship between the symmetry group of particular sets of designs, and pairwise variation, a measure of the variability within the set.

- **Jason Douma**, University of Sioux Falls
Does 3 belong to 17? (and Other Absurd Questions)

Paul Benacerraf famously told a story about two budding mathematicians (Ernie and Johnny) who could not agree on whether 3 “belongs” to 17. On its face, this seems a pointless argument to entertain. The question is marginally well-defined and most likely irrelevant to the actual practice of mathematics. However, the answer to the question—or more precisely, the difficulty in obtaining an answer to the question—does tell us something about the nature of the subject matter with which we work. This talk will examine what might be learned by pondering “absurd questions” in mathematics, including Benacerraf’s little gem.

- **Donna Flint**, South Dakota State University
Easy Ways to Engage Real Analysis Students

Teaching Real Analysis can be a challenge as we try to engage and excite students for whom this course may be their first or second foray into the world of theoretical mathematics. Many students don’t know how to interact effectively with this new kind of material, either in class or outside of class. Thus, they spend class time frantically taking notes, hoping they can decipher them later...between social media postings...with their music on...late at night. This talk will present ideas about how to engage students in class and guide them towards productive study outside of class.

- **Damiano Fulghesu***, Minnesota State University-Moorhead, **Sayel Ali**, Minnesota State University-Moorhead
Necklaces

Let C be a smooth algebraic plane curve. We study three different kinds of modifications of C using analytic periodic functions. The goal is to obtain a new curve that oscillates about C . In some cases, the resulting curves remind us of the shape of a necklace.

- **Harris Ahmed Mohammed Ismail** (graduate), University of Minnesota
An Exposition on the Proof of Dwork’s Rationality Theorem

In this talk, I will first introduce the local zeta function of an algebraic variety over a finite field, and then give a few examples of zeta functions. Then I will briefly state the classical Weil conjectures (which are now theorems). Then I will describe the basic strategy and the essential ingredients of Dwork’s proof of the rationality of the zeta function, the first of the Weil conjectures, highlighting the exciting mathematical ideas used in the process. The ingredients include Dwork’s splitting function and its p -adic analytic properties, the trace formula, Borel’s rationality criterion and the p -adic Weierstrass Preparation Theorem. I will conclude with a brief discussion on applications and directions in which Dwork’s theory could be extended.

- **Jung-Han Kimn***, South Dakota State University, **Stephen Gent**, South Dakota State University
Experience of Simulation and Analysis REU Sites at South Dakota State University

South Dakota State University Simulation and Analysis REU program focused on simulation and analysis techniques in a variety of STEM areas including mathematical and engineering disciplines, which use similar simulation techniques but have different applications. Our REU students gained a broad perspective of the theory and application of simulations in interdisciplinary setting. We will present the lesson we learned from our REU site directors’ experiences and what can be readily applied to our new REU Site: HPC (High Performance Computing) in STEM Disciplines at South Dakota State University.

- **Jessie Lenarz**, St. Catherine University, **Kristine Pelatt**, St. Catherine University,
Matthew Welz, University of Wisconsin-Stevens Point
Extended Symmetric Spaces and θ -Twisted Involution Graphs of S_n

Given an involution θ of the symmetric group S_n , we define the extended symmetric space of θ -twisted involutions as $R_\theta = \{g \in S_n \mid \theta(g) = g^{-1}\}$. While extended symmetric spaces for Weyl groups play an important role in algebraic geometry and representation theory, our talk will have a more combinatorial flavor. In particular, we consider the action of various generating sets on R_θ and a graph, the θ -twisted involution graph, induced by this action. We present results on these graphs, and give conditions under which this action gives rise to a poset-defining relation. While these results are interesting in their own right, we believe the subject material is especially well-suited for undergraduate research, and provide a gentle introduction to permutation groups, group actions, and elementary group theory. This research was funded by AIM, ICERM, and NSF at the July 2016 Research Experience for Undergraduate Faculty (REUF).

- **Xiao (Marshall) Ma** (undergraduate), Carleton College, **Noah Goldman** (undergraduate), Carleton College, **Jason Zhu** (undergraduate), Carleton College
Assembling Jigsaw Puzzles

Assembling jigsaw puzzles by hand is a fun and challenging activity. But can we teach a computer to do it for us? Solving this problem involves a great mixture of applied mathematics: image processing, mathematical modeling, differential geometry, linear algebra and data analysis. In this talk we will present the ideas behind an algorithm we have developed for shape recognition and jigsaw puzzle assembly, beginning with the raw image data from a real jigsaw puzzle and ending with geometric information about (potential) matches between different pieces that can be combined into a completely solved puzzle!

- **María Jesús Muñoz-López*** (graduate), University of Minnesota-Twin Cities, **Robert S. Anderssen**, CSIRO Data61, **Maureen P. Edwards**, University of Wollongong, **Peter M. Waterhouse**, Queensland University of Technology
Modeling Viral Spread on the Leaf of a Plant

The spread of a virus on the leaf of a plant is a causal process in both space and time in that the spread is a local process with the boundary of the infected region advancing causally. For the viral spread on a leaf, one can use reaction-diffusion equations which have compactly supported solutions. In this work, a solution with compact support for a non-linear diffusion equation is found using Lie symmetry analysis. It is shown numerically that there are compactly supported solutions when reaction terms for which the model equation admits non-trivial Lie symmetries are added, and the existence of a compactly supported solution in one such situation is proven. Finally, a way to choose the particular form of the model and ways to visualize the solutions in order to apply the results to real data are suggested.

- **Dick Smith**, University of Dubuque, **Kris Nelson** (graduate student), University of Dubuque, **Dan Flath**, Macalester College
Curious Area and Volume Ratios

Create an octagon by drawing two line segments from each vertex of a square to the points on the square ONE unit from the opposite vertex. The ratio of the area of the square to the octagon produces triangular numbers. As the square gets very large the octagon approximates a square with area $1/2$. A 3D extension draws three segments from each vertex of a cube to points ONE unit from the opposite vertex, producing a solid with 24 edges. When the edge of the cube is an integer, the ratio of the volume of the cube to the solid is always a whole number. As the cube gets very large the solid's volume approximates $1/4$.

- **Nicholas Stegmeier*** (undergraduate), South Dakota State University, **Jeffrey Doom**, South Dakota State University, **Jung-Han Kimn**, South Dakota State University
A Study of Parallel Implementations of CFD Simulations using PETSc (Portable, Extensible Toolkit for Scientific Computation)

We will present our current progress on parallel implementations of CFD problems based on the compressible Navier-Stokes equations. The main problem is a simulation of counter-rotating vortex pairs to test our parallel implementations. Each of the Navier-Stokes equations is solved separately, and a predictor-corrector approach is used to solve the momentum and energy equation. We redesign the data structures and the linear solvers with preconditioners using the PETSc by Argonne National Laboratory. The updated implementation results are scalable, efficient, and robust. We are trying to extend this parallel implementation to the simulation of impinging jets with turbulent flow.

- **Aaron Wangberg***, Winona State University, **Tisha Hooks**, Winona State University, **Brian Fisher**, Lubbock Christian University, **Jason Samuels**, CUNY-BMCC, **Elizabeth Gire**, Oregon State University
Factors Influencing Instructor Use of Student Ideas in the Multivariable Calculus Classroom

Raising Calculus to the Surface (NSF DUE #1246094) utilizes physical manipulatives and multiple representations to help students discover multivariable calculus concepts. Despite these goals, instructors rarely approached the project because of its emphasis on student inquiry. In this talk, we'll describe how 16 adopting instructors' modified their teaching practices and their expectations for student contributions as they implemented the materials in 2014-2015. We also identify features baked into the curriculum which might support these shifts in instructor practices and beliefs.

- **Ian Whitehead**, University of Minnesota-Twin Cities
Bite-sized Projects for First-Year Calculus

I will discuss some assignments I've written for Honors Calculus I at the University of Minnesota. They lie somewhere on the spectrum between ambitious homework problems and small independent research projects. The students work in groups to create a short writeup or a class presentation. I find that these projects help motivate the class and frame important course themes.

- **Jed Yang**, Carleton College
Tiling with Puzzle Pieces is Hard

Is a region tileable by a collection of tiles? Answering this is (computationally) hard in the finite case and undecidable in the infinite case. Tilings with puzzle pieces (introduced by Knutson, Tao, and Woodward) of triangular regions (with edge labels) are counted by Littlewood-Richardson coefficients, which are numbers that appear naturally in many contexts. A consequence is that tileability of triangular regions by puzzle pieces can be decided in polynomial time. In this talk, we will discuss the problem of tiling arbitrary regions with these puzzle pieces.

NCS MAA Spring 2017 Meeting: April 21-22, 2017 at Anoka Ramsey Community College

NCS MAA Fall 2017 Meeting: TBD

Section Website: <http://sections.maa.org/northcen/>