Annual Meeting
of the
Pacific Northwest Section
of the
Mathematical Association of America

Seattle University
Seattle, Washington

April 9-10, 2010

Annual Meeting
of the
Pacific Northwest Section
of the
Mathematical Association of America

Sponsored by

The Mathematical Association of America
Seattle University
College of Science & Engineering
Department of Mathematics

Hosted by

Seattle University
Mathematics Department
Seattle, Washington
April 9-10, 2009

Friday, April 9

7:45	**Packet pickup for Project NExT** *Pigott Atrium*		
8:00 2:15	**Project NExT Meeting** *Casey Commons*		
2:30	**Minicourse:** **Visualizing 4-D Space [3]** *Pigott 202*	**Minicourse:** **Thinking about Problem Solving…[1]** *Pigott 203*	**Minicourse** **Using Sage…[2]** *Administration 224*
5:30	**Student Packet Pickup & Reception** *5:30-7:30* *Casey Commons*	**Project NExT Dinner & Discussion**	*6:00 Piecora's Pizza* *1401 E. Madison* *(206) 322-9411*
7:00		**Packet Pick-up**[1] *Pigott Atrium*	
8:00	**Friday Evening Lecture: Jeff Weeks** *The Shape of Space* **[4]** *Pigott Auditorium*		
9:00 10:00	**Reception** *Pigott Atrium*		

[1]Packet pickup for participants is also available for attendees arriving in the afternoon in Pigott Atrium from 2:00-3:30

Saturday, April 10

7:30	**Executive Committee Meeting**	*Casey 516*
8:00	**Packet Pickup & Registration**	*Pigott Atrium*
9:00	**Introduction and Welcome:** Michael J. Quinn, Dean of the College of Science and Engineering, SU; **Invited Talk: Jeff Weeks** *Visual Introduction to Curvature* **[5]**	*Pigott Auditorium*
10:00	**Book Sale**	*Pigott Atrium*
10:30	**Contributed Talks**	*Pigot 100, 101, 102, 103, 201, 202, 203, 204*
12:30	**Student Poster Session**	*Pigott Mezzanine 3rd Floor*
12:30	**Lunch (provided)**	*Pigott Atrium*
1:15	**Business Meeting**	*Pigott 103*
1:50		
2:00–3:00	**Invited Talk: Gerard Venema, Calvin College,** *Dimension, Fractals, and Wild Cantor Sets* **[6]**	*Pigott Auditorium*
3:15	**Contributed Talks**	*Pigot 100, 101, 102, 103, 201, 202, 203, 204, 304*
5:15	**Social Hour**	*Campion Ballroom*
6:15	**Section Awards**; **Banquet Dinner**; **Invited Lecture: Steve Dunbar, University of Nebraska** *MAAs American Mathematics Competitions: Easy Problems, Hard Problems, History and Outcomes* **[7]**	*Campion Ballroom*

Program of Contributed Papers

The program of contributed papers appears on the following pages. In some cases, titles or other information are abbreviated for reasons of space; please see the full abstract for more information.

A dagger (†) indicates which contributor(s) will present when multiple contributors are listed and fewer are presenting the work. An asterisk (*) indicates the contributor is a graduate student. Double asterisks (**) indicate the contributor is an undergraduate student.

Session Organizers

- *Quantitative Methodology Used in Biological, Natural Resources and Environmental Sciences*: Vincent Gallucci, University of Washington; Jay Allen Johnson, University of Washington
- *Fundamental Tools of Analysis*: James Bisgard, Central Washington University
- *Innovations and Issues in Quantitative Literacy*: Stuart Boersma, Central Washington University; Deann Leoni, Edmonds Community College
- *Panel Discussion: Outreach to Local Schools and the Community*: Allison Henrich, Seattle University; Inga Johnson, Willamette University
- *Teaching Gems*: Jeff Stuart, Pacific Lutheran University
- *Junior Faculty Research*: Hans Nordstrom, University of Portland
- *Undergraduate Research*[2]: Donna Pierce, Whitworth University
- *General Contributed Papers*: Hans Nordstrom, University of Portland

Please contact the session organizer with any questions about a session.

Moderators: Please start each talk on time, but **not** early. Meeting participants often move between sessions and will want to be there when the talks is scheduled to begin.

[2]Some of the student research papers involve solutions to this year's Mathematical Contest in Modeling.This year's two problems were:

Problem A: *The Sweet Spot*, (S) Every hitter knows that there is a spot on the fat part of a baseball bat where maximum power is transferred to the ball when hit. Why isnt this spot at the end of the bat? A simple explanation based on torque might seem to identify the end of the bat as the sweet spot, but this is known to be empirically incorrect. Develop a model that helps explain this empirical finding.

Problem B: *Criminology*, (C) In 1981 Peter Sutcliffe was convicted of thirteen murders and subjecting a number of other people to vicious attacks. One of the methods used to narrow the search for Mr. Sutcliffe was to find a center of mass of the locations of the attacks. In the end, the suspect happened to live in the same town predicted by this technique. Since that time, a number of more sophisticated techniques have been developed to determine the geographical profile of a suspected serial criminal based on the locations of the crimes. ?
Your team has been asked by a local police agency to develop a method to aid in their investigations of serial criminals. The approach that you develop should make use of at least two different schemes to generate a geographical profile. You should develop a technique to combine the results of the different schemes and generate a useful prediction for law enforcement officers.

See the COMAP website, `http://www.comap.com`, for more information.

Contributed Talks – Saturday Morning

	Panel Discussion: Outreach	Quantitative Methods in Biological, Nat. Res. & Env. Sci.	Fundamental Tools of Analysis
	Pigott 100	*Pigott 101*	*Pigott 204*
10:30–10:45	*Mathletes Coaching Project* [87] **Ksenija Simic-Muller, PLU**	*Applied Mathematics for Environmantal Sciences: A Discussion* [25] **Dennis Hartmann, UW†** **Loveday Conquest, UW†** **Vince Gallucci, UW†**	*Bootstrapping Methods in the Analysis of Differential Equations* [38] **Chris Hallstrom, UP**
10:50–11:05	*Sonia Kovalevsky Day* [15] **Cheryl Beaver, WOU**	*The Analytical Closed Form Computation of Stat. Parameters for Modeling - Its Use in Airtanker Modeling* [37] **Francis Greulich, UW**	*The Fourier Transform, $L^2(\mathbb{R})$, and the Riemann-Lebesgue Lemma* [14] **Scott Beaver, WOU**
11:10–11:25	*Explorations in Math* [29] **Mary Cropp, Dir.,Explorations in Math**	*Estimating Population Dynamics with Spatially Replicated Time Series* [84] **Kevin See, UW**	*Brunn-Minkowski-Type Inequalities* [44] **David Hartenstine, WWU**
11:30–11:45	*The Splash Summer Program* [17] **Michelle Bernson, Boeing**	*Reducing Seabird Bycatch in Alaska Longline Fisheries From GLMs and GAMS to Policy and Regulation* [26] **Loveday Conquest, UW**	*Martingales and Martingale Problems* [98] **Kathy Temple, CWU**
11:50–12:05	**Panel Discussion**	*Using a Simple Model to Replicate Spacial Patterns in Low-Sensitivity Fire Regimes* [55] **Maureen C. Kennedy, UW†** **Don McKenzie, USFS**	*The Euler-MacLaurin Summation Formula* [90] **Michael Spivey, UPS**
12:10–12:25		*A Model of the Ocean Migration of Pacific Salmon* [21] **Chloe Bracis, UW***	*The Arzela-Ascoli theorem and Its Uses* [19] **James Bisgard, CWU**

Contributed Talks — Saturday Morning

Student Papers 1	Student Papers 2	Student Papers 3
Pigott 201	*Pigott 202*	*Pigott 203*
Investigations of an Upper Bound for the Univalent Bloch-Landau Constant [36] **Ryan Grandy**†** **Hannah Hsu**†** **Sabrina Houser****, **Cassandra Bradley, SPU****	*The Three Point Ellipse* [95] **Dylan Helliwell, SU** **Everett Sullivan, SU**†**	*Investigating Ion Channel Gating Using Mathematical Modeling* [9] **Tyler Allen, HU****
Random Matrix Theory for Finance [33] **Jason Foster, SU**†**	*Geometric Analysis: A Proof by Picture?* [88] **Kevin Sonnanburg, Whitworth**	*Towards Individualised Code Encryption, Obfuscation, and Tamper Resistance* [28] **Dillon Cower, BSU****
On Local Regularization for an Inverse Problem [61] **Ruya Huang**** **Cynthia Lester, Linfield**†**	*Level sets and extreme curvature of polynomials* [74] **Edward Niedermeyer, GU****	*Three-Way Higher-Order Operator Splitting Techniques* [72] **Hao Nguyen, SU****
Statistical Analyses of Metagenomic Data [80] **Todd Regh, SOU**†** **(***See Abstract for Other Authors***)**	*Knotted Surfaces* [16] **David Bell-Garrison, GU****	*Stability of the Soliton Solution of the Two-Dimensional Nonlinear Schrödinger Equation* [86] **Natalie Sheils, SU****
Optimizing Software Architecture for Efficient Probability Modeling [45] **Chris Harvery, UP****	*Protein Classification with Knot Polynomials* [18] **Rachael Burnt, GU****	*Numerical Analysis of the Nonlinear Schrödinger Equation with Discontinuous Initial Data* [77] **David Prigge, SU****
Modelling photosynthesis in benthic tidal communities using abiotic factors [71] **Brad Nelson, SPU**†** **Brian Gill, SPU**	*Understanding Symmetry: Distinguishing Number of a Graph* [93] **Cody Stein, PU****	*Integer-valued Sinusoidal Functions* [64] **James Mahoney, UP****

Contributed Talks – Saturday Morning

	General Papers 1	General Papers 2
	Pigott 102	*Pigott 103*
10:30–10:45	*The Development of Interest in a Business Math Course* [69] **Lawrence Morales, SCCC**	*Techniques for actively engaging students in learning cryptology* [11] **Liljana Babinkostova, BSU**
10:50–11:05	*Motivation & Belief Profiles of Mathematics Students at All Levels of the Community College System* [41] **Allen Harbaugh, SCCC**	*Biosphere 3: Quantitative Prediction in the Freshman Biology Laboratory* [51] **R. Higley, HCC** **V. Hunt, CWU**† **T. Sorey, CWU**
11:10–11:25	*History in a Math Course for Teachers: How and Why* [92] **Robert Stein, CSUSB**	*The Codependent Arising of Math and Mathematicians* [103] **Luke Wolcott, UW**∗
11:30–11:45	*Density in the calculus sequence* [52] **Martin Jackson, UPS**	*A survey to examine students' perspectives of statistics as a quantitative reasoning course* [57] **Daniel Kimm, SOU**
11:50–12:05	*Teaching mathematics with a Strip of Paper* [23] **Nicholas Cain, UW**∗	*An Introductions and Analysis of Birth-Death Probability Models* [22] **Megan Buzby, UAKSE**† **Donald Estep, CSU**
12:10–12:25	*Independent Events: How Do Informal Definitions and Sample Problems Contribute to Students Misconceptions?* [10] **Barbara Alvin, EWU**† **Jacqueline Coomes, EWU**†	*Permutation Techniques for Multivariate Ecological Data* [12] **J.D. Bakker, UW**

Contributed Talks – Saturday Afternoon

	Innovations and Issues in Quantitative Literacy	Quantitative Methods in Biological, Nat. Res. & Env. Sci.	Junior Faculty Research
	Pigott 100	*Pigott 101*	*Pigott 204*
3:15–3:30	*A Comparative Study of the QL and Writing Accress the Curriculum Initiatives: What can Mathematicians Learn* [49] **Cinnamon Hillyard, UW Bothell**	*Simulation of Geophysical Hazards: Tsunamis, Debris Flows, and Storm Surges* [63] **David George, Post-Doc, USGS, Jihwan Kim, UW*** **Randall LeVeque, UW** **Kyle Mandli, UW†***	*Finite dimensional division algebras over fields* [66] **Kelly McKinnie, UM**
3:35–3:50	*It seemed like a good idea: reflections on a cross curricular QL project* [60] **Emily Lardner, ESC**	*Risk Analysis for the Management and Conservation of the Blue Shark in the North Atlantic Ocean* [34] **A.M. Aires-da-Silva, UW*** **V.F. Gallucci, UW†**	*Geometry, Topology, Group Theory, and Killer Robots* [76] **Valerie Peterson, UP**
3:55–4:10	*Math Across the Curriculum–One Strategy for QL* [101] **Beverly Vredevelt, SFCC**	*Estimating Shark Abundance Using Mathematical Models* [97] **Ian Taylor, UW**	*Surface structures and contructing 3-manifolds* [30] **Ryan Derby-Talbot, QU**
4:15-4:30	*Using Integrative Projects to Encourage Quantitative Reasoning* [58] **John Knudson†** **Greg Langkamp†** **Jane Muhich†** **Greg Hinckley, SCCC†**	*Circular Migrations and HIV Transmission Dynamics* [56] **Aditya Khanna, UW***	*A Biomathematician's Journey into Novel Signaling Pathways* [24] **Hannah Callender, UP**
4:35-4:50	*Teaching Quantitative Reasoning with the News* [20] **Stuart Boersma, CWU**	*Estimation of the Lift and Drag Coefficients for Zebra and Quagga Mussels. . .* [54] **Jay A Johnson, UW†** **Suzanne Peyer, UWI** **John Hermanson, USDA**	*An Effective Method for Replenishing Items with Seasonal Intermittent Demand* [73] **Gary Mitchell** **Meike Niederhausen, UP†**
4:55-5:10	*Using "Prepare and Reflect" Worksheets to Foster Student Responsibility* [75] **Debra Olson, SFCC**	*Can Species Keep up with Climate Change?* [104] **Ying Zhou, UW***	*Quantum mechanics from a geometric point of view* [83] **Barbara Sanborn, WWU**

Contributed Talks – Saturday Afternoon

	Student Papers 4	Student Papers 5	Student Papers 6
	Pigott 201	*Pigott 202*	*Pigott 203*
3:15–3:30	*Making the Sweet Spot Sweeter (S)* [42] **Tyler Harmon**†** **Jason Haun** **Veronica Siller, Linfield**†**	*Optimal Bluffing Strategies in Poker* [91] **Mitch Staehle, WOU****	*Techniques to determine food web stability* [79] **Aaron Ragsdale, UP****
3:35–3:50	*Resonance as an Explanation for the "Sweet Spot" (S)* [100] **Robert Ferrese**** **Katie Grainey**** **Julianne Upton, Linfield**†**	*The Towers of Hanoi Get a New Peg* [27] **Daniel Corliss, WOU****	*Using Mathematica as a Tool for Teaching Calculus* [99] **Cory Druffel,**†** **Alaina Thompson, Whitworth**†**
3:55–4:10	*Criminal Minds of Arkham (C)* [65] **Duncan McGregor** †** **J. Alex Patton,** †** **Chris Upshaw, PU**†**	*A Mathematical Journey* [68] **Dania Morales, WOU****	*Grade Inflation at Whitworth* [53] **Joshua Jensen, Whitworth****
4:15–4:30	*An Interdisciplinary Approach to Math Modeling* [102] **Collin Weigel, PU****		*Counting with Catalan* [89] **Brett Berry**** **Kevin Sonnanburg, Whitworth**†**
4:35–4:50	*Shuffle Your Way to Order* [13] **Michaela Balkus, PU****		*Fibonacci Numbers in Nature* [67] **Rebecca Meyer, Whitworth****
4:55–5:10	*Cyclotomic Integers* [35] **Z. Michael Gehlke, SU****		*Tiling the Fibonacci identities* [62] **Stephanie Lowrey, PU****

Contributed Talks — Saturday Afternoon		
Teaching Gems	**General Papers 3**	**General Papers 4**
Pigott 102	*Pigott 103*	*Pigott 304*
How do you know? [47] **Daniel Heath, PLU**	*First digits of numbers in data* [82] **Kenneth Ross, UO**	*Newton Coefficients of Ehrhart Polynomials* [50] **Matt Hudelson, WSU**
Assess the Accuracy: Critical Thinking in Intro Stats Courses [70] **Ashlyn Munson, PLU**	*How fast does a continued fraction converge?* [32] **C.E. Falbo, SSU**	*Distinguishing ad Fixing Numbers of Matroids* [81] **Mary Riegel, UM***
Using Writing to Teach mathematical Modeling [46] **Chris Hay-Jahans, UAKSE**	*Cubes and Squares* [43] **James Harper, CWU**	*Wavelets on Graphs via Spectral Graph Theory* [39] **David Hammond, UO†** **Pierre Vandergheynst, EPFL**
Adopt-a-Group Project with a Course Wiki [31] **Tom Edgar, PLU**	*Combinatorial Approaches to Sonority Analysis* [85] **Michael Severino, UM†*** **Gregory St. George, UM**	*Helicoid surfaces of constant anisotropic mean curvature* [59] **Chad Kuhns, ISU***
Using Instructor Error to Extend Mathematical Understanding and Change Students' Epistemic Beliefs [40] **Allen Harbaugh, SCCC**	*Partitioning Pythagorean Triangles* [96] **Carl E. Swenson, SU†** **André L. Yandl, SU**	*Probabilistic Nonconstructive Existence Proofs* [78] **Liam Rafferty, UM***
Inverses for matrices without inverses [94] **Jeffrey Stuart, PLU**	*Formal series and asymptotics for hyperbolic differential equations* [8] **Paul T. Allen, Lewis & Clark College**	*Geometry Playground* [48] **Daniel J. Heath, PLU†** **Joshua Jacobs, UW†*** **Ksenija Simic-Muller, PLU†**

Social Events

Thursday Project NExT Gathering
7:00 Elysian Brewery, 1221 E. Pike ST, (206) 860-1920

Friday Project NExT Dinner
6:00 Piecora's, 1401 E. Madison, (206) 322-9411
Sponsored by the MAA

Friday Student Reception
5:30-7:30 Casey Commons

Friday Invited Lecture
The Shape of Space
Jeff Weeks [4]
8:00 Pigott Auditorium

Friday Reception
9:00 Pigott Atruim

Coffee and Pastries
8:30-9:00 Pigott Atrium

Saturday Lunch
12:30 Pigott Atrium

Student Poster Session
12:30 Pigott Mezzanine, 3rd Floor

Saturday Evening Social Hour
Awards Ceremony and Banquet Dinner
5:15 Campion Ballroom

MC: Klay Kruczek

Introduction of new Section Project NExT Fellows

Presentation of 25- and 50-year MAA membership certificates

PNW MAA Distinguished Teaching Award

Saturday Evening Invited Lecture
MAA's American Mathematics Competitions: Easy Problems, Hard Problems, History and Outcomes
Steve Dunbar [7]

Minicourse Descriptions

Friday, April 13

1 *Thinking about Problem Solving by Learning about Problem Posing*
Steve Dunbar, University of Nebraska

A description of an ideal student might be “A mathematical thinker with well-developed habits of mind:

1. Understands which tools are appropriate when solving a problem
2. Is flexible in his or her thinking
3. Uses precise mathematical definitions
4. Understands there exist multiple paths to a solution
5. Is able to make connections between what one knows and the problem
6. Knows what information in the problem is crucial to its being solved
7. Is able to develop strategies to solve a problem
8. Is able to explain solutions to others
9. Knows the effectiveness of algorithms within the context of the problem
10. Is persistent in his or her pursuit of a solution
11. Displays self-efficacy while doing problems
12. Engages in meta-cognition by monitoring and reflecting on the processes of conjecturing, reasoning, proving, and problem solving.”

In this workshop, we’ll monitor and reflect on the processes of conjecturing, reasoning, proving, and problem solving by focusing on the process of creating interesting and challenging problems. Using examples from the American Mathematics Competitions, we’ll look at problem-posing techniques including:

1. Looking from strange directions
2. Counting solutions instead of finding solutions
3. Symmetrizing, and un-symmetrizing
4. Transforming domains of the problem
5. Integer geometry and algebra
6. Inverting a standard problem

The goal is to think more deeply about the process of problem-solving in order to better teach mathematics and creativity.

2 *Using Sage to Spice up Your Undergraduate Courses*

William Stein, University of Washington
Rob Beezer, University of Puget Sound

Sage (http://sagemath.org) is an open-source mathematical software system designed to be an alternative to Mathematica,Maple, Matlab and Magma. Since the project's founding in 2005 by William Stein, it has attracted over 200 developers worldwide and funding from NSF, Google, Microsoft, and many other organizations. Sage's notebook interface allows you and your students to use this powerful software for free, in a web browser on any computer at the freely-available http://sagenb.org, by connecting to a server you might install on your campus, or just by running Sage locally on your own computer.

This minicourse will teach you how to get started using Sage for your classes. We will start with an overview of the notebook interface in which we will explain how to execute Sage commands,get help on command usage, share or publish worksheets, create interactive demonstrations and seek assistance from the Sage community. We will then work through examples from single-variable and multivariate calculus, introductory statistics, discrete mathematics, linear algebra, abstract algebra and number theory, some of which the presenters have used in their own courses. These will expose you to Sage's 2D and 3D plotting capabilities and hint at a few of the mature open-source packages (such as R and GAP) that provide much of Sage's functionality. At the conclusion of the minicourse, we hope that you will be able to begin productively using Sage in your own courses.

3 *Visualizing 4-Dimensional Space*

Jeff Weeks, Freelance Mathematician

The workshop will begin with an introductory lesson on visualizing 4-dimensional space. Once everybody iscomfortable with the basic method, participants will split into groups of 3-4 people to work on their choice of 4D visualization exercises from a list that will be provided. The list will contain novice, intermediate and expert level exercises, so people can start with the simple ones and move onward as time permits. After a short break, the whole group will reconvene so the small groups can report their progress and discuss any remaining issues. The workshop will conclude with a look at physicists' 4D view of the natural world (spacetime) and its philosophical implications.

Abstracts of Invited Talks

(in chronological order)

4 *The Shape of Space*
Jeff Weeks, Freelance Mathematician

When we look out on a clear night, the universe seems infinite. Yet this infinity might be an illusion. During the first half of the presentation, computer games will introduce the concept of a multiconnected universe. Interactive 3D graphics will then take the viewer on a tour of several possible shapes for space. Finally, we'll see how recent satellite data provide tantalizing clues to the true shape of our universe.
The only prerequisites for this talk are curiosity and imagination, so bring your students, and bring your family too if they're interested (suitable for middle school and high school students).

5 *Visual Introduction to Curvature*
Jeff Weeks, Freelance Mathematician

Physical models and software simulations will introduce participants first to curved surfaces and then to curved 3-dimensional space. The contrasting properties of spherical and hyperbolic geometry will be savored.

6 *Dimension, Fractals, and Wild Cantor Sets*
Gerard Venema, Calvin College

The discovery of unexpected examples forced a reexamination of the concept of dimension in the early twentieth century. Several competing definitions of dimension emerged from that process. They do not all give the same answer when applied to subsets of Euclidean space and do not even necessarily yield integers as answers. In this talk I will review the various definitions of dimension from an elementary point of view and then look at examples, focusing especially on examples of Cantor sets. A simple construction yields Cantor sets in $\mathbb{R}^n$ of dimension s for every real number s in the range $0 \leq s \leq n$. Antoine's necklace is a classic example of a wild Cantor set in $\mathbb{R}^3$ will explain why the Hausdorff dimension of an Antoine's necklace Cantor set must always be at least 1 and how to construct an Antoine's necklace of Hausdorff dimension s for every s in the range $1 \leq s \leq 3$. This is a special case of a much more general theorem that relates Hausdorff dimension to wildness.

7 *MAAs American Mathematics Competitions: Easy Problems, Hard Problems, History and Outcomes*
Steve Dunbar, University of Nebraska

How do you get bright students hooked on mathematics? How do you keep teachers intellectually engaged and pedagogically innovative? A proven way is to involve them both in mathematics competitions with great problems that span the curriculum. The Mathematical Association of America has continuously sponsored nationwide high-school level math contests since 1952. The sequence of contests now has 5 different contests at increasing levels of mathematical sophistication. Students who succeed at the top level on these contests become the team representing the U.S. at the annual International Mathematical Olympiad. I'll showcase some interesting, easy and hard contest problems, and a little bit of history. Along the way, I'll comment about the intersection of these contests with the school mathematics curriculum.

Abstracts of Contributed Talks

(in alphabetical order, by presenter)

8 *Formal series and asymptotics for hyperbolic differential equations*

Paul T. Allen, Lewis & Clark College

A number of interesting physical questions can be addressed by studying the asymptotic behavior of differential equations modeling the system of interest. One way to describe asymptotic behavior is to use a formal power series. In this talk, I will give a precise denition of convergence to a formal series and then discuss applications to some hyperbolic differential equations arising in the eld of mathematical relativity.

9 *Investigating Ion Channel Gating Using Mathematical Modeling*

Tyler Allen, Heritage University[**]

My research involves ion channels and the important role that mathematics plays in this field of biology. Data was previously collected from a voltage-gated channel through experimenting and I continued the project by modeling the collected data. By using MatLab, I was able to devise a plot of the experimental data points along with fitting the plot to an exponential function. Future data analysis involves creating a mathematically model using differential equations that produces identical results to that of the experimental data originally collected. A mathematical model will help predict the outcome of future experiments that will save time and resources for the sake of the lab and future researchers.

10 *Independent Events: How Do Informal Definitions And Sample Problems Contribute To Students Misconceptions?*

Barbara Alvin, Eastern Washington University[†]
Jacqueline Coomes, Eastern Washington University[†]

The presenters will share their experience with students responses to exercises designed to explore their understanding of independent events. Reasons for students misconceptions, as reported by the students, will be presented.

11 *Techniques for actively engaging students in learning cryptology*

Liljana Babinkostova, Boise State University

Cryptology studies mathematical methods used to achieve information security objectives. With society's increasing dependence of on computing and communication over insecure channels the need for providing information security has become more important than ever. Cryptology encompasses both the mathematical design of cryptographic systems to accomplish information security objectives (cryptography) and the mathematical analysis of the vulnerability of these systems to attacks (cryptanalysis).

We describe our experience in creating and teaching courses in cryptology at Boise State University. We discuss our innovations in teaching these courses to give students a realistic exposure to cryptology and its mathematical foundations, the computational issues underlying information security, and to promote the notion that information has value worth protecting.

12 *Permutational Techniques for Multivariate Ecological Data*
J.D. Bakker, University of Washington

Community ecology is replete with data that do not satisfy the assumptions of parametric statistics. Permutation-based techniques have been developed that do not require these assumptions, but are computationally intensive. Technological advances in recent years have made these techniques feasible for widespread application. I will review two techniques that may not be familiar to practitioners of parametric techniques. PERMANOVA enables permutation-based tests of linear models, including complex designs with categorical and continuously distributed variables. NMDS is an ordination technique and a useful visualization tool. Both techniques will be illustrated with examples from my ecological research.

13 *Shuffle Your Way to Order*
Michaela Balkus, Pacific University**

In this talk we will explain and explore the "pinch" shuffle introduced in *Number Theory* by George Andrews. We will discuss a general formula to answer the question of how many "pinch" shuffles it takes to get decks of various sizes back to their original orders. In addition, upper and lower bounds for the necessary number of "pinch" shuffles for any given deck to return back to its original order will be given.

14 *The Fourier Transform, $L^2(\mathbb{R})$, and the Riemann-Lebesgue Lemma*
Scott Beaver, Western Oregon University

Though conveniently defined pointwise on the Banach space $L^1(\mathbb{R})$, the Fourier and inverse Fourier transforms of functions in the Hilbert space $L^2(\mathbb{R})$ are generally only defined by denseness and an associated limiting process. However, if both f and its Fourier transform $\hat{f}$ reside in $L^1(\mathbb{R})$, the Riemann-Lebesgue Lemma (which we'll prove) can be used to show that both $f, \hat{f} \in L^2(\mathbb{R})$, permitting pointwise definitions of the transform pairs for this class of $L^2(\mathbb{R})$-functions.

15 *Sonia Kovalevsky Day*
Cheryl Beaver, Western Oregon University

Sonia Kovalevsky Day is a program of hands-on workshops for high school girls and their teachers. Western Oregon University has hosted a Sonia Kovalevsky Day for six years. We will discuss some of the workshops we've done and how to go about organizing and running a Sonia Kovalevsky Day.

16 *Knotted Surfaces*
David Bell-Garrison, Gonzaga University**

In mathematics, a knot is an embedding of a circle in 3-dimensional Euclidean space, $\mathbb{R}^3$, considered up to continuous isotopies, in other words, a string tied in a knot with its ends glued together. In this presentation we will be discussing some basic properties of knots and exploring how they can be related to certain topological surfaces called Seifert surfaces.

17 *The SPLASH Summer Program*
Michelle Bernson, Boeing

SPLASH is a summer program in math and science for girls entering 8th grade. Hosted by Seattle University, it is designed to give girls a chance to learn about math and its applications in the physical world. The girls learn skills that will help them excel in their classes during the school year. They also learn about careers in math and science and about opportunities to use their knowledge and skills to serve their community. I will discuss my involvement in this program and share information regarding how others could get involved or start programs of their own.

18 *Protein Classification with Knot Polynomials*
Rachael Bernt, Gonzaga University[**]

We will apply knot theory to the problem of characterizing proteins based on knot invariants, in hopes that knot theory will yield a quantitative method for classifying proteins. More specifically, we will represent proteins with Alexander-Conway polynomials to clearly distinguish between different proteins and group similar proteins into families based on shared structure.

19 *The Arzela-Ascoli theorem and Its Uses*
James Bisgard, Central Washington University

As undergraduates, we learn that in $\mathbb{R}^n$ closed and bounded sets are compact. However, in more general spaces, this is no longer true. For example, in the space of continuous functions with the maximum norm, closed and bounded sets might not be compact. However, compactness is a very useful property, particularly in proving the existence of minimizers. The Arzela-Ascoli theorem characterizes compact sets in the space of continuous functions with the maximum norm. I will state the theorem, as well as present a couple of common applications in minimization problems.

20 *Teaching Quantitative Reasoning with the News*
Stuart Boersma, Central Washington University

The daily newspaper has numerous examples illustrating the need to be able to deal critically with quantitative information in today's society. Newspaper articles provide a variety of changing contexts which emphasize the relevance of quantitative reasoning in everyone's life. Additionally, being current and relevant, newspaper articles provide students with an easy answer to the question "When will I ever use this?" By carefully choosing articles and constructing meaningful study questions, an instructor can help students investigate absolute and relative change, make sense of very large (or small) quantities, and extract information from simple mathematical models. Newspaper articles can be used in a variety of effective pedagogical settings and naturally provide numerous different contexts for student exploration, review, and assessment of basic mathematical skills. Specific examples of articles, study questions, assessment instruments, and resources for teaching such a course will be presented.

21 *A Model of the Ocean Migration of Pacific Salmon*
Chloe Bracis, University of Washington*

Salmon migration on the high seas is poorly understood in comparison with freshwater migration. This model of the oceanic phase of Pacific salmon migration combines advection by ocean currents with fish swimming behavior to model trajectories of salmon. The behavior rules are based on possible responses to components of the earth's magnetic field, and the ocean currents are provided by a numerical ocean model. The model is used to examine spring run Chinook salmon returning from the high seas to the Columbia River, including the effects of interannual variability in ocean currents and what variability among stocks in arrival timing suggests in terms of probable ocean distributions.

22 *An Introduction and Analysis of Birth-Death Probability Models*
Megan Buzby, University of Alaska Southeast†
Donald Estep, Colorado State University

Differential equations are used to describe much of the universe as we know it: from the spread of bubonic plague to weather modeling and prediction. These equations are an approximation when they're used to describe discrete events, such as population and disease dynamics, where a single individual may be born, die, become infected or recover from a disease. If the differential equation is of the form $\dot{y} = f(y) = yg(y)$, there is a consistent method to define the probabilities of each "event" using time discretization and local numerical approximations. The natural way to compare these two models then, is using the expected value of the discrete probability model and the solution to the differential equation. Locally, these two models behave similarly. Globally, however, the difference may be at most exponential in nature. In this talk, I'll give an introduction to how such probability models are constructed, show simulations for a few examples in ecology, and discuss the error bounds as time allows.

23 *Teaching Mathematics with a Strip of Paper*
Nicholas Cain, University of Washington*

Mathematics lessons that are simultaneously hands-on and engaging, while still teaching important concepts relevant to an undergraduate mathematics curriculum, can be as rare as they are useful. In this talk I will introduce an algorithm for dividing a strip of paper into n segments, using a simple iterative folding scheme. A prime example of Vertical Integration in mathematics instruction, I consider it a teaching gem because it provides a scaffolding to teach a diverse range of mathematical concepts to students of a variety of ages and abilities.
At its most basic level, I have used this lesson in elementary school education as a fun hands-on activity to teach concepts such as algorithm and convergence. I have also personally used this lesson with advanced high-school students (pre-calculus) as an exercise in critical thinking, algebra, and concept exploration. Concepts such as prime factorization and fixed-points of a map are also readily introduced at this level.
To the undergraduate, this lesson reaches its full potential as an exploratory tool for a dynamical systems course, in the hands of students with both calculus and proof-construction experience. A simple proof for the algorithm relying on the Fundamental Theorem of Arithmetic and the Strong Law of Induction provides students with a connection between abstract proof technique and hand-on mathematical experiment, and will be presented in the talk. Advanced extensions of this lesson, some quite challenging and geared towards exploration projects, will also be discussed.

24 *A Biomathematicians Journey into Novel Signaling Pathways*
Hannah Callender, University of Portland

Here I will discuss my journey through the development and analysis of a mathematical model of a G-protein-coupled receptor signaling pathway in macrophages that has been linked to several physiopathological conditions, including atherosclerosis (which causes blockage of arteries) and hypertension (high blood pressure). The model is based on time-course measurements of several key pathway components, with a particular focus on differential dynamics of multiple species of diacylglycerol. Diacylglycerol is an important second messenger molecule implicated in several cell behaviors, including proliferation, programmed cell death (apoptosis), differentiation, and tumor promotion, and the better we can understand the production and degradation of this molecule within the signaling pathway, the better chance we have of developing novel therapeutic treatments for diseases related to the malfunction of this pathway. Current results of our modeling effort have suggested an additional branch to the signaling pathway, and sensitivity analysis has provided guidance as to where we should direct further study.

25 *Applied Mathematics for Environmental Sciences: A Discussion*
Dennis Hartmann, University of Washington†
Loveday Conquest, University of Washington†
Vince Gallucci, University of Washington†

Dr. Hartmann, Interm Dean of the College of the Environment, along with colleagues Dr. Conquest, the Director of Quantitative Ecology and Resource Management and Dr. Gallucci, the Director of the Center for Quantitative Science, will give a brief overview of each of the organizations they head and lead a discussion on the role of mathematics in the study of the environment, ecology and natural resource management.

26 *Reducing Seabird Bycatch in Alaska Longline FisheriesFrom GLMs and GAMs to Policy and Regulation*
Loveday L. Conquest, University of Washington

”Bycatch” denotes the accidental mortality of seabirds from commercial fishing activities. Thus, Alaskan commercial fisheries are concerned with incidental mortality of endangered seabirds. A study comparing bycatch reduction technologies was carried out in Alaska’s Bering Sea. The three technologies were: integrated weight longlines (IW), IW with paired streamer lines (IWPS), and unweighted longlines with paired streamer lines (UWPS). Generalized additive models (GAMs) were used to evaluate treatment effects and other factors influencing catch rates. Seabird bycatch rates were reduced by all mitigation methods; the relative effectiveness varied by foraging guild. A management practice that adds weighted lines to the paired streamer lines already in use can help seabird conservation in longline fisheries, while not appreciably reducing fish catch.

27 *The Towers of Hanoi Get a New Peg*
Daniel Corliss, Western Oregon University**

Solutions to the Towers of Hanoi puzzle have been known for many years, with an optimal solution for n disks taking $2^n - 1$ moves. Using more than three pegs for n disks will obviously lower the potential number of moves required for a solution, but how much more efficient an algorithm can get has not yet been shown. I will present a solution to this puzzle for four pegs and briefly introduce the proof that it is an optimal solution to the puzzle. Further, we will discuss the patterns found in the number of moves required for a solution of any number of disks, just as $2^n - 1$ moves solved three towers. We will see that this new puzzle follows a similar sequence of optimal moves, but for large n, having just one additional tower will save massive numbers of moves!

28 *Towards Individualized Code Encryption, Obfuscation, and Tamper Resistance*
Dillon Cower, Boise State University**

Software piracy has been a growing issue in the software industry for decades, and impersonal licensing schemes are often distant and unrelated to a program's execution. This means it can be trivial to remove a program's protection schemes, or even reverse engineer its license checking algorithm to produce a valid license, not tied to a particular user or corporation. I propose to combat this by encrypting and obfuscating executable code on a per-user basis, producing a unique executable for each license that exists, in addition to having numerous checks for tampering within the executable. Altogether this creates an interesting and difficult challenge for software pirates.

29 *Explorations in Math*
Mary Cropp, Community Outreach Director for Explorations in Math

Explorations in Math is a Seattle-based non-profit partnering with elementary school communities to fundamentally change attitudes about math. Our before- and after-school math clubs, family math nights, all-school math challenges, parent and teacher workshops and Mathematicians-in-Residence, among other offerings, inspire children, teachers, and parents to explore, play with, and enjoy the challenge of math. Fostering this enjoyment of math builds a culture in which all children do more mathand believe they can succeed doing it.

30 *Surface structures and constructing 3-manifolds*
Ryan Derby-Talbot, Quest University

An important investigation in low-dimensional topology is to identify what properties a manifold inherits from smaller pieces out of which it is constructed. For example, many topological properties of 3-manifolds are determined by the types of surfaces embedded in them, and one can ask what happens to this surface structure when 3-manifolds are combined or glued together in various ways. In this talk, I will discuss (with lots of pictures) several methods for constructing 3-manifolds via a variety of gluing methods, and explore what happens to topological properties (particularly those involving embedded surfaces) under these constructions. For those aware of the terminology, we will investigate primarily the effects on essential and Heegaard surfaces of gluing along tori and Dehn filling.

31 *Adopt-a-Group Project with a Course Wiki*
Tom Edgar, Pacific Lutheran University

In the Fall of 2009, I attempted to update an idea from Ralph Czerwinski designed to have abstract algebra students participate in a writing assignment. The goal was to have each student "adopt" a mathematical group and determine interesting properties of the group based on the topics we discussed during the course. Instead of requiring a full-on paper due at the end of the year, I tried to have the students compile their work online in a wiki format, updating continuously. I consider this assignment simultaneously a success and a failure. In this talk, I will discuss the benefits I found from the assignment, including the benefit of using online communities like blogs and wikis, as well as the problems I encountered. I intend on using this assignment again, and I will explain the ways I hope to improve the assignment next time.

32 *How fast does a continued fraction converge?*
C. E. Falbo, Sonoma State University

Let b be any positive number and $u(b)$ be the positive root of the quadratic equation $x^2 - bx - 1 = 0$. We show how to compute the rate at which continued fractions (cf) converge to $u(b)$. It turns out that this rate depends only upon b and not upon whether the limit is rational or irrational, thus raising questions about the claim that ϕ is the most irrational number.

33 *Random Matrix Theory in Finance*
Jason J. Foster, Seattle University**

Random Matrix Theory (RMT) is the study of the statistical properties of matrices with independent random elements. By observing the deviations from the theoretical RMT behavior, we are able to analyze nonrandom properties of the system. That is, we may study the interactions of the underlying data. To simulate RMT behavior, we present numerical methods in the statistical programming language, R. We also present an application of RMT to financial correlation matrices, which is a widely used statistical method in financial risk management. Doing so allows us to show that the structure of the financial correlation matrix is dominated by noise but that there exists deviating eigenvalues that contain information. Similarly, interpretation of the largest deviating eigenvalue follows from the behavior of the financial market. That is, all assets in our sample participate in the largest deviating eigenvector. We conclude by identifying the dominant sectors of the financial market from the deviating eigenvectors.

34 *Risk Analyses for the Management and Conservation of the Blue Shark in the North Atlantic Ocean*
A. M. Aires-da-Silva, University of Washington*
V. F. Gallucci, Professor, University of Washington†

Management and conservation of the blue shark are handicapped by limited adequate stock-assessment data. The status of this stock is ambiguous at a time when catch appears to be on the rise and new trade and exploitation patterns are emerging. This is a demographic and risk analysis using non-catch data. An age-structured matrix population model with stochastic vital rates was constructed. A mean finite rate of population increase of 1.23 year and a mean population doubling time (t2) of 3.08 years suggest that the blue shark is one of the most productive shark species. However, this high productivity is misleading because an elasticity analysis shows a strong dependence of the population growth rate on the survival of juveniles ($<$04 years). An analysis of the risk that the captured (directed and bycatch) mass will force the population to decline to levels below a threshold of 50% of pre-exploited population levels was conducted. This population level is considered a critical point for sustainable population dynamics. The risk analysis is proposed as a way to evaluate the probability that a given management strategy will put the population at risk of decline.

35 *Cyclotomic Integers*
Z. Michael Gehlke, Seattle University**

Cyclotomic integers are a special class of algebraic integers, which, in turn, are a generalization of the ordinary integers. In this talk I will discuss recent results on the classical problem of determining power bases for certain sets of cyclotomic integers. Necessary background on cyclotomic integers and number theory will be given.

36 *Investigations of an Upper Bound for the Univalent Bloch-Landau Constant Using Circle Packing*

Ryan Grandy, Seattle Pacific University†**
Hannah Hsu, Seattle Pacific University†**
Sabrina Houser, Seattle Pacific University**,
Cassandra Bradley, Seattle Pacific University**

In this talk, we provide some background on the Bloch-Landau constant for univalent functions including known bounds for the constant, and we describe a domain conjectured by Thomas H. MacGregor to improve on the known upper bounds for the constant. We also lay out some necessary background on circle packing and discrete analytic function theory. Finally, we present some preliminary findings using Circle Packing to estimate an upper bound for the univalent Bloch-Landau constant based on the domain conjectured by MacGregor.

37 *The Analytical Closed-Form Computation of Statistical Parameters for Modeling Random Distances Between and Within Polygonal Regions - Its Use in Airtanker Modeling*

Francis E. Greulich, University of Washington

The location and dispatch of airtankers for fire control involves the optimal allocation and use of an expensive resource. The effective use of the airtanker is time-critical; delays result in loss of life and property. One of the mathematical issues encountered and solved in addressing this allocation problem is the calculation of the first two moments of the random distance within and between polygonal regions. The analytical solution to this problem has been unsuccessfully addressed by mathematicians from the time of Émile Borel (1925) to Harold Ruben (1978). The successful development of closed form analytical expressions for the first two moments provides incomparably fast calculation of these parameters to machine precision. Operations research analysts modelling the allocation of airtankers now have easy access to these parameters.

38 *Bootstrapping Methods in the Analysis of Differential Equations*

Chris Hallstrom, University of Portland

Many results in the analysis of differential equations are based on the so-called *bootstrap principle* in which an assumption about a solution u is used to prove an even stronger and unconditional result. For example, by assuming that a solution u obeys some quantitative bound, we can use the differential equation to establish even stronger control on u. Also known as continuity arguments, these methods are essentially a continuous version of mathematical induction. I will briefly discuss an example or two.

39 *Wavelets on Graphs via Spectral Graph Theory*

David Hammond, NeuroInformatics Center, University of Oregon †
Pierre Vandergheynst, Ecole Polytechnique Fédérale de Lausanne

Wavelet analysis has proved to be a very successful tool for signal analysis and processing. However, many interesting data sets are defined on domains with complicated network-like structure to which classical wavelets are not suitable. In this talk I will describe a novel approach for generating a wavelet transform for data defined on the vertices of a finite weighted graph. A fundamental obstacle to extending classical wavelet analysis to graph domains is the question of how to define translations and scalings for functions defined on an irregular graph. We sidestep this by appealing to analogy with the graph analogue of the Fourier transform generated by the spectral decomposition of the discrete graph Laplacian $\mathcal{L}$. Using a bandpass-shaped generating function g and scale parameter t, we define the scaled wavelet operator $T_g^t = g(t\mathcal{L})$. The spectral graph wavelets are then formed by localizing this operator by applying it to indicator functions at each vertex. An analysis at fine scales shows that this procedure yields localized wavelets. I will describe how spectral graph wavelet frames can be designed through sampling of the scale parameter, with controllable frame bounds. Additionally, I will describe a fast algorithm for computing the wavelet coefficients based on Chebyshev polynomial approximation, which avoids the need to diagonalize $\mathcal{L}$. I will conclude with illustrative examples of the spectral graph wavelets on several different problem domains.

40 *Using Instructor Error–Intentional or Not–To Extend Mathematical Understanding and Change Students' Epistemic Beliefs*

Allen G. Harbaugh, Seattle Central Community College

The nature of mathematical research is often hidden from our students by well written textbooks, error-free classroom lectures, and single-strategy homework exercises. What students do not see is the many errors that lead to fruitful discoveries, the dead-end strategies pursued along the way, or the spark of creativity which illuminates the correct direction to obtain the desired solution. This presentation will discuss how errorsbe they intentional or noton the part of the instructor can lead to rich classroom discussions, a deeper mathematical understanding of the problems (often via clarification of assumptions), and changes in students epistemic beliefs regarding the nature of mathematical knowledge. Three problems will be presented, one each from trigonometry, statistics and differential equations. The error and origination of each problem will be discussed in light of the pedagogic benefits serendipitously made available to the students. In addition to the pedagogic benefits, this presentation will also examine the epistemic beliefs held by math students and how exploration of mathematical errors can illuminate the nature and ramifications of such beliefs. A brief introduction to the theory of personal epistemology and mathematical epistemic beliefs will be incorporated into the presentation.

41 *Motivation & Belief Profiles of Mathematics Students at All Levels of the Community College System*

Allen G. Harbaugh, Seattle Central Community College

This study addressed two research questions. (1) Is the multitrait-multimethod (MTMM) confirmatory factor analysis (CFA) the better statistical tool to detect the presence of five distinct dimensions in a traditional survey tool for epistemic beliefs? (2) What are the epistemic belief and achievement goal orientation profiles of students at different levels of mathematics in the junior collegesystem? Participants were enrolled in all levels of mathematics classes from a community college district in the Pacific Northwest. An epistemic belief scale was constructed using items from survey instruments in the personal epistemology literature. Along with epistemic belief dimensions (certainty, structure, authority, innate ability, quick learning), the survey items were also classified as being axiomatic, ontologic, deontologic or procedural in nature. The MTMM analysis revealed the presence of five distinct dimensions of belief, and accounted for an additional source of variance related to the wording of the items. Fit indices suggest a strong correspondence between model and data. Students achievement goal orientations were measured with a survey based on Nicholls original task, ego and work-avoidant framework. Statistically distinct profiles emerged for the four levels of mathematics surveyed (developmental, terminal/non-calculus math, calculus preparation, and post-calculus). Differences between the math levels were detected for all epistemic belief dimensions except structure of knowledge. The effect of math level was statistically significant for all three goal orientations. Relationships between the measured constructs will be presented, along with future research plans regarding the MTMM CFA protocol for survey research.

42 *Making the Sweet Spot Sweeter (S)*
Tyler Harmon, Linfield College†**
Jason Haun, Linfield College**
Veronica Siller, Linfield College†**

Sports teams are always searching for the best equipment and strategy to give their team an edge. Our goal was to create a model that shows the return velocity of a baseball with different impact spots on the bat in order to show the effects of a sweet spot on a baseball bat. We also modeled bats of different flexibility and with corking effects. We successfully created a discrete model based on the Euler method. The model assumes that all interactions follow Hookes law and that the energy loss can be ignored. The results show a distinct sweet spot, a distance from the end, where the return velocity is maximized. The magnitude of this boost has been shown to vary for different flexibilities. In addition, the model shows improvement in the properties of the sweet spot for a corked bat. The model also suggests that there is an optimal corking length.

43 *Cubes and Squares*
James D. Harper, Central Washington University

The sum of two cubes is not a cube. This is Fermats Last Theorem for the case $n = 3$. However, the sum of two cubes can be a square: $1^3 + 2^3 = 3^2$. Using this triple as a seed I will derive a beautiful formula that will generate an infinite number of solutions to the Diophantine equation $A^3 + B^3 = C^2$. Different seeds will generate different formulas. I will also provide a formula for $A^2 + B^2 = C^3$.

44 *Brunn-Minkowski-Type Inequalities*
David Hartenstine, Western Washington University

The Brunn-Minkowski inequality is central to geometry and analysis. Since its discovery more than 100 years ago, it has been generalized in many ways. In particular, several Brunn-Minkowski-type inequalities related to partial differential equations have been established. After surveying known results in this direction, recent results concerning Monge-Ampere equations and variational capacity will be presented.

45 *Optimizing Software Architecture for Efficient Probability Modeling*
Chris Harvey, University of Portland**

Probability modeling and advanced forecasting are often leveraged in operations research to optimize product inventory levels. This study focuses on improving probability models replenishing items with intermittent and seasonal demand. This was done by implementing probability models that were engineered in the high level statistical language R. Because the initial code implemented was not engineered for speed or efficient memory use it limited our ability to quickly test different simulation methods. To address this problem the simulations were re-engineered in a manner that compartmentalized the code into distinct pieces that were unaware of the overarching data structure. This resulted in simulations with significantly decreased run times. The modular nature of the main simulation code also allowed for rapid adaptation to various updating methods. We will discuss the problematic design structure of the original simulations, and how the newly engineered code addressed these issues.

46 *Using Writing to Teach Mathematical Modeling*

Chris Hay-Jahans, University of Alaska Southeast, Juneau

One of the goals of the Mathematical Modeling course at UAS is to provide students with a feel of the interdisciplinary nature of mathematics through a rigorous treatment of problem solving and an exposure to further mathematics. Because of the mixed backgrounds of students who enroll in this course, there is a need for an alternative approach so as to achieve upper division quality, yet allow less experienced students to benet from the course. This talk outlines a delivery strategy that has evolved through experiences in past courses. While there have been trying times, the end results of teaching this course have always been rewarding. The talk will close with a brief discussion on what might be expected while teaching such a course.

47 *How do you know?*

Daniel J. Heath, Pacific Lutheran University

We discuss a simple first day of "College Geometry" homework assignment. The assignment is to construct (and save) an isosceles triangle using freeware "Geometry Playground," to send the file to the instructor, and to come to the second class prepared to discuss how you know your triangle is isosceles. This simple assignment ensures that all students can both access software for checking geometric conjectures and contact their instructor outside of class. However, the main result of this assignment is the commencement of a rich conversation, "How do you know?" that will follow us through the semester.

48 *Geometry Playground*

Daniel J. Heath, Pacific Lutheran University†
Joshua Jacobs, University of Washington†∗
Ksenija Simic-Muller, Pacific Lutheran University†

We present *Geometry Playground*, an open-source, freeware application for geometry educators. Geometry Playground is a continuing collaborative effort that allows straightedge and compass construction in multiple geometries. It continues to grow organically as people contribute as programmers, curricula writers, beta-testers, or linguistic translators. Our goal in this presentation is to raise awareness of the opportunities available from use of or contribution to this growing tool for geometry educators.

49 *A Comparative Study of the QL and Writing Across the Curriculum Initiatives: What can Mathematicians Learn?*

Cinnamon Hillyard, University of Washington Bothell

In recent years, the quantitative literacy (QL) movement has grown in depth and breadth. A similar, curricular movement, Writing Across the Curriculum (WAC), started about twenty years earlier and has changed the ways in which most college and university courses are designed. It is now considered best practice for any Writing 101 course to move beyond a skills course to writing within some thematic context. Further, most college courses, across all disciplines, are expected to contain some writing component, and most colleges have an associated Writing Center. Parallel results including nationwide, campus-wide integration of QL are certainly worthwhile goals. This paper will provide a comparative, historical analysis of the QL and WAC movements and suggest recommendations from the WAC literature that could apply to ensure future growth of QL education.

50 *Newton Coefficients of Ehrhart Polynomials*
Matt Hudelson, Washington State University

Given a polytope P in $\mathbb{R}^n$ whose vertices are integer lattice point, we let $f(n)$ represent the number of lattice points in or on the surface of nP, the polytope that is P magnified by a factor of n. The function $f(n)$ is well-known to be a polynomial called the "Ehrhart Polynomial." We examine an interpretation of this polynomial via Newton coefficients and show that under certain conditions, these coefficients provide information about dissections of P into fundamental n-dimensional simplices.

51 *Biosphere 3: Quantitative Prediction in the Freshman Biology Laboratory*
R. Higley, Highline Community College
V. Hunt, Central Washington University†
T. Sorey, Central Washington University

We discuss a marine biology unit for college freshmen that incorporates substantial quantitative literacy and that was developed in accordance with the goals of the Curriculum for the Bioregion Project and the Mathematics Across the Curriculum project. Placed in the engaging context of marine biology and global environmental issues, students develop skill in thinking through the larger implications of data collected in the course of a lab experiment, and make quantitatively based predictions from their data sets.

52 *Density in the calculus sequence*
Martin Jackson, University of Puget Sound

Density may deserve more attention as a theme in the calculus sequence than we often give it. A typical calculus text might introduce mas density, somewhat off-handedly, in sections on center of mass and moments of inertia. Students mightbenet from an earlier and more detailed introduction to density. Students typically bring to calculus a notion that density is mass divided by volume. This initial notion can be generalized in several ways:

- from mass to other quantities such as number, cost, charge, or probability
- from volume to length or area
- from uniform to non-uniform

The first two generalizations are common in applications from outside mathematics that involve density. The last generalization is where calculus comes into play. I have been developing course materials with the goal of helping students generalize the initial idea of density they bring with them and moving them toward a more general notion of density as something to be integrated. I'll describe the handouts and problems Ive drafted so far with the hope of inviting suggestions for improvements and extensions.

53 *Grade Inflation at Whitworth*
Joshua Jenson, Whitworth Universerty**

Grade inflation has been a on-going issue in higher education across the nation, with schools typically experiencing in between 0.1 to 0.15 grade point increase in inflation per decade since the 1980s. In fact, Cornell and University of Michigan recently released similar studies. For some of Whitworths tenured professors, the change has been noticeable since the beginning of their career at Whitworth. Few long term studies have been conducted. Therefore, valuable knowledge can be gained on accepted trends by taking a long term approach in order to unearth trends before the 1980s. Also, valuable inferences on the changes of Whitworths grading standards can be observed in relative terms.

54 *Estimation of the Lift and Drag Coefficients for Zebra and Quagga Mussels Using an Inverse Method Calculation Procedure*

Jay A Johnson, University of Washington†
Suzanne Peyer, University of Wisconsin
John Hermanson, USDA

Zebra and Quagga mussels have invaded the Great Lakes and inland waterways of North America. Zebra mussels dominate in habitats with higher water velocity, however. Mussel shell morphology is known to have functional consequences for mussels subjected to water flow. At higher velocities, the byssal thread attachment system can fail dislodging the mussel from its moorings. Using data collected in fluid flow experiments, a novel inverse method calculation was developed to find values of the lift and drag coefficients which ameliorate the results of theoretical models with the results of binomial experiments involving the frequency of detachment failure of mussels subjected to three velocities of fluid flow.

55 *Using a Simple Model to Replicate Spatial Patterns in Low-Severity Fire Regimes*

Maureen C. Kennedy, University of Washington†
Don McKenzie, US Forest Service

Landscape ecologists use neutral models to generate null hypotheses for pattern-process interactions, which enable us to separate intrinsic stochastic processes from other underlying processes. The faithful reconstruction of historical (pre-1900) fire regimes is a difficult, yet essential, task to inform ecosystem management. A database of fire-scarred trees in low-severity fire regimes provides a record of historical fire occurrence, but these records do not inform the mechanisms that generated individual fires (e.g., fuels and weather). We produce a neutral model for fire history, which is a simple stochastic representation of fire spread on a blank raster grid. We will discuss the results of our model and how it conforms with the historical data

56 *Circular Migrations and HIV Transmission Dynamics*

Aditya Khanna, University of Washington∗

The objective of this work is to investigate the impact of circular migrations – the repetitive movement of people between two or more locations –on the transmission dynamics of HIV. It is known that HIV infectivity varies with time since infection. Since AIDS has a long latency period, the high infectivity of HIV before symptoms appear can have a major impact if infected individuals are changing locations and partners frequently, potentially without knowing their infection status. The interaction between timing since infection and variable infectivity is the major focus of the current work. I am investigating this interaction using compartmental Ordinary Differential Equation (ODE) models that are an extension of the classic Susceptible-Infected-Recovered (S-I-R) structure, and a stochastic network-based framework based on Exponential Random Graph Models (ERGM). The ERGM framework allows us to model person to person transmission and consider relational timing, and hence, concurrency. I will present results from the two modeling frameworks that allow us to study the relative properties of the two approaches.

57 *A survey to examine students perspectives of statistics as a quantitative reasoning course*
Daniel Kim, Southern Oregon University

Typical student course evaluations focus on instructors ability as a teacher, but do not on course itself. As a result, such evaluations fail to provide opportunity for instructors to understand students perspectives of course itself. A survey was designed to examine students perspectives of statistics as a quantitative reasoning course. This survey was conducted to a sample of statistics students at Southern Oregon University. In this talk we will share our findings from the survey.

58 *Using Integrative Projects to Encourage Quantitative Reasoning*
John Knudson, Seattle Central Community College†
Greg Langkamp, Seattle Central Community College†
Jane Muhich, Seattle Central Community College†
Greg Hinckley, Seattle Central Community College†

A report on several works-in-progress at Seattle Central Community College in which students use the perspectives of mathematics and another discipline to understand a concrete problem that has strong ties to the world around them.
Reasoning quantitatively and using math is essential in understanding the problem, but also the concreteness of the problem and conditioners for understanding the math.

59 *Helicoidal surfaces of constant anisotropic mean curvature*
Chad Kuhns, Idaho State University*

At a point on a surface one may consider the collection of curves given as the intersections of the surface with planes given as the span of the unit normal and a vector tangent to the surface. The curvatures of these curves at the point may be recorded, and the maximum and minimum averaged to obtain the mean curvature of the surface at the point. The critical surfaces of the surface area functional are characterized by having constant mean curvature. Given a smooth function γ on the 2-sphere satisfying a regularity condition, a generalized functional is obtained by integrating over a surface the function $\gamma(\nu)$, where ν is a Gauss map. Such a functional assigns an anisotropic energy to an immersed surface. We seek the critical points that exhibit helicoidal symmetry; they are characterized by constancy of what we call anisotropic mean curvature. The Euler-Lagrange equation of this functional is found, and then specialized to helicoidal surfaces. By generalizing a recently published result, we show that a simple transformation of the prole curves of helicoidal CAMC surfaces can be given as level sets of an elementary functions defined on $\mathbb{R}^2$ that depends on γ. Examples are illustrated using Maple software.

60 *It seemed like a good idea: reflections on a cross curricular QL project*
Emily Lardner, The Evergreen State College

In this talk, I outline unexpected difficulties that emerged in the context of an NSF project intended to promote quantitative literacy across the curriculum through spreadsheet modules. The challenges we facedidentifying the most essential quantitative skills, identifying appropriate and authentic contexts for those skills, and assessing students quantitative background knowledgesuggest the complexity involved in any large-scale quantitative literacy efforts.

61 *On Local Regularization for an Inverse Problem of Option Pricing*
Ruya Huang, Linfield College**
Cynthia Lester, Linfield College$^{\dagger **}$

We explore the theoretical and numerical application of local regularization methods to an inverse problem rising from financial option pricing. Our purpose is to find the volatility function from noisy call option prices. This is an important problem not only in theory but also for practitioners working in the financial world. However, it has been shown that finding the volatility function from option prices is an ill-posed inverse problem. That is, very small noise in the observed data will lead to huge deviation in the solution (instability). Whenever faced with ill-posed problems due to instability, we need to apply some regularization methods in order to stabilize the problem. However, the existing methods such as Tikhonov regularization, do not take the special structure (causal structure) of this option pricing problem into consideration which leads to nontrivial computational costs. We apply local regularization to the option pricing problem. In addition, we discretize the problem and show our results through numerical examples.

62 *Tiling the Fibonacci identities*
Stephanie Lowrey, Pacific University**

In this talk we will consider Fibonacci identities and prove them combinatorially using tilings. We will first explore tilings using squares and dominoes. We will then generalize this to identities involving tilings with n-ominoes

63 *Simulation of Geophysical Hazards: Tsunamis, Debris Flows, and Storm Surges*
David George, Post-Doc, USGS, Vancouver, WA
Jihwan Kim, University of Washington*
Randall LeVeque, University of Washington
Kyle Mandli, University of Washington$^{\dagger *}$

Shallow water flows such as tsunamis, debris flows, and storm surges, comprise a class of large and complex fluid flows that pose a significant hazard to many communities in the Pacific Northwest. In order to better understand these flows and mitigate some of the hazard they pose, we have been working with geophysicists and hazard planners to numerically model these flows using adaptive techniques in order to reduce the computational complexity making the solutions tractable even on a laptop. In this talk we will present simulations from realistic hazards and discuss future research directions aimed at better representing these flows.

64 *Integer-valued Sinusoidal Functions*
James Mahoney, University of Portland**

The process of discovery in mathematics is highlighted while the examination of a real life situation is detailed. A space filling problem turns into a tiling problem which turns into a regression analysis problem which turns into an exploration of integer-valued sinusoidal functions, with a little modular arithmetic thrown in for good measure. We start out trying to maximize the number of ”cities” on a grid and end up with a class of sinusoidal functions that are integer-valued for periods of three, four, and six.

65 *Criminal Minds of Arkham (C)*
Duncan McGregor, Pacific University†**
J. Alex Patton, Pacific University†**
Chris Upshaw, Pacific University†**

Terror strikes the heart of the city! Mayhem and Murder are on the loose! Who cansave us from these dark and desperate times? To be honest, we can. The police commissioner of Arkham City has contacted our algorithm design team as consultants in an attempt to catch the Arkham Killer before the next attack. The goal was to create two algorithms that would attempt to geographically profile the killer without using a center-of-mass-based method. Traits and patterns of the average serial killer were investigated and we decided to focus one two of them: that serial killers often attack victims/places with similar defining characteristics and that their patterns are often guided by the varying degrees of difficulty of travel within the area. Two algorithms were created: one that profiles based on the characteristics of both the site of attack and victim, and one that uses a mixture of minimal spanning and minimal distance algorithms. These were combined, refined, and tested.

66 *Finite dimensional division algebras over fields*
Kelly McKinnie, University of Montana

My research is in the field of non-commutative algebra. I study the class of finite dimensional division algebras over a field. A familiar example of such an object is the 4-dimensional real Hamilton quaternions. In this talk I will discuss some of the main open questions regarding finite dimensional division algebras, including the cyclicity question and questions regarding indecomposability. I will also relate how my research fits into this arena, briefly stating new results regarding how precisely splitting fields determine a division algebra.

67 *Fibonacci Numbers in Nature*
Rebecca Meyer, Whitworth University**

Many people are familiar with the popular Fibonacci sequence and the fact that it appears in nature. While life and growth in nature appear to be completely random, the truth is there are some mathematical explanations for the patterns that we see. In this talk I will discuss the many places that you can find the Fibonacci sequence in nature and explore some of the reasons why we see the patterns that we do.

68 *A Mathematical Journey*
Dania Morales, Western Oregon University**

Over the course of this presentation I will expand upon the findings of Juame Paradis, Pelegri Viader, and Lluis Bibiloni in the article ”A Mathematical Excursion: From the Three-Door Problem to a Cantor-type Set” whilst guiding you through a mathematical journey. We will start our trip somewhere well known–the Three-door Problem. We will then examine a generalized problem called the n-box problem. In solving for these problems we will discover a new representation of the reals in $(0,1]$, using Pierce expansions. By utilizing this expansions we are able to enumerate the rationals, and prove the irrationality of Euler's number, e. The next stop in our trip, is exploring sets of Pierce expansions in $(0,1]$ and their associated Lebesgue measures. Finally, we end our trip at Cantor-type Perfect sets and Cantor-type perfect sets comprised completely of transcendental numbers.

69 *The Development of Interest in a Business Math Course*
Lawrence Morales, Seattle Central Community College

In this study, a community college business mathematics course using extended, real-world team projects was examined. Nine students and 2 instructors were interviewed and observed several times during a 12-week time period. Students were interviewed and asked about what caught and held their interest in course content, and how they perceived the course content to be useful to the attainment of future goals. Instructors were asked about their goals and ideas about effective teaching and learning, as well as student interest. Taking a grounded theory approach, data analysis showed the major factor that caught student interest was the meaningful application of mathematical content to authentic real-life and business-related problems. Student interest was held by both meaningful and involving activities, and was supported by increased levels of stored knowledge about mathematics and its application. Stored knowledge, stored value, positive affect, and a willingness to re-engage in future mathematically related tasks characterized the emergence of individual interest for certain students. Future time perspective theory was integrated into the study to examine the degree to which students looked into the future to see the utility of their present tasks. Levels of endogenous instrumentality and situational interest started high at the beginning of the course and remained at those levels. Strong correlations emerged between these two constructs, suggesting a relationship between them in this context. There was support for hypotheses in the Four Phase Model of Interest Development proposed by Hidi & Renninger (2006). The roles of meaningfulness, endogenous instrumentality, and stored knowledge in the development of interest, and how they might be different in a context where course content closely aligns with student expectations and goals, are discussed in light of previous research and models of interest development.

70 *Assess the Accuracy: Critical Thinking in Introductory Statistics Courses*
Ashlyn Munson, Pacific Lutheran University

Introductory statistics courses often contain students from a wide variety of backgrounds whose primary reason for taking the course is to satisfy a major requirement. As such, many students are content to learn the steps necessary to complete basic inference, such as t-tests, confidence intervals and regressions, without understanding the need for such tests and the reasons behind their decisions. In an effort to make students embrace the critical thinking behind statistics, I have introduced an ongoing discussion throughout the course called *Assess the Accuracy.*This involves problems which are short descriptions of data collection and analysis written with deliberate inaccuracies that students are asked to identify. This talk will detail the varying success of this implementation within a class discussion, lab and homework assignments, and exams.

71 *Modeling photosynthesis in benthic tidal communities using abiotic factors*
Brad Nelson, Seattle Pacific University[†**]
Brian Gill, Seattle Pacific University

In benthic tidal communities, variation in sunlight and depth determine the light available for photosynthesis. While photosynthesis can drive changes in oxygen concentration, other factors may also influence availability. A Hach data Sonde was used to measure water depth, oxygen concentration, temperature and salinity in a benthic tidal community in Ship Harbor, near Anacortes, WA. These data were compared to surface light intensity measured at Shannon Point Marine Center to model photosynthetic response to abiotic factors, using oxygen concentration as a proxy. Results suggested that temperature was the most important predictor of oxygen concentration, and that a model using temperature and light at depth was the most parsimonious. Future investigations would benefit from measuring light intensity at depth directly, but this study elucidates many of the factors that influence benthic tidal producers, as well as their relative importance.

72 *Three-Way Higher-Order Operator Splitting Techniques*
Hao Nguyen, Seattle University**

Most ordinary and partial differential equations cannot be solved analytically. For these equations, one must rely on numerical methods in order to obtain approximate solutions. Unfortunately, many of these differential equations can only be solved numerically by computationally intensive calculations. Operator-splitting algorithms are fast methods for solving certain classes of differential equations. Operator-splitting algorithms for equations that can be "split" into two parts were developed by Yoshida. By generalizing Yoshida's two-way operator splitting algorithms, a three-way operator splitting scheme is found. However, these three-way operator splitting schemes are recursive and are computationally expensive. Following the work of Yoshida, we developed a new, more efficient, three-way operator-splitting scheme. We present both three-way operator-splitting algorithms and results from detailed comparisons. Finally, we present results from numerical simulations of models of water waves.

73 *An Effective Method for Replenishing Items with Seasonal Intermittent Demand*
Gary Mitchell, University of Portland
Meike Niederhausen, University of Portland†

We consider an important inventory management problem experienced by many retailers, wholesalers, and service operations. Specifically, we consider the problem of replenishing items characterized by non-stationary (seasonal) intermittent demand and address key operational questions inventory managers must answer. Given information about the likely time between demand events and size of the demand (in units), how should an inventory manager determine when and how much to order? Should an order be placed after every demand event? Should an order be placed if no demand event has occurred? We develop a new type of ordering policy that addresses these questions. We introduce a new probability distribution to model non-stationary demand inter-arrival times. Finally, we compare the performance of our algorithm to Crostons Method in terms of inventory levels and associated net profits and discuss implications for inventory managers.

74 *Level sets and extreme curvature of polynomials*
Edward Niedermeyer, Gonzaga University**

Let f be a real polynomial of degree n greater than 1, and let κ be its curvature. Determining the maximum number of zeros of κ is an easy problem: since the zeros of κ are the zeros of f'', the curvature of f is 0 at most $n-2$ times. A much more intriguing problem is to determine the maximum number of relative extreme values for the function κ, or equivalently, determine the maximum number of zeros of κ'. I provide a partial solution to this problem and explore some of its intricacies.

75 *Using "Prepare and Reflect" Worksheets to Foster Student Responsibility*
Debra Olson, Spokane Falls Community College

How often do math instructors ask/suggest/beg their students to read the textbook, arrive prepared, do high quality work, or reflect upon their own thinking? How do we make these skills and habits a regular and expected part of our classroom cultures? This presentation will provide participants with a brief history or where these questions and our attempts to answer them have led a number of people in our department, and a model developed that uses daily Prepare and Reflect worksheets to clarify and require these valuable skills in the classroom.

76 *Geometry, Topology, Group Theory, and Killer Robots*
Valerie Peterson, University of Portland

In certain manufacturing settings one encounters the very practical problem of having to coordinate robotic agents in order to accomplish an assembly task while avoiding collisions. This robotic coordination problem motivates a larger mathematical exploration into how to coordinate moving agents in more general settings. In this talk, well see a variety of such settings–applied and abstract–and introduce a cube complex that records independent movements. Well also discuss some of the interesting topological, geometric, and group theoretic properties of the cube complexes that arise in this context.

77 *Numerical Analysis of the Nonlinear Schrödinger Equation with Discontinuous Initial Data*
David Prigge, Seattle University**

The NLS equation exhibits a Gibbs type phenomenon for small t when given discontinuous initial conditions. Consequently, any numerical method used will have difficulties due to the high oscillations. However, there are previous results that asymptotically describe the small time behavior of some solutions. The goal of this project is to compare the numerical procedure that beings from the discontinuous initial condition with a numerical procedure that first uses the asymptotic formula for small t, then numerically evolves.

78 *Probabilistic Nonconstructive Existence Proofs*
Liam Rafferty, University of Montana*

As a PhD student in mathematics I have been studying and doing research using the Probabilistic Method. The Probabilistic Method is a type of nonconstructive existence proof pioneered by Paul Erdos, which has been used extensively in Combinatorics (and in particular Graph Theory which is my area of expertise) and Number Theory to prove the existence (or nonexistence) of a particular mathematical object. While this method uses probability theory in its arguments, the existence (or nonexistence) of an object is determined with certainty. In this talk I plan to explain, in general terms, what it is that a mathematician using the Probabilistic Method is doing and what he can expect to accomplish.

79 *Techniques to determine food web stability*
Aaron Ragsdale, University of Portland**

We are all familiar with the concept of food webs, and lines connecting pictures of bears and salmon immediately come to mind. However, food web network structure is quite complex, and determining their structural characteristics can prove difficult. In this talk, we will discuss what it means for a food web to be stable, and we introduce a simple technique to numerically determine the stability of food web network.

80 *Statistical Analyses of Metagenomic Data*
Todd Regh, Southern Oregon University[†**]
Naneh Apkarian, Pomona College[**]
Michelle Creek, Chapman University[**]
Eric Guan, Torrey Pines HS
Mayra Hernandez[*]**, San Diego State University**
Kate Isaacs, San Jose State University[**]
Chris Peterson, Pomona College[**]

The ability to discriminate between environments through multivariate statistical analyses of metagenomes is found. The metabolic profile of a metagenome is taken as a representation of the functional diversity of the environment. Analyzing the metabolic profile of a metagenome provides a way to statistically compare metagenomes from similar and differing environments. The use and effectiveness of both supervised and unsupervised multivariate statistical analyses on the metabolic profiles of metagenomes from microbial communities is discussed.

81 *Distinguishing and Fixing Numbers of Matroids*
Mary J Riegel, University of Montana[*]

Recently some work has been done to characterize, for certain classes of matroids, a fixing number and a determining number. The fixing number is the smallest number of elements of the ground set which need to be fixed before the only remaining automorphism is trivial. The determining number is the smallest number of colors needed to color all the elements of the ground set so that the only color preserving automorphism is trivial. In this talk we will discuss the behavior of these two numbers under certain matroid operations. Understanding how these two matroid invariants behave under different operations may prove useful in the development of a universal structure theorem for matroids.

82 *First digits of numbers in data*
Kenneth A. Ross, University of Oregon

Benford's Law is based on the observation that in many sets of data, the first digit is 1 about 30% of the time, the first digit is 9 about 5% of the time, and the frequencies of the other possible first digits lie between 5% and 30%. This is a statistical phenomenon that isn't easy to understand, but it also occurs in a deterministic setting. I will suggest a way that it can be explained to anyone who understands logarithms; by resorting to pictures, one can even avoid logarithms. I will present two versions of Benford's Law that serve as models for data that grow exponentially over time, such as populations of towns or counties.

83 *Quantum mechanics from a geometric point of view*
Barbara Sanborn, Western Washington University

The standard algebraic approach to quantum mechanics is to view it in terms of linear operators on a complex Hilbert space. However, because quantum measurements involve expectation values of these operators, the results are independent of phase, and the (normalized) physical states must be defined as elements of the projective Hilbert space. Since complex projective space is a Kahler manifold, it is equipped with a symplectic form and a Riemannian metric. The symplectic structure enables us to view quantum dynamics as a classical Hamiltonian dynamical system and the Schrodinger equation can be viewed as Hamilton's equations on the projective space. The Riemannian metric yields a measure of the dispersion of observables, accounting for the uncertainty or probabilistic nature of quantum mechanics. This topic provides fertile ground for applications of differential geometry in terms of principal bundles and connections, holonomy, curvature, torus actions and integrability.

84 *Estimating Population Dynamics with Spatially Replicated Time Series*
Kevin See, University of Washington*

State-space models of population dynamics account for two separate types of errors: process noise or environmental stochasticity, and observation error. Although both types of error are modeled, it can be difficult to separate the two. Collecting replicated samples provides some hope of reconciling this difficulty. I will present results from a simulation study that characterizes the benefits of replicated sampling and describes the diminishing returns from additional replication.

85 *Combinatorial Approaches to Sonority Analysis*
Michael Severino, University of Montana†*
Gregory St. George, University of Montana

We look at David Reiner's use of Polyas Theorem and Burnsides Lemma in enumerating musical structures such as chords, scales and tone rows (Enumeration in Music Theory in The American Mathematical Monthly, 92, 1985). We present a new proof using burnsides Lemma to nd a closed form for the number of symmetric tone rows in a n-tone equally tempered scale. We then present an algorithm which uses vector representations of chords in order to measure tension within a composition.

86 *Stability of the Soliton Solution of the Two-Dimensional Nonlinear Schrödinger Equation*
Natalie Sheils, Seattle University**

The two-dimensional (2D) cubic nonlinear Schrödinger (NLS) equation can be used to model the evolution of waves on deep water, pulse propagation in optical bers, and Bose-Einstein condensates. The 1D soliton solution of the 1D NLS equation is linearly stable. However, the 1D soliton solution of the 2D NLS equation is unstable. Currently, both asymptotic and numerical results establish that the 1D soliton solution is unstable with respect to low-frequency 2D perturbations. Further, numerical results establish the soliton solution is unstable with respect to high-frequency 2D perturbations, but no analytic or asymptotic results exist in this limit. The goal of our current work is to asymptotically establish that the 1D soliton is unstable with respect to 2D perturbations.

87 *Mathletes Coaching Project*
Ksenija Simic-Muller, Pacific Lutheran University

The Mathletes Coaching Project trains PLU undergraduates to coach students from local middle schools for the Washington State Math Olympiad; these coaches work very closely with teachers they are paired up with. We primarily work with schools with a high percentage of students who qualify for free or reduced lunch. In our presentation, we will talk about the history and structure of the project, coach training, structure of the coaching sessions, the benefits of the program, and the challenges of running it. We hope to bring along one or two coaches to talk about their experiences with the program.

88 *Geometric Analysis: A Proof by Picture?*
Kevin Sonnanburg, Whitworth University**

Geometric Analysis field with set of powerful techniques for proof that are unfamiliar for many, especially for undergraduates. Sometimes appearing just a "proof by picture," it uses a legitimately analytic look at the geometry to make things wonderfully simple. For example, the daunting problem of finding the multidimensional Hausdorff measure of an n-pyramid is simplified to a single easy integration. Here will be presented a few examples of application for a very pure approach.

89 *Counting with Catalan*
Brett Berry, Whitworth University**
Kevin Sonnanburg, Whitworth University†**

There exists a variety of methods for counting n-paths on a directed acyclic graph. We will explore these different kinds of paths on a Catalan digraph, describe techniques and formulas for counting them, as well as prove these formulas. Furthermore, we will conjecture an explicit formula for counting specific nonintersecting n-paths of the form D_n^t such that origin-destination pairs n are fixed instead of distance t.

90 *The Euler-Maclaurin Summation Formula*
Michael Z. Spivey, University of Puget Sound

Gian-Carlo Rota once called the Euler-Maclaurin summation formula ”one of the most remarkable formulas of mathematics.” Despite this, it does not appear to be well-known, and I had not even heard of it until I was a couple of years out of graduate school. In short, Euler-Maclaurin is a general formula for trading a finite sum for an integral. In this talk I will give a brief overview of the Euler-Maclaurin summation formula, outline its derivation, and discuss two instances in which I have used it in my research.

91 *Optimal Bluffing Strategies in Poker*
Mitch Staehle, Western Oregon University†**

Do you know when to hold ’em and when to fold ’em? Do you enjoy math that has true applications which you can use in casinos? Then this is the talk for you! Even if you don’t know how to play, that’s OK. I am going to be exploring very basic and common situations in poker in which everyone can understand.
We will explore the idea of determining when your opponent is using a non-optimal strategy and how you can take advantage of this. The calculations will be made simple and easy to understand. There is a saying in poker that you should never call, always raise or fold. This idea is investigated and given support in my paper, in some of the most basic situations in poker. You will walk away knowing how often you should try to catch your opponent bluffing, and what your expected gain will be.

92 *History in a Math Course for Teachers: How and Why*
Robert Stein, California State University, San Bernardino

Mathematics courses for teachers are so very full of material that it may seem strange to even consider adding some history of mathematics. However, doing so can be very rewarding in some contexts. We will examine some mathematical topics and present possible uses of history to enhance teaching those topics. This talk will focus primarily on examples from K-12 mathematics, but the ideas presented apply at any level.

93 *Understanding Symmetry: Distinguishing Number of a Graph*
Cody Stein, Pacific University**

What makes a graph symmetric? If a graph can be rotated, reflected, or is in some other way symmetric, what special properties does that imply about the graph? Distinguishing graphs is the process of observing these inherent symmetries and assigning a coloring to the vertices such that these symmetries no longer exist.

The distinguishing number of a graph, denoted $D(G)$, is the minimum number of colors, r, required to distinguish the graph G. We define an algorithm that will determine if a specific coloring of a graph is distinguished by systematically determining if each similar vertex and set of vertices are distinguished. With these properties, we will formally prove the distinguishing number of the cycle graph, C_n, the wheel graph W_n, the complete graph K_n, the complete bipartite graph $K_{n,m}$, and the star graph S_n. A greedy algorithm for finding $D(G)$ of a tree graph has been found. We seek to elaborate on or create a new algorithm with which to find the distinguishing number of a more general graph.

94 *Inverses for matrices without inverses*
Jeffrey Stuart, Pacific Lutheran University

Everyone who has taken linear algebra knows that the matrix A has in inverse B if and only if $AB = BA = I$, and that if you apply row operations to the augmented matrix $[A \mid I]$ to obtain $[rref(A) \mid M]$ where $rref(A)$ denotes the reduced row echelon form of A, then M is the inverse of A exactly when $rref(A) = I$. What happens when A does not have an inverse? What information does M convey? What inverse-like properties can we hope for? Addressing these questions provides an opportunity to show students how mathematicians settle for less to get more while also reinforcing some of the important connections between topics in a first course in linear algebra.

95 *The three point ellipse*
Dylan Helliwell, Seattle University
Everett Sullivan, Seattle University†**

Classically, an ellipse is the set of points whose sum of the distances from the two foci are a constant. After normalizing, the equation defining the curve is

$$\sqrt{(x+1)^2+y^2}+\sqrt{(x-1)^2+y^2}=d.$$

We explore a generalization where the curves are defined by more than two focal points, specifically when we have three foci. We also consider the centroid of the region bounded by the curve when d is small and as d approaches infinity, and its relation to the triangle defining the curve.

96 *Partitioning Pythagorean Triangles*
Carl E. Swenson, Seattle University†
André L. Yandl, Seattle University

Does there exist an interior point of a Pythagorean triangle, so that the segments from the point to the three vertices divide the angles into six angles, each with the property that both the sine and cosine are a rational number? This question arose from investigations of partitioning a Pythagorean triangle into right triangles whose sides are rational numbers without having all of the small triangles similar to the original triangle.

97 *Estimating Shark Abundance Using Mathematical Models*

Ian Taylor, University of Washington

The spiny dogfish (Squalus acanthias), which is found in Puget Sound and many other temperate coastal regions, is the longest lived shark in the world. Many shark populations are now recognized as vulnerable to overfishing, but the process of estimating their abundance and the impact of fishing using mathematical models is challenging, often because data have only been collected in recent years. For spiny dogfish in the NE Pacific, tagging and sampling programs actually began in the 1940's, and archived samples were recently re-analyzed using modern methods. A combination of these historic data with recent measurements formed the basis for a population dynamics model which was used to estimate changes in dogfish abundance from the 1930's to today for a set of spatial areas in the US and Canada, along with rates of movement between these areas. Results of this model are presented, along with a discussion of general issues related to stock assessment modeling, including the increasing demand for more skilled modelers.

98 *Martingales and Martingale Problems*

Kathy Temple, Central Washington University

A martingale is a type of random process that can be thought of as modeling a fair game. Martingales turn out to have many useful properties. In particular, they can be used to characterize other random processes via a "martingale problem." Martingale problems bear some similarities to differential equations–for instance, the first questions are always existence and uniqueness of solutions. We'll define what is meant by a martingale and martingale problem and indicate why they are important tools in some areas of probability theory.

99 *Using Mathematica as a Tool for Teaching Calculus*

Cory Druffel, Whitworth University[†**]
Alaina Thompson, Whitworth University[†**]

Mathematica is a software program that can perform a vast array of tasks. One aspect of Mathematica that is remarkable is its ability to graphically show data and compute problems. This program can be manipulated to achieve just about any visual representation. Our research project is based on the uses of Mathematica for teachers in the field of education. We are both going into secondary education, where we believe Mathematica would be a very helpful teaching tool in the classroom. Our program is interactive and allows the students to visualize the concepts involved in a lesson. We have created four animations that can be used as demonstrations in teaching. These demonstrations include: (1) Derivatives and Limits (2) 2D and 3D Integrals, (3) Vector Properties, and (4) Law of Sines and Law of Cosines.

100 *Resonance as an Explanation for the "Sweet Spot" (S)*

Robert Ferrese, Linfield College[**]
Katie Grainey, Linfield College[**]
Julianne Upton, Linfield College[†**]

Experimental data locates a node of several of the resonant frequencies of a baseball bat several inches from the end. We believe this resonance accounts for the Sweet Spot phenomenon, and have developed a mathematical model that agrees with the experimental resonance data.

101 *Math Across the Curriculum – One Strategy for QL*
Beverly Vredevelt, Spokane Falls Community College

One strategy for improving quantitative literacy (QL) is to integrate mathematics across the curriculum to allow students to see when, how, and where math is used in other disciplines. Through summer and winter institutes and traveling workshops, the Mathematics Across the CC Curriculum project has supported faculty from across the nation to integrate math and QL into about forty disciplines. After a brief introduction to the NSF-funded project, the presenter will describe a few examples of different models and levels of infusing mathematics into other courses.

102 *An Interdisciplinary Approach to Math Modeling*
Collin Weigel, Pacific University†**

Building models from data is a highly important function for mathematics, but in some cases, like the MCM, one is not able to gather ideal data. This talk will discuss an approach to the 2010 MCM problem with great data, but also an approach for when such high quality data cannot be obtained. Econometrics is a specialized area of mathematics, that math majors often do not have the pleasure of studying, which utilizes regression analysis and can be very helpful in this kind of modeling problem. This talk uses my experience from the 2010 MCM problem on baseball bats to explore ways of answering this question using a more theoretical approach as well as an econometrics approach for two conditions: great data, and not so great data.

103 *The Codependent Arising of Math and Mathematicians*
Luke Wolcott, University of Washington*

Mathematicians create mathematics, but mathematics also creates mathematicians. The body of knowledge we call mathematics and the community that does mathematics have been codependently evolving for millenia. I'll try to describe, from a sociological perspective, several prominent characterists of the math culture, and suggest how aspects of math itself may have helped to bring about these characteristics. Conversely, I'll suggest ways that our methods of doing math have affected the development of mathematical knowledge.

104 *Can Species Keep up with Climate Change?*
Ying Zhou, University of Washington*

Many species are responding to global climate change by shifting their ranges poleward in latitude or upward in elevation. Ideally, if dispersal abilities or restrictions are not considered, predictions of future species distributions can be made, as suggested by ecological niche theory, by correlating current species distributions with climatic variables and combining them with projections of climate change. This approach might not work, however, if the species considered is not entirely sessile, but has limited dispersal ability. In this talk, I will describe a mathematical model that combines growth, dispersal, and a constant-speed, climate-induced range shift. Specifically, I am going to focus on those species that have distinct growth and dispersal stages, and describe an integrodifference equation, which is a discrete-time model with a protean integral kernel to accommodate versatile dispersal scenarios. As a result, the model shows that a shifting population of poor dispersers can die out, even if the width of its range remains constant. Furthermore, such extinction occurs when the range-shift speed is above a critical value, and this critical speed is affected by the growth rate and the shape and scale of the dispersal kernel.

Abstracts of Student Posters

(in alphabetical order, by presenter)

105 *Puzzling Polyominoes*
Luke Bryan, George Fox University

Polyominoes have become popular in many forms. They are used in wooden puzzles, in games such as Tetris and Blokus, and in mathematics and computer science. This poster summarizes various ways people and computers can solve these puzzles.

106 *Integer Programming for an Optimal X Chromosome*
Saehee Choi, Simon Frasier University
Ryan Coghlan, Simon Frasier University†

Finding the genome sequences of extinct animals is a longstanding problem in genomics, one compounded by the fact DNA decays over time. Due to this even if DNA samples of long extinct animals are found, one cannot reliably sequence their genome. Therefore in order to find the genomes of such animals, methods other than DNA sequencing must be employed.

A first step towards inferring ancestral genomes consists of inferring the order of ancestral genomic markers on their chromosomes, by looking at the DNA of the extinct animal characters, indicating these characters were possibly present in the ancestral genome.

Previous work in this area looked for arrangements where no gaps were allowed in conserved ancestral sets of markers and thus all markers formed an unbroken sequence in any valid arrangement. In our work we extend this approach to allow allowed gaps of size one between any two markers. This generalization is motivated by the recent publication of low resolution datasets for mammalian genomes.

This search for genomic arrangements with gaps of size one is strongly related to a property of binary matrices known as the 1-Consecutive Ones Property (1-C1P), that generalizes the classical Consecutive-Ones Property.

107 *Maximizing the Probability of a Big Sweepstakes Win*
Robert Hall, George Fox University

The winner of a sweepstakes is chosen by dividing entries according to date received, then randomly choosing one of the dates and subsequently choosing one of the entries from that date, after the entry acceptance time period is over. This article examines how sending in all of one's entries at once vs. sending them in separately affects that person's chances of winning.

108 *Wrapping Spheres with Flat Paper*
Vinh Ho, George Fox University

We study wrappings of smooth (convex) surfaces by a flat piece of paper or foil. Such wrappings differ from standard mathematical origami because they require infinitely many infinitesimally small folds (”crumpling”) in order to transform the flat sheet into a surface of nonzero curvature. Our goal is to find shapes that wrap a given surface, have small area and small perimeter (for efficient material usage), and tile the plane (for efficient mass production). Our results focus on the case of wrapping a sphere. We characterize the smallest square that wraps the unit sphere, show that a 0.1% smaller equilateral triangle suffices, and find a 20% smaller shape contained in the equilateral triangle that still tiles the plane and has small perimeter.

109 *Dinner Tables and Concentric Circles: A Harmony of Mathematics and Music*
Austin J. Huelsbeck, Geoge Fox University

About 20 years ago, John Clough, who at that time headed the music theory program at SUNY Buffalo, posed two related circle problems. These problems are now known as the Dinner Table Problem and the Concentric Circles Problem. The Dinner Table Problem: Suppose one wishes to seat m men and n women around a circular dinner table. How should they be placed so that they are distributed "as evenly as possible" around the table? The Concentric Circles Problem: Place m white points evenly around one circle, and n black points similarly around another circle of the same size. Superimpose the circles so that no two points coincide. How can the resulting distribution of points be represented? By now you may have several questions: What is meant by "as evenly as possible"? What do these problems have in common? Why would a musician be interested in such seemingly non-musical problems? The answers to these questions come with a theory - now known as the theory of maximally even sets - that began in 1991 with an investigation of the structure of musical scales.

110 *Circles, Angles, and Trigonometry in Complex Space*
Stephen H. Kenyon, George Fox University

An examination of how the sine and cosine functions work with complex numbers. It begins by studying what a complex unit circle looks like and how to compute distance in complex space. It then moves on to define complex radians based on the unit circle. Finally, the sine and cosine functions our extended to the complex numbers.

111 *The Number Pad Game*
Amanda Paulson, George Fox University

Here are the rules for the game: In a calculator the number keys (except 0) are arranged like this:

7	8	9
4	5	6
1	2	3

Player A turns on the calculator, presses a digit key and then presses the '+' key. Then a second player B presses a digit key in the same row or column of the last digit key pressed by A, except the same key pressed by A, then presses the '+' key. The game proceeds with the two players taking turns alternately. The first player who reaches a sum greater than 30 loses. We need to determine which player has a winning strategy and describe it.

112 *Winning at Rock-Paper-Scissors*
Jessica Plummer, George Fox University

Rock-paper-scissors is a popular way to settle simple disputes because it is can be played quickly, can accommodate multiple players, and is presumably fair. Game theory confirms that RPS between two players is fair, provided that at least one of the two players follows the optimal strategy of choosing rock, paper, and scissors uniformly at random. Experimental results show that people do not follow the optimal strategy in practice, and there are two suggested strategies for defeating human opponents in RPS.

113 *Collatz Generalized*

Danny Rorabaugh, Seattle Pacific University

This undergraduate student poster dislpays the students current senior research project, which is an exploration of a generalization of the Collatz conjecture an unsolved number theory problem involving the following $3x+1$ function on the positive integers:

> The Collatz conjecture is that, given any positive integer x, the infinite sequence called the trajectory of x will contain the number 1. Although the conjecture has been proven for x up to at least 1017, it remains unproven for all positive integers.

The research project investigates the problem within a broader context of the following $Ax+B$ function:

Under this wider scope, the project explores the relationships between A, B and x that cause the trajectory of x to contain 1, to loop without reaching 1, or to be unbounded above with no positive integer occurring twice. Understanding these relationships may help to shed light on why the trajectory of every positive integer under the $3x+1$ function contains 1, if that is in fact the case.

114 *Partial Fractions in Number Theory and Calculus*

Jessica A. Sonk, George Fox University

This subject explores the development of the method of partial fraction decomposition from elementary number theory through calculus, showing why rational functions can always be written in terms of partial fractions.

115 *Straw Movements, Cantor Sets and Cyclical Limits*

Jacob T. Sturdy, George Fox University

This poster will present the information and findings in Kevin Iga's paper "The Truck Driver's Straw Problem and Cantor Sets" which is summarized as follows:

A straw move consists of placing a straw vertically in one glass, covering the top of the straw with a finger, thereby trapping water in it, and then transferring that water to the other glass. One questions whether, by alternately moving water from one glass to the other, there would ever be the same amount in both glasses, and if not, whether one would approach a fifty-fifty split in the limit. Here, Iga explores that question and addresses some famous and beautiful areas of mathematics, including the Cantor set, binary expansions of real numbers, and subtle issues surrounding the convergence of series. He concludes, with a summary of his main results on infinite sequences of straw moves, that if there are only finitely many forward moves, then X_n converges to 1; and if there are only finitely many reverse moves, then X_n converges to 0.

Campus Information

Internet Access: Please see registration packet insert.

SU Public Safety and Security Information:

All life-threatening emergencies: 911

Campus Emergency: (206) 296-5911

24-hour Information Line (Non-emergency): (206) 296-5990

SEATTLE UNIVERSITY

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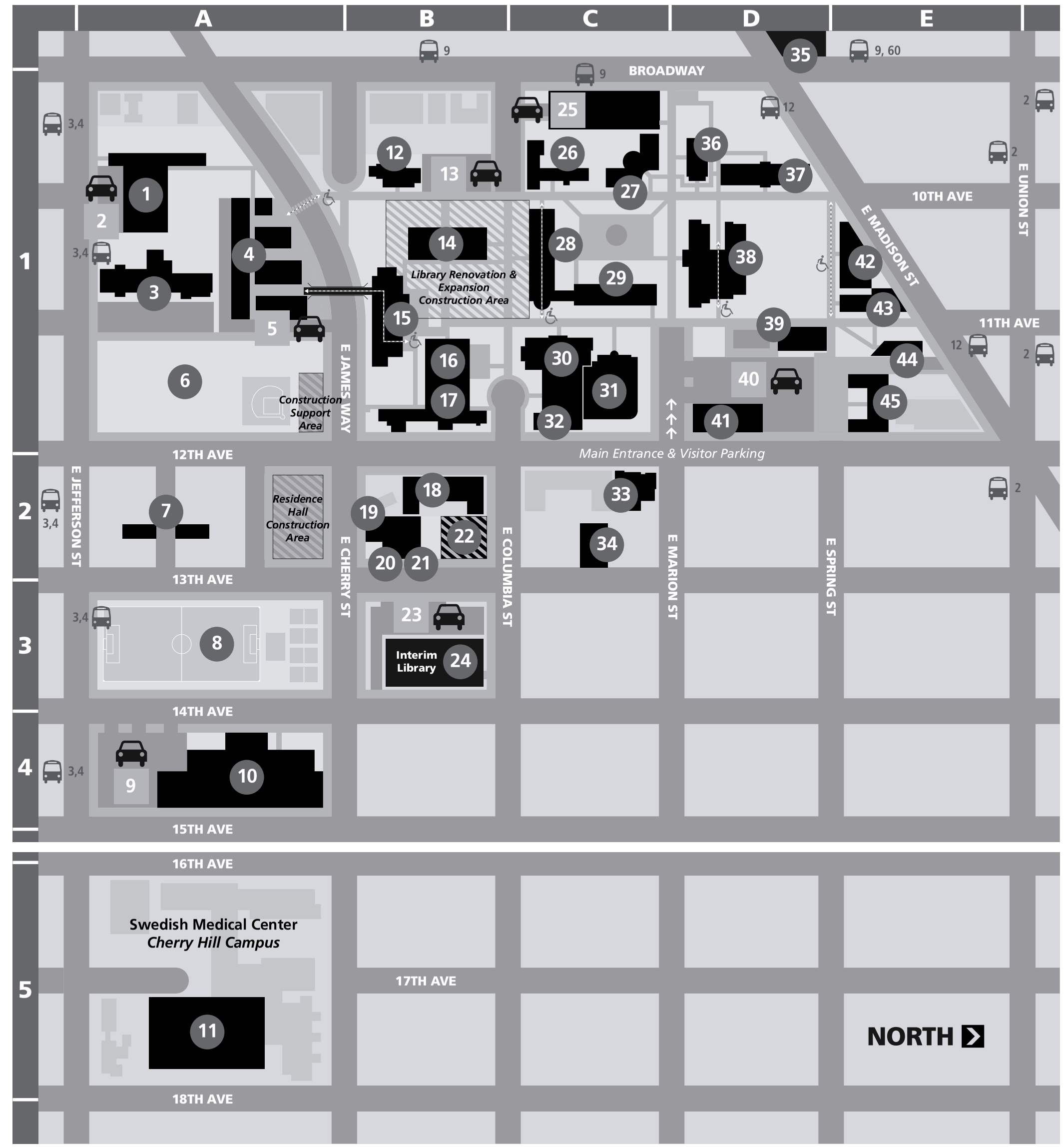
Buildings & Areas

709 13th Avenue Building	B2	**20**
715 13th Avenue Buidling	B2	**21**
1001 Broadway Building	D1	**35**
1218 East Cherry Building	B2	**19**
1313 East Columbia Building	B3	**24**
Administration Building	D1	**37**
Admissions & Alumni Building	C2	**33**
Archbishop Murphy Apartments	A1	**4**
Arrupe Jesuit Residence	B1	**12**
Bannan Engineering Building	C1	**28**
Bannan Science Building	C1	**29**
Bellarmine Residence Hall	B1	**17**
Campion Residence Hall	A1	**1**
Casey Building	C1	**27**
Championship Field	A3	**8**
Chapel of St. Ignatius	D1	**39**
Connolly Center	A4	**10**
Fine Arts Building	E1	**42**
Garrand Building	D1	**36**
Hunthausen Hall	E1	**43**
James Tower	A5	**11**
Kolvenbach Residences	C2	**34**
Lee Center for the Arts	D1	**41**
Lemieux Library & McGoldrick Learning Commons *Reopening Fall 2010*	B1	**14**
Interim Library at 1313 East Columbia Building	B3	**24**
Logan Court Residences	A2	**7**
Logan Field	A1	**6**
Loyola Hall	C1	**26**
Lynn Building	E1	**44**
Pigott Building	D1	**38**
Rianna Building	B2	**18**
Seaport Building *Future Law School Annex*	B2	**22**
Student Center	B1	**15**
Student Center Pavilion	B1	**16**
Sullivan Hall	C1	**30**
Teilhard de Chardin Hall	A1	**3**
University Services Building	C1	**31**
Xavier Residence Hall	E1	**45**

Parking Areas

10th & East Jefferson Lot	A1	**2**
Murphy Garage	A1	**5**
13th & East Cherry Lot	B3	**23**
14th & East Jefferson Lot	A4	**9**
10th & East Columbia Lot	B1	**13**
Broadway Garage	C1	**25**
Main Parking/Visitor Parking	D1	**40**



Acknowledgments

On behalf of the Pacific Northwest Section of the Mathematical Association of America, I would like to thank everyone who has been instrumental in making this annual meeting possible. As with past meetings, the section officers and past meeting chairs have given vital advice, direction, and assistance to this year's program committee. I would like to further acknowledge the following people for their extraordinary contributions:

The program committee members Klay Kruczek (Western Oregon University), Nancy Ann Neudauer (Pacific University) and Jeff Boersema (Seattle University) made the arrangements for this year's speakers and organized the program.

Hans Nordstrom (University of Portland) coordinated the special contributed paper sessions, collected and edited abstracts, and organized the Junior Faculty Research, Student and General Paper sessions. He also assembled this conference program brochure and provided valuable advice throughout the planning process.

Donna Pierce (Whitworth University) helped organized the student portion of the program, assembled the judges for the student sessions, and promoted opportunities for student involvement leading to a substantial increase in student participation.

Jenny McNulty (University of Montana) arranged the Project NExT program.

Lisa Berman (Seattle University Mathematics Department Administrative Assistant) received and processed registrations, prepared a data base of registrants, and oversaw many necessary tasks in preparation for the meeting.

Catherine Holdren (Seattle University Conference and Events coordinator) arranged for rooms and equipment for the meeting activities and provided much helpful advice.

Finally, the entire Mathematics Department at Seattle University, and its chair, Jeff Boersema, enthusiastically volunteered hours of time in preparing for the meeting, and will assist with the many last minute details such as manning the resgistration and book sale tables.

Thank you,

Mary Ehlers

Local Arrangements Chair