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

Central Washington University
Ellensburg, Washington

April 3-4, 2009

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

Sponsored by
The Mathematical Association of America
George Pólya Lecturship
Central Washington University
Office of the Provost
Department of Mathematics

Hosted by
Central Washinton University
Mathematics Department
Ellensburg, Washington
April 3-4, 2009

Friday, April 3

<table>
<tr><td>7:45</td><td colspan="3">Packet pickup for Project NExT
Grupe Center</td></tr>
<tr><td>8:00
2:20</td><td colspan="3">Project NExT Meeting
Grupe Center</td></tr>
<tr><td>2:30
5:30</td><td>Minicourse:
Theory of Partitions [1]
Science 115</td><td>Minicourse:
Using Sage [2]
Brooks Library 154 [Comp. Lab]</td><td>Minicourse
Intro to Mathematica [3]
Bouillon 103 [Comp. Lab]</td></tr>
<tr><td>6:00</td><td rowspan="2">Student Reception
Bouillon 107
Flatland, the Movie
Bouillon 110</td><td colspan="2">Project NExT Dinner & Discussion
Ellensburg Pasta Company</td></tr>
<tr><td>6:45
7:45</td><td>Packet Pick-up
SURC Mezzanine</td><td>600 N. Main ST
Ellensburg, WA
(509) 933-3330</td></tr>
<tr><td>8:00</td><td colspan="3">Friday Evening Lecture: Stan Wagon
Impossible, Unbelievable…but True Results of Mathematics [4]
SURC Theater</td></tr>
<tr><td>9:00
10:00</td><td colspan="3">Reception
SURC Ballroom</td></tr>
</table>

Saturday, April 4

<table>
<tr><td>8:00</td><td rowspan="4">Book Sale
SURC Mezzanine</td><td rowspan="4">Packet Pickup
& Registration
SURC Mezzanine</td><td>Refreshments
SURC Mezzanine</td><td>Executive Committee Meeting
SURC 301</td></tr>
<tr><td>9:00</td><td colspan="2">Introduction and Welcome:
Aaron Montgomery, CWU; Provost Wayne Quirk
Section Governor, Nancy Neudauer, Pacific University
SURC Theater</td></tr>
<tr><td>9:15</td><td colspan="2">Pólya Lecture: George Andrews [5]
“The Lost Notebook of Ramanujan”
SURC Theater</td></tr>
<tr><td>10:30</td><td colspan="2">Contributed Talks
Dean Hall 102, 103, 112, 113</td></tr>
<tr><td>12:30</td><td colspan="2" rowspan="2">Student Poster Session
SURC Mezannine</td><td colspan="2">Lunch (provided)
SURC Mezzanine</td></tr>
<tr><td>12:45
1:50</td><td></td><td>Business Meeting
Dean 106</td></tr>
<tr><td>2:00
3:00</td><td colspan="4">Invited Talk: William Stein, [6]
“Open Source Mathematical Software”
SURC Theater</td></tr>
<tr><td>3:15
5:15</td><td colspan="4">Contributed Talks
Dean Hall 102, 103, 112, 113</td></tr>
<tr><td>5:45</td><td colspan="4">Social Hour
Sue Lombard Dining Room</td></tr>
<tr><td>6:45
7:30</td><td colspan="4">Section Awards
Banquet Dinner
Sue Lombard Dining Room</td></tr>
<tr><td>8:30
9:30</td><td colspan="4">Invited Lecture: Stan Wagon [7]
“A Computational View of the Four-Color Problem for Planar Maps”
Sue Lombard Dining Room</td></tr>
</table>

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

- *Mathematical Modeling in Biological and Environmental Sciences*: Sergey Lapin, Washington State University; Elissa Schwartz, Washington State University
- *Teaching and Research in Actuarial Science*: Gary Parker, Simon Fraser University
- *Undergraduate Research*[1]: Michael Aristidou, DigiPen Institute of Technology; Donna Pierce, Whitworth College
- *Learning to Prove: Motivation and Methods*: Stephanie Salomone, University of Portland
- *Junior Faculty Research Talks*: James Bisgard, Central Washington University; Kathryn Temple, Central Washington 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.

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

Problem A: *Designing a Traffic Circle*, which asked teams to "use a model to determine how best to control traffic flow in, around, and out of a circle." Talks on Problem A are designated with a (T).

Problem B: *Energy and the Cell Phone*, which had five requirements for a successful analysis: "(1) [m]odel the consequences of [the change from land-lines to cell phone service] for electricity utilization," (2) provide an analysis of "the optimal way of providing phone service to this country from an energy perspective," (3) "[m]odel the energy costs of [the] wasteful practice" of leaving a charger plugged in when not charging a phone, (4) estimate "the amount of energy that is used by various recharger types (TV, DVR, computer peripherals, and so forth) when left plugged in but not charging the device," and (5) "For each 10 years for the next 50 years, predict the energy needs for providing phone service based upon your analysis in the first three requirements." Talks on Problem B are designated with a (E).

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

Contributed Talks – Saturday Morning		
	Undergraduate Research I	**Undergraduate Research II**
	Dean Hall 112	*Dean Hall 113*
10:30–10:45	*The Asymptotic Behavior of Dynamic Equations on Time Scales* [42] **Dylan Poulsen, University of Puget Sound**	*Kaleidoscopes: Spinning our Way through Multiple Geometries* [12] **Brittany Cuff,** **Meagan Potter, Pacific University**
10:50–11:05	*Patching the Holes in Quasiderivations* [51] **Maria Walters, Pacific University**	*How to Compute a Puiseux Expansion* [15] **Annie K. Didier** **Kevin M. Sonnaburg, Whitworth University**
11:10–11:25	7-*D Cross Product and Orthogonality* [47] **Adrian Sotelo, DigiPen Institute of Technology**	*Peg Solitaire* [16] **Jenne Elston, Western Oregon University**
11:30–11:45	*Some Properties of Semi-Vector Spaces* [35] **Mark Nichols, DigiPen Institute of Technology**	*Random Juggling: Which State Happens Most?* [25] **Masaki Ikeda, Western Oregon University**
11:50–12:05	*Stability of the Soliton Solution of the Two-Dimensional Nonlinear Schrödinger Equation* [45] **Natalie Sheils, Seattle University**	*The Last Round of Betting in Poker* [43] **Michael Rivers, Western Oregon University**
12:10–12:25	*Rubik's Cube Cipher* [44] **Matthew Schmidgall, Western Oregon University**	*Exploration of variable types* [21] **Artemus Harper, Central Washington University**

Contributed Talks — Saturday Morning	
Modeling in Biology and Environmental Sciences[2]	**Teaching and Research in Actuarial Science**
Dean Hall, 102	*Dean Hall, 103*
Bayesian Model-Based Alignment of Terminal Restriction Fragment Length Polymorphism (T-RFLP) Profiles of 16S rRNA [8] **Zaid Abdo, University of Idaho**	*On the Modeling of Bonus-Malus Systems* [56] **Ting Zhang, Simon Fraser University**
Gumbelers Ruin: Beneficial Fitness Effects are not Exponential for Two Viruses [27] **Paul Joyce, University of Idaho**	*A Nonhomogeneous Poisson Hidden Markov Model for Claim Counts* [33] **Yi Lu, Simon Fraser University**
A Stochastic Model of Cytotoxic T Lymphocyte (CTL) Responses in HIV-1 Infection [29] **L.J. Kwon, WSU**†* **S. Lapin, WSU** **L.G. de Pillis, Harvey Mudd College** **E.J. Schwartz, WSU**	*Enhancing Actuarial Mathematics Undergraduate Studies* [17] **Jill Falkenberg, Simon Fraser University**
Mathematical Model of Strain Competition in Retroviruses [50] **Greg Vogel** †* **Elissa Schwartz** **Sergey Lapin, Washington State University**	*Pricing Annuities Univariate versus Multivariate Models* [52] **Zhong Wan, Simon Fraser University**
Implementation of channel-routing routines in the Water Erosion Prediction Project (WEPP) model [53] **William J. Elliot, USFS** **Fritz R. Fiedler, University of Idaho** **Sergey Lapin, WSU** **Li Wang, WSU** †* **Joan Q. Wu, WSU**	*Application of Ordering in Ruin Theory* [49] **Cary Tsai, Simon Fraser University**
Teaching Lotka-Voltera model with a Statistical Perspective [28] **Daniel Kim, Southern Oregon University**	*A Different Distance Sampling Applied to Actuarial Science* [11] **Yvonne Chueh, Central Washington University**

[2] This session will carry over in the afternoon at 3:15 in Dean Hall 106. Yves Nievergelt, EWU will be presenting *Generic Data Without Best-Fitting Verhulst Curves* [36]

Contributed Talks — Saturday Afternoon

	Undergraduate Research III *Dean 113*	Junior Faculty Research *Dean112*
3:15–3:30	*Answering a Burning Question: Analyzing Methods to Estimate Remaining Oil Reserves and Peak Oil Production* [19] **Kerensa Gimre, Pacific University**	*A note on Quaternion Rings over $\mathbb{Z}_n$* [14] **Michael Aristidou, DigiPen Institute of Technology** **Andy Demetre, Seattle University†**
3:35–3:50	*MCM 2009: Circular Logic* (T) [54] **Kerensa Gimre** **Collin Weigel†** **Maggie Wigness, Pacific University**	*Generating Varieties for Affine Grassmannians* [32] **Peter Littig, University of Washington, Bothell**
3:55–4:10	*Modeling Roundabouts in Discrete Time Intervals* (T) [10] **Tyler Bryson** **Tyler Armon** **Bradley Schorer, Linfield College**	*Preliminary results for* $x_{n+1} = \frac{\alpha_n+\beta_n x_n+\gamma_n x_{n-1}}{A_n+B_n x_n+C x_{n-1}}, n = 0,1,2,\ldots$ *with period-two coefficients* [40] **Carol Gibbons, Salve Regina University** **Carol Overdeep, Saint Martin's University†**
4:15–4:30	*Modeling Energy Consumption and Phone Use* (E) [20] **Amber Goodrich** **Sara Hanold** **Geoff La Brant, Central Washington University**	*Inverse Problem and Local Regularization Methods for Nonlinear Volteraa-Hammerstein Integral Equations* [34] **Xiaoyue Luo, Linfield College**
4:35–4:50	*Large-Scale Linear Programming and Heuristic Algorithms* [30] **Kaylee Linthicum, Seattle Pacific University**	*Why Automobile Sunshades Fold Oddly: An Intriguing Application of Topology* [18] **Curtis Feist, Southern Oregon University†** **Ramin Naimi, Occidental College**
4:55–5:10	*Hide and Seek with* $(7,3,1)$ [41] **Wesley Parker, Western Oregon University**	*The Relationship Between Missing Graded Homework and Student Outcomes in Mathematics Courses* [13] **Lorraine Dame, University of Victoria**

Contributed Talks — Saturday Afternoon	
Learning to Prove: Motivation and Methods	**General Papers**
Dean 102	*Dean 103*
Styrofoam Spheres and Pushpins [9] **Bonnie Amende, St. Martin's University**	*Evaluating Labeled Tree Expressions Using Determinants of Nearly Skew-Symmetric Matrices* [24] **Matthew Hudelson, Washington State University**
The Use of a Proof Notebook in Introduction to Proofs [38] **Jennifer Nordstrom, Linfield College**	*Invariants in Hyperplane Arrangements and Matroids* [39] **Joseph Oldenburg, University of Montana**
Some Strategies for Teaching Introductory Proof Techniques [37] **Hans Nordstrom, University of Portland**	*The continuous primitive integral* [48] **Erik Talvila, University of the Fraser Valley**
An Introduction to Proofs Class at George Fox University [26] **John M. Johnson, George Fox University**	*Ramanujan, Quadratic Forms and the Sum of Three Cubes* [22] **James Harper, Central Washington University**
Using Classroom Presentations to Promote Student Learning [55] **Nick Willis, Willamette University**	*A Free Online Math Assessment and Course Management System* [31] **David Lippman, Pierce College Ft. Steilacoom**
Using Inquiry Based Learning in a Large Class: A Case Study [23] **Chris Hallstrom, University of Portland**	*Some Convex Solutions to the Sofa Problem* [46] **James Sommers**† **Ruthven Murgatroyd** **Robin Oakapple, Albany OR**

Social Events

Friday Project NExT Dinner
6:00 - Ellensburg Pasta Company, 600 N. Main ST
Sponsored by the MAA

Friday Student Reception & Movie
6:00 - Bouillon 107 & 110

Friday Invited Lecture
Introduction by Dan Curtis, Central Washington University
Impossible, Unbelievable... but True Results of Mathematics
Stan Wagon [4]
8:00 - SURC Theater

Friday Reception
9:00 - SURC Ballroom

Saturday Lunch
12:30 - Box lunches provided on SURC Mezzanine

Student Poster Session
12:30 - SURC Mezzanine

Saturday Evening Social Hour
Awards Ceremony and Banquet Dinner
5:45 - Sue Lombard Dining Room

MC: Section Chair John Thurber, Eastern Oregon University

Introduction of new Section Project NExT Fellows, Nancy Neudauer, Pacific University

Presentation of 25- and 50-year MAA membership certificates

PNW MAA Distinguished Teaching Award

Saturday Evening Invited Lecture
Introduction by Hans Nordstrom, University of Portland

A Computational View of the Four-Color Problem for Planar Maps,
Stan Wagon [7]

Closing Remarks: Hans Nordstrom, University of Portland

Minicourse Descriptions

Friday, April 13

1 *The Theory of Partitions*
George Andrews, Pennsylvania State University

This will be an elementary course requiring at most familiarity with infinite series. The object will be to provide enough background so that the Polya Lecture on the following day will be placed in historical context. Partitions are representations of positive integers as unordered sums of positive integers. The minicourse will begin with the discoveries of Euler. It will mix the combinatorial aspects with the study of generating functions. We hope to include the Rogers-Ramanujan identities. These identities have a marvellous story behind them, and contain wonderful surprises.

2 *Using Sage to Spice up your Undergraduate Courses*
William Stein, University of Washington

Sage (http://sagemath.org) is an open source mathematical software project that I started in 2005, which has around 50 active developers and funding from NSF, Google, Microsoft, and many other organizations. I will given an overview of how easy it is to install Sage, how many goodies come with the installation, and some of the benefits of open source. I will then demo many of the interesting capabilities of Sage in the context of undergraduate mathematics education. I'll talk about how to use R with Sage for introductory statistics, how to plot 2d and 3d functions, compute limits, derivatives, and integrals, and do linear algebra, group theory, and discrete mathematics. I'll also explain how to share online Sage notebooks, create interactive web-based demos of mathematics, and setup your own sage server like the one at http://sagenb.org.

3 *Introduction to Mathematica for Mathematicians*
Stan Wagon, Macalester College

A survey of the basic methodology of using Mathematica: plotting, 3-dimensional visualizations, numerical computing, creating dynamic manipulations, using data sets and advanced algorithms.

Abstracts of Invited Talks

(in chronological order)

4 *Impossible, Unbelievable ... but True Results of Mathematics*

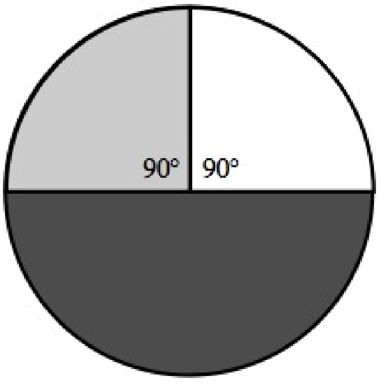
Stan Wagon, Macalester College

Mathematics is full of surprising results, both concrete and abstract. Modern computing tools allow us to visualize and confirm many surprising things. In this talk I will give a sampling of several that have made a strong impression on me, such as:

A drill that can be driven in a standard drill press and cut out an exact square hole. A bicycle with square wheels that one can ride perfectly smoothly. The Banach-Tarski Paradox: A ball can be decomposed into pieces and rearranged into two balls of the same size. A non-straight unicycle track that a bike can follow. How playing two losing games in a certain combination leads to a winning game. A bizarre property of Riemann's prime-counting function R(x). Surprises in Brownian motion and sparse linear algebra from the SIAM 100-digit challenge.

And a cake puzzle that is easy for anyone to understand, but which causes professional mathematicians to almost always give the wrong answer with complete confidence.

A round cake has icing on the top but not the bottom. Cut out a piece in the usual shape (sector of a circle with vertex at the center), pull it out, turn it upside down, and replace it in the cake to restore roundness. Do the same with the next piece; i.e., take a second piece with the same vertex angle, but rotated counterclockwise from the first one so that one boundary edge coincides with a boundary of the first piece. Remove, flip, and replace it. Keep doing this in a counterclockwise direction. The diagram shows the pieces involved in the first two moves when the central angle is 90. For some central angles what happens is clear. For the illustrated 90 angle, eight moves brings all the icing back to the top. If the angle is 180, it takes four moves to return to the initial state. Suppose the central angle is 181. When does all the icing first return to the top? What if the angle is 1 radian?



5 *The Lost Notebook of Ramanujan*
George Andrews, Pennsylvania State University

In 1976 quite by accident, I stumbled across a collection of about 100 sheets of mathematics in Ramanujan's handwriting; they were stored in a box in the Trinity College Library in Cambridge. I titled this collection ”Ramanujan's Lost Notebook” to distinguish it from the famous notebooks that he had prepared earlier in his life. On and off for the past 32 years, I have studied these wild and confusing pages. Some of the weirder results have yielded entirely new lines of research. I will try to provide a gentle account of where these efforts have led. I hope to include some discussion of recent efforts to present Ramanujan's life in film, theatre, and opera.

6 *Open Source Mathematical Software*
William Stein, University of Washington

In January 2005, I started the free open source mathematical software project Sage (see `http://sagemath.org/`). It has since grown dramatically, with well over 100 developers and many thousands of users. In 2007, Sage was awarded first prize in the Trophees du Libre for scientific software. This talk will be explain the history and motivation behind this project, where it is headed, and demo how Sage is useful to you as a mathematician.

7 *A Computational View of the Four-Color Problem for Planar Maps*
Stan Wagon, Macalester College

The four-color theorem is true. But what is the best way to four-color a planar graph? By implementing several algorithms one can learn good ways of doing it so that complicated planar graphs can be 4-colored. Since the problem originated as a map problem, it is natural to color maps, and that adds some complexity to the issue. The talk will give an overview of these algorithms and discuss some applications to real-world coloring problems as well as to related unsolved coloring problems.

Abstracts of Contributed Talks

(in alphabetical order, by presenter)

8 *Bayesian Model-Based Alignment of Terminal Restriction Fragment Length Polymorphism* (T-RFLP) *Profiles of* 16S rRNA
Zaid Abdo, University of Idaho

Clustering is a popular method utilized in analyzing T-RFLP data that is used in studying some human microbial ecosystems (Zhou et al. 2007 for example). Clustering is used to identify microbial community kinds that share similar structure. Clustering T-RFLP data takes place in two steps: 1) similar operational taxonomic units (OTUs) between different samples are identified based on the similarity of associated fragment lengths (a step referred to as alignment or binning) and 2) different sample profiles are clustered based on the abundance of the identified OTU's in each sample. Both steps jointly affect the accuracy of the final clustering. In this talk I present a new, model-based-Bayesian-simultaneous alignment approach to inferring the relationships between sampled T-RFLP profiles. I compare this method to a distance based alignment approach that we developed previously. I utilize simulated data in these comparisons. Preliminary results indicate that the new model-based approach is superior to distance-based one in improving the recovery of the true clustering structure of the data.

9 *Styrofoam Spheres and Pushpins*
Bonnie Amende, Saint Martin's University

One of the first courses in which students become exposed to proofs is high-school geometry. Students are introduced to the fundamentals of euclidean geometry, where many concepts seem natural, and then learn to produce formal arguments using axioms derived from these intuitive concepts. In college geometry, we take this process another step further by introducing students to other geometries, like the finite geometries and the non-euclidean geometries. Again students are asked to perform proofs, but this time the ideas are much less familiar. To aid in their understanding, we developed some creative group activities through which our students became more comfortable with these other geometries. The purpose of this talk is to describe some of these group activities. In particular, one activity involves using styrofoam spheres and pushpins to help our students understand the elliptic geometry.

10 *Modeling Roundabouts in Discrete Time Intervals* (T)
Tyler Bryson, Linfield College**
Tyler Harmon, Linfield College**
Bradley Schorer, Linfield College**

We decided to model traffic circles in discrete time based on the inherent difficulty of describing moving cars along a lane in real time. We successfully wrote a computer program that models traffic flow on an n-lane traffic circle of any length R with as many as R access points. Algorithms also model lane changing and the functioning of on/off ramps with minimal assumptions about driver behavior. Our model predicts that the most efficient traffic flow is a steady-state system on the outermost ring. In order to maintain this steady state, control systems are required such as stop lights and sensors to detect traffic density along only the outermost lane.

11 *A Different Distance Sampling Applied to Actuarial Science*
Yvonne Chueh, Central Washington University

Unlike the distance sampling as a widely used group of closely related methods for estimating the density and/or abundance of biological populations, this sampling method to present was applied to assets-liabilities cash flow models to capture the tail distribution under a small number of scenario runs. The method, as an entirely different distance sampling approach from environmetrics, defined distance metrics based on a given set of risk parameters, expected model functional involved, and characteristics of backing assets and liabilities. A pivoting process for scenario sampling/picking was created to assist appropriate sampling to address the accuate tail distribution under limited computational resources and time.

12 *Kaleidoscopes: Spinning our Way through Multiple Geometries*
Brittany Cuff, Pacific University**
Meagan Potter, Pacific University**

Ever wonder how a kaleidoscope produces the beautiful images that change with each rotation? Those images are multiple reflections of a single image generated by three mirrors inside the kaleidoscope. But, what happens if we change the relative angles of the mirrors inside? What happens if we bend the mirrors, or rather, use straight mirrors according to a different geometry?

Three main models of geometry are Euclidean, hyperbolic, and spherical. Basic characteristics of Euclidean geometry include a unique parallel line, m, to another line, l, through a given point, p, and triangles with angle sum equal to $180°$. In hyperbolic geometry, there exist infinitely many parallel lines to l through p and triangles with angle sum strictly less than $180°$. Spherical geometry is a model in which parallel lines do not exist and triangles have angle sum strictly greater than $180°$.

Using Euclidean geometry and knowledge of mirror reflections, we determine a good angle for a kaleidoscope to be $\frac{\pi}{n}$, for $n \in \mathbb{Z}$. We deduce that for $m,n,p \in \mathbb{Z}$ the $\frac{\pi}{m}+\frac{\pi}{n}+\frac{\pi}{p}=\pi$ gives good angles for a Euclidean kaleidoscope, $\frac{\pi}{m}+\frac{\pi}{n}+\frac{\pi}{p}<\pi$ gives good angles for a hyperbolic kaleidoscope, and $\frac{\pi}{m}+\frac{\pi}{n}+\frac{\pi}{p}>\pi$ gives good angles for a spherical kaleidoscope. We build kaleidoscopes in each geometry in order to effectively show how the image changes. Finally, we develop these ideas into a curriculum for secondary education as an interesting and effective way of introducing higher level geometry.

13 *The Relationship Between Missing Graded Homework and Student Outcomes in Mathematics Courses*
Lorraine Dame, University of Victoria$^{\dagger *}$
Michelle Edwards, University of Victoria*
Gary MacGillivray, University of Victoria

What factors significantly correlate with a student missing graded homework and what relationship does missing graded homework have with failure outcomes in university level first year math? Data from an anonymous in-class survey were used to analyze the correlation of math help and other factors at the University of Victoria (UVic) with the proportion of missing graded homework for these students. Course grade sheets for the spring term of 2008 were used to analyze the relationship between the proportion of missing graded homework and failure outcomes. The results of this analysis allow us to infer that an improvement in class attendance, individual performance satisfaction, number of suggested problems completed, satisfaction with math and stats support and frequency of visits to the assistance centre could have a positive influence on student success rates. These factors are predictors of a lower proportion of missing graded homework and students who miss less graded homework are also significantly less likely to fail.

14 *A Note on Quaternion Rings over $\mathbb{Z}_n$*
Michael Aristidou, Digipen Institute of Technology
Andy Demetre, Seattle University†

In this paper, we point out a *false* theorem by Kandasamy regarding the finite ring $\mathbb{H}/\mathbb{Z}_n$. Contrary to Kandasamy's claim, we show that the set $\mathbb{H}/\mathbb{Z}_n$ does *not* form a finite skew field. We provide a counterexample and other literature to support our claim.

15 *How to Compute a Puiseux Expansion*
Annie K. Didier, Whitworth Univserity**
Kevin M. Sonnanburg, Whitworth University**

In this paper, an explanation of the Newton-Peiseux algorithm is given. This explanation is supplemented with well-worked and explained examples of how to use the algorithm to find fractional power series expansions for all branches of a polynomial at the origin.

16 *Peg Solitaire*
Jenne Elston, Western Oregon University**

The expository presentation, based on the work of several authors, will show the connection of the popular game "peg solitaire" to the infamous Klein-4 group. I will extend this to boards of different shapes and sizes. I will also impress the audience with solutions to the game using packages.

17 *Enhancing Actuarial Mathematics Undergraduate Studies*
Jill Falkenberg, Simon Fraser University*

Actuarial students studying for professional exams may be familiar with finding the expected value and variance of the present value of the benefit of a standard insurance contract. They may also be familiar with its probability distribution function. Although real life problems are beyond the scope of undergraduate programs, students can benefit from working on more realistic problems. Simple actuarial projects will be presented. For example, I will simulate the distribution of the total cost of an insurance portfolio and study the effect of the length of the contract, the number of contracts and the interest rate on this distribution.

18 *Why Automobile Sunshades Fold Oddly: An Intriguing Application of Topology*
Curtis Feist, Southern Oregon University†
Ramin Naimi, Occidental College

Most of us are familiar with Magic Shade "automatic folding" sunshades, even if we don't recognize the actual brand name; these shades for automobile windshields are roughly the shape of a circular disk when "open", and then fold up into a coil of several smaller circles when "closed", thus allowing the shades to be stored in a relatively small space. In this talk we discuss topological ideas that explain, with respect to folding, how these sunshades must behave.

19 *Answering a Burning Question: Analyzing Methods to Estimate Remaining Oil Reserves and Peak Oil Production*
Kerensa Gimre, Pacific University**

Since its introduction in the 1950s by M. King Hubbert, peak oil has plagued the minds of oil industry experts, politicians, and scientists. United States oil production peaked in 1970, and worldwide, production has already peaked in thirty-three of the forty-eight largest oil producing countries. Due to the vast economic implications of running out of fuel, peak oil is a critical problem.

We will investigate methods estimating quantities of subterranean oil, and the subsequent calculation of remaining supply. Among these methods is the Level Set Method of image processing, used to enhance seismic images and eliminate noise. From a consequent application of the Hamilton-Jacobi equation, we find an approximation for amount of untapped oil. We will then calculate the timing of peak oil by analyzing the popular Hubbert's Method, as well as less traditional, yet equally valid methods.

20 *Modeling Energy Consumption and Phone Use* (E)
Amber Goodrich, Central Washington University**
Sara Hanold, Central Washington University**
Geoff La Brant, Central Washington University**

To model changes in energy use due to the increase in cell phone usage, we create models of the population growth and the growth in the number of households per year in the United States. We then model the energy consumption of the United States population if all landline telephones are replaced with cell phones during a transitional period and a subsequent steady state period. A logistic model for the percentage of households that only use cell phones combined with the growth model for households and the average household size yields the number of cell-phone-only users after t years. We project the energy usage of phone service in a pseudo U.S. by establishing guidelines to restrict cell phone service to jobs that require traveling, fieldwork, and emergency assistance. We then calculate the number of devices in use at any given time t. Finally, we determine the amount of energy both consumed and wasted by the pseudo U.S. and provide a table with projections on energy consumption for the next 50 years. Based on this model, our pseudo U.S. will use over 2.7 million barrels of oil in 2009 to provide phone service, which implies that the use of cell phones has placed a greater strain on U.S. oil consumption.

21 *Exploration of variable types*
Artemus Harper, Central Washington University**

Many programming languages describe variables with a type (i.e., category). The type of a variable indicates the valid operations that can be performed on it. However, the ability to describe what the variable may hold, and what values it can be given is very limited. In particular, describing a variable within another variable (such as a list) is further limited. Even if such a language could be created to describe inner relationships, its details are not clear as there are various trade-offs in how they are expressed. This talk will give a brief overview of existing systems, their limitations, and explore a new way of typing variables.

22 *Ramanujan, Quadratic Forms and the Sum of Three Cubes*
James D. Harper, Central Washington University

We all know $3^2+4^2=5^2$. But did you know that $3^3+4^3+5^3=6^3$? Isn't that interesting! Euler had a non-homogenous parametric solution Diophantine equation $A^3+B^3+C^3=D^3$. Ramanujan discovered a quadratic form representation that satisfies this equation and asked find other quadratic expressions satisfying similar relations. Using this cubic identity as a seed I will show how to construct a quadratic form representation for our Diophantine equation. Different seeds will generate quadratic forms. Surprisingly, Fermat's method of making a quadratic a square will play an important role. Unlike its Pythagorean cousin, it is not known whether there is an integer formula that will generate all integer solutions to the aforementioned Diophantine equation. The prerequisites to understand this talk are minimal: All you need to bring is a strong set of pre-calculus skills. Students are welcome.

23 *Using Inquiry Based Learning in a Large Class: A Case Study*
Christopher Hallstrom, University of Portland

In the fall of 2008, I used a modified Moore method to teach Real Analysis in a class with over 20 students. In this talk I will highlight some of the challenges to using inquiry based learning methods in a larger class and discuss some possible approaches.

24 *Evaluating Labeled Tree Expressions Using Determinants of Nearly Skew-Symmetric Matrices*
Matthew Hudelson, Washington State University

Given a rooted tree whose vertices are assigned numerical labels, we can associate with this tree an expression called a 'labeled tree expression (LTE).' As an example,

$$x_0+\frac{1}{x_1}+\frac{1}{x_2+\frac{1}{x_3}}+\frac{1}{x_4+\frac{1}{x_5}}+\frac{1}{x_6+\frac{1}{x_7}+\frac{1}{x_8+\frac{1}{x_9}}}$$

is a labeled tree expression. LTEs generalize continued fractions; in fact, continued fractions are the LTEs of paths rooted at one end. We demonstrate that an LTE can be calculated using the determinants of two nearly skew-symmetric matrices that resemble the adjacency matrix of the tree in question.

25 *Random Juggling: Which State Happens the Most?*
Masaki Ikeda, Western Oregon University**

Juggling is well known as a very friendly entertainment. Suppose one keeps juggling RANDOMLY for a certain time. We will examine which of the situations of objects caught/thrown happens more likely than others using Markov chains, as described in a paper by G. S. Warrington.

26 *An Introduction to Proofs Class at George Fox University*
John M Johnson, George Fox University

In this talk we summarize the features of our course Math 290 Mathematical Logic and particularly emphasize the features that may be different from similar courses at other schools. We also identify what we believe are the strengths and weaknesses of the course, from a faculty perspective as well as from students who have completed the course and gone on to graduate school.

27 *Gumbelers Ruin: Beneficial Fitness Effects are not Exponential for Two Viruses*
Paul Joyce, University of Idaho

The distribution of beneficial fitness effects for new mutations is of paramount importance to adaptation. It has been widely assumed that the fitnesses of new mutations follow an exponential distribution, e.g., in theoretical treatments of quantitative genetics, clonal interference, and the genetics of adaptation under strong selection and weak mutation. The use of the exponential distribution arose from a key insight of Gillespie (1984), appealing to the statistical theory of extreme values, because beneficial mutations should represent draws from the extreme right tail of the fitness distribution. Using the insights of Gillespie, Orr (2002,2003) argued that extreme value theory allowed for a robust theory of adaptation. Yet in extreme value theory, there are three different limiting forms for right tails of distributions, and the exponential distribution represents just one of these, the Gumbel domain of attraction. We describe a likelihood ratio framework for analyzing the fitness effects of beneficial mutations, focusing on testing the null hypothesis that the distribution is exponential. We also describe how to account for missing the smallest effect mutations, which are often difficult to identify experimentally. This technique makes it possible to apply the test to gain-of-function mutations, where the ancestral genotype is unable to grow under the selective conditions. Using beneficial mutations from two viruses, we show for the first time that the Gumbel domain can be rejected in favor of a right-truncated distribution. Both data sets are consistent with a uniform distribution of beneficial fitness effects, thus providing evidence for an upper bound on fitness effects and violating the common view that small-effect mutations greatly outnumber large-effect mutations.

28 *Teaching Lotka-Voltera model with a Statistical Perspective*
Daniel Kim, Southern Oregon University

Lotka-Voltera model arises often in biological context to relate two time-dependent variables in a differential equation format. The model begins with four parameters and its analytic solution eventually ends up having five parameters. In teaching this subject we normally make an assumption that the parameters are give to us somehow and do not ask a question seriously as to where they come from. In this talk we consider an accessible strategy to estimate the parameters with an example so that undergraduate students can comprehend the Lotka-Voltera model from a practical point of view.

29 *A Stochastic Model of Cytotoxic T Lymphocyte (CTL) Responses in HIV-1 Infection*
L.J. Kwon, Washington State University[†*]
S. Lapin, Washington State University
L.G. de Pillis, Harvey Mudd College
E.J. Schwartz, Washington State University

In higher biological organisms, the immune system is a complex system consisting of various types of responses. Cytotoxic T lymphocytes (CTL) play the major role in the immune response to control viral infections. A stochastic model has been constructed to study the CTL response in HIV-1 infection. This model accounts for infection, mutation, CTL killing, and new viral production. It is used to determine what characteristics give rise to the evasion of HIV-1 from CTL killing. The model was implemented using a computational simulation written in MATLAB. The aim of this project was to increase the efficiency of the program as well as the graphical depiction of the results. This was accomplished by separating the graphical displays from the solver, and then by adding in the ability to vary not only the probability with which infected cells are killed by CTL but also any degree of incomplete killing. The graphical 3-D display now allows visualization of many simulations (i.e., patients) at once. Next steps include development of a program with a more realistic number of viral particles and infected cells. Such an improvement will enable the model to more accurately predict wild type and mutant viral production profiles in response to immune system challenge. These predictions may lead to vaccination strategies or new therapies.

30 *Large-Scale Linear Programming and Heuristic Algorithms*
Kaylee Linthicum, Seattle Pacific University**

Linear programming problems are commonly solved using the Simplex Method. Although the Simplex Method performs well in finding the optimal solution for relatively small scale problems, it proves to be inefficient when problems get too large. In an attempt to save time, heuristic algorithms have been developed to solve these problems more quickly while still arriving at a close to optimal solution. I will discuss the specific problem of survivable telecommunication network and design. I will present two heuristic algorithms, and discuss the performance of each. I will also suggest possible alterations to the algorithms to allow for the design of more complex networks.

31 *A Free Online Math Assessment and Course Management System*
David Lippman, Pierce College Ft. Steilacoom

IMathAS / WAMAP.org is a free, open source online course management and assessment tool, providing immediate feedback on algorithmically generated questions with numerical or algebraic expression answers. Some examples of use will be shown, ranging from homework to placement tests. Content has been collaboratively developed by faculty for arithmetic through calculus and differential equations. This software is comparable to Webassign, WebWork, and MyMathLab, but without the costs or setup headaches.

32 *Generating Varieties for Affine Grassmannians*
Peter Littig, University of Washington, Bothell

The affine Grassmannian associated to a simple, simply-connected, compact Lie group G is an infinite-dimensional ind-variety $\mathcal{L}_G$ whose homotopy type coincides with that of ΩG, the space of based loops in G. In this talk I will provide a brief overview of the construction of $\mathcal{L}_G$ and then describe, for each G, a canonical finite-dimensional Schubert variety that generates the homology of $\mathcal{L}_G$ and, in a precise sense, the affine Grassmannian $\mathcal{L}_G$ itself.

33 *A Nonhomogeneous Poisson Hidden Markov Model for Claim Count*
Yi Lu, Simon Fraser University

We propose a non-homogeneous Poisson hidden Markov model for a time series of claim counts that accounts for both, seasonal variations and random fluctuations, in the claims intensity. It assumes that the parameters of the intensity function for the non- homogeneous Poisson distribution vary according to an (unobserved) underlying Markov chain. This occurs with natural phenomena that evolve in a seasonal environment, for example hurricanes, that are subject to random fluctuations (El Niño-La Niña cycles) affecting insurance claims. The expectation-maximization (EM) algorithm is used to calculate the maximum likelihood estimators for the parameters of this dynamic Poisson hidden Markov model. Statistical applications of this model to Atlantic hurricanes and tropical storms data are discussed.

34 *Inverse Problem and Local Regularization Methods for Nonlinear Volterra-Hammerstein Integral Equations*
Xiaoyue Luo, Linfield College

Inverse problems are problems where causes for a desired or an observed effect are to be determined. The area of inverse problems in quite broad and involves the qualitative and quantitative analysis of a wide range of physical models.

In many applications, the inverse problem can be written in terms of a Volterra integral equation of Hammerstein type, as for example in chemical absorption kinetics, in epidemic models, and also in situations when Laplace transform techniques are used to reduce systems of ordinary or partial differential equations to Volterra integral equation. We develop a local regularization theory for the nonlinear Volterra problem of Hammerstein type. Our method retains the causal structure of the original Volterra problem and allows for fast sequential numerical solution. The fundamental difference between our method and the previous existing local regularization method for Hammerstein equations is that for our method we do not need to solve a nonlinear equation at every step of a numerical implementation. We only have to solve a nonlinear equation for the first step. We prove the convergence of the regularized solutions to the true solution as noise level in the data shrinks to zero with a certain convergence rate.

35 *Some Properties of Semi-Vector Spaces*
Mark Nichols, DigiPen Institute of Technology[**]

We introduce the concept of a Semi-Vector Space and discuss some interesting properties pertaining to them. In particularly, we examine linearly dependent and independent vectors, and show that some of their well-known properties get ”distorted” in semi-vector spaces.

36 *Generic Data Without Best-Fitting Verhulst Curves*
Yves Nievergelt, Eastern Washington University

In the topological space of all sets of three points in the plane, there exists a non-empty open subset where each set of three points does not admit of any best-fitting growth curve of Verhulst's type. This counter-example demonstrates the need for theorems to guarantee the existence of a best-fitting curve or surface in every application.

37 *Some Strategies for Teaching Introductory Proof Techniques*
Hans Nordstrom, University of Portland

The University of Portland utilizes a Discrete Math course as its introductory course in proof technique. I will discuss several methods of approaching direct and indirect proof techniques, including induction, as well as the implementation of formal LaTeX typesetting to reenforce the editorial process in writing proofs.

38 *The Use of a Proof Notebook in Introduction to Proofs*
Jennifer Nordstrom, Linfield College[†]

Rather that use a textbook in Introduction to Proofs, I have my students create their own. By giving students the responsibility of creating their own resource, students feel more ownership of the various proof techniques. The goal is to have students understand that the ability to write a clear, correct, and complete proof is a skill that they will use throughout their mathematics career. Students are expected to rewrite proofs, as only clear, correct, and complete proofs are eligible for inclusion in their notebook. The process of rewriting proofs helps students learn to be critical of their own writing.

39 *Invariants in Hyperplane Arrangements and Matroids*
Joseph Oldenburg, University of Montana[*]

It has been proven using discrepancy in hyperplane arrangements that the oriented flow number for all rank 3 matroids is less than or equal to 4. More than one hyperplane arrangement can represent a given matroid, and it is unknown in general how many. Only some of these arrangements admit the minimum discrepancy which yields the matroid's minimum flow number. A goal of this project and topic of this presenation is to describe which arrangements admit this minimum, and to observe any other enumerative properties of hyerplane arrangements along the way.

40 *Preliminary results for*

$$x_{n+1} = \frac{\alpha_n + \beta_n x_n + \gamma_n x_{n-1}}{A_n + B_n x_n + C x_{n-1}}, n = 0, 1, 2, \ldots$$

with period-two coefficients

Carol Gibbons, Salve Regina University
Carol Overdeep, Saint Martin's University†

In this talk we extend the known results of the nonautonomous difference equation in the title to the situation where (i) the parameters α_n, β_n, γ_n, A_n, and B_n are period-two sequences of nonnegative real numbers with γ_n not identically zero and $A_n + B_n \neq 0$; and (ii) the initial conditions x_{-1} and x_0 are such that $x_{-1}, x_0 \in [0, \infty)$ and $x_{-1} + x_0 \in (0, \infty)$.

41 *Hide and Seek with* $(7, 3, 1)$

Wesley Parker, Western Oregon University**

This report on a paper by Ezra Brown will either introduce or reacquaint the audience with the object known by one name as $(7, 3, 1)$ and cover a subset of many branches of mathematics where this object has been found. Join me in a game of hide and seek with $(7, 3, 1)$.

42 *The Asymptotic Behavior of Dynamic Equations on Time Scales*

Dylan Poulsen, University of Puget Sound**

Time scales calculus is a generalization of calculus which is applicable on any closed subset of the real numbers. This leads to a natural generalization of difference equations and differential equations called dynamic equations on time scales. Dynamic equations on time scales rarely have closed form solutions. In order to understand the behavior of the solutions, the long term, or asymptotic, behavior is studied. We present an introduction of dynamic equations on time scales and discuss the insights this abstraction gives about difference equations and differential equations. We also present original results relating to the asymptotic behavior of a certain class of dynamic equations.

43 *The Last Round of Betting in Poker*

Michael Rivers, Western Oregon University**

Every poker player has a way to determine what decision to make in the last round of betting, but few use the power of game theory to maximize their profits.

Some specific solutions exist, but playing optimally is not always the best you can do. In *The Last Round of Betting in Poker*, Jack Cassidy discusses an interesting notion: how should you play if you can determine your opponent's strategy? In many situations a dominant strategy to the usual optimal strategy for the last round of betting exists.

Learn basic principles that are easy to apply and will help you make the mathematically correct decisions in order to maximize your profits at your next poker game.

44 *Rubik's Cube Cipher*

Matthew James Schmidgall, Western Oregon University**

How can a children's puzzle be used to protect national security? In this talk we will be considering the Rubik's Cube as a basis for an encryption algorithm. We will explore it as a permutation cipher, the possibility of key collisions, and some methods that may be used to increase the cipher strength and security.

45 *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 fibers, 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 examine the stability of the 1D soliton solution of the 2D NLS equation with respect to high-frequency perturbations using asymptotic analysis.

46 *Some Convex Solutions to the Sofa Problem*
James Sommers, Albany, OR†
Ruthven Murgatroyd, Albany OR
Robin Oakapple, Albany OR

The Sofa Problem, the question of the largest (two-dimensional) body able to turn the corner in a hallway of width one, is considered solved by the Gerver-Logan Sofa, but the case where the body is required to be convex appears to be unexplored. It has been speculated by Wagner that the area should exceed the semicircle. We have found a larger-circle segment (CMJ Problem 840) and we investigate segments of the other conic sections for maximal corner-turning areas. Finally, a simple computational algorithm is illustrated for finding still-larger bodies of the type bounded by a straight-line segment and an overlying arc. The largest found thus far is about 4.7 percent larger than the semicircle, and this is proposed as a marker for this still-unsolved problem.

47 *7-D Cross Product and Orthogonality*
Adrian Sotelo, DigiPen Institute of Technology**

In $\mathbb{R}^3$, given two non-parallel vectors, the cross product operation produces a *unique* direction orthogonal to those vectors. However, in $\mathbb{R}^7$ the ”cross product” produces an *infinite* set of vectors that qualify as orthogonal directions to two given vectors, which form a 4-D sphere $\mathbb{R}^5$.

48 *The continuous primitive integral*
Erik Talvila, University of the Fraser Valley

One way of defining an integral is by properties of its primitive. If $f:[a,b]\to\mathbb{R}$ then the primitive is the function $F(x)=\int_a^x f$. For example, f is Lebesgue integrable if F is absolutely continuous and $F'(x)=f(x)$ for almost all x. If f is a Schwartz distribution (generalised function) then f has a *continuous primitive integral* if there is a continuous function F such that $F'=f$ (distributional derivative). In this case, $\int_a^b f=F(b)-F(a)$. We will see that this gives an integral that contains the Lebesgue, Henstock–Kurzweil and improper Riemann integrals but is very easy to work with. The space of integral distributions is a Banach space and Banach lattice. This talk will only assume a basic knowledge of calculus, at the level of the Riemann integral. The necessary background in distributions will be included.

49 *Application of Ordering in Ruin Theory*
Cary C.L. Tsai, Simon Fraser University

In this talk we study orders of pairs of ruin probabilities resulting from two claim severity random variables, each of which is the underlying risk with or without a deductible and/or a policy limit imposed. Numerical examples are also given to illustrate the results of the proposed theorems for ordering ruin probabilities.

50 *Mathematical Model of Strain Competition in Retroviruses*
Greg Vogel, Washington State University†*
Elissa Schwartz, Washington State University
Sergey Lapin, Washington State University

Our research aims to improve and develop new mathematical models of retroviral infection dynamics. Specifically we are interested in determining the effect of mutation and strain competition on the magnitude of viral production. Such models are relevant to the study of the Human Immunodeficiency Virus (HIV-1), and Equine Infectious Anemia Virus (EIAV) infection, which is a large animal model of HIV-1 infection. Our starting point was to use a previously developed model by Ball, et al. and to vary the viral mutation rate within infected T cells (the parameter epsilon). We implemented the model numerically with the Runge-Kutta 4th order method on our system of ODEs. The code, written in java, simulated the dynamics every 6 hours over a 1000 day period. We varied the mutation rate and viral production rate parameters and compared our results against published clinical data. Our results closely resembled clinical data during initial dynamics, but like many other models, they go to a steady state, and don't show the resurgence of virus that is seen in the disease. We were able to discover, however that competition between different strains of the virus limits the production of the virus. The magnitude of infection during initial dynamics was severely limited as the number of viral strains increased. We can conclude that competition between strains of a virus will yield less total viral production as compared to infection by a single strain of the virus.

51 *Patching the Holes in Quasiderivations*
Maria Walters, Pacific University**

"Number derivatives" or "quasiderivations" $\Delta(x)$ were first mentioned over 40 years ago in the Putnam Competition as a map from the integers to the integers that would satisfy the product rule. This definition was later expanded to all nonzero rational numbers. In 2007, this allowed Emmons to define the quasiderivation of a function $f(x)$ for any "number quasiderivation" Δ. However, this definition was found to have a large number of "holes" whenever $\Delta(x) = 0$. This motivated us to incorporate the limit of an infinitely-dimensional vector in order to patch these holes and define a continuous quasiderivation $f^{\Delta}(x)$. We then touch on a few examples where this quasiderivation $f^{\Delta}(x)$ resembles our standard derivative $f'(x)$, and many more cases where they differ widely.

52 *Pricing Annuities Univariate versus Multivariate Models*
Zhong Wan, Simon Fraser University*

Most retirees will annuitize their marketable wealth eventually. The portion of the wealth being annuitized and the timing of the annuitization greatly depend on life annuity prices. The asset allocation, between equity and bonds for example, is a key factor in determining the price of an annuity. One pricing approach consists in modeling the rate of return on each asset class by a conditional univariate stochastic process. The different processes obtained are then combined to price the annuity. Alternatively, one could use a conditional multivariate process modeling the rates of return on all asset classes simultaneously. Preliminary results comparing the two approaches are discussed.

53 *Implementation of channel-routing routines in the Water Erosion Prediction Project (WEPP) model*

William J. Elliot, US Forest Service, Moscow, ID
Fritz R. Fiedler, University of Idaho, Moscow, ID
Sergey Lapin, Washington State University, Pullman, WA
Li Wang, Washington State University, Pullman, WA †*
Joan Q. Wu, Washington State University, Pullman, WA

Water Erosion Prediction Project (WEPP) is a process-based, continuous-simulation, watershed hydrology and erosion model. Presently, its applicability is limited to relatively small watersheds ($<$ 260 ha) since it does not simulate permanent channel flow. The main goal of this study is to develop a suitable channel-routing module for WEPP to enhance its functionality. The channel-routing routines will be based on numerical solutions of the kinematic wave equations for water flow in a channel network. The routines will be assessed by comparing the results with analytical solutions for simplified cases, and with results from an alternative model for a case watershed.

54 *MCM 2009: Circular Logic* (T)

Kerensa Gimre, Pacific University**
Collin Weigel, Pacific University†**
Maggie Wigness, Pacific University**

As the number of vehicles on the road swells, controlling their movement becomes a higher priority. Unfortunately, not all roads combine in a neat and perfect manner. We seek to design an optimal traffic control system of signals for the use of traffic circles. To assure our models are realistic, we account for traffic flow at various times during the day and utilize real-world data of car behavior at roundabouts and at traffic lights to develop 4 models.

Our first simulation calculates the time difference between a yield sign and a stop sign for a single car entering a vacant traffic circle. To create a more dynamic scenario, our second simulation models a selected car yielding to another car in the traffic circle. In our third model, we consider the wait time for the selected car in a line of traffic at a stop sign. Probably the most realistic situation, our fourth model randomly places cars on the roads entering the traffic circle. After collecting wait times for the selected car to reach the roundabout using different traffic controls and comparing the results, we determine the combination of variables most efficient in reducing wait time for a given scenario. Our model produces the least amount of waiting based on the traffic concentration during the day, the number of roads that enter into the traffic circle, and the size of the traffic circle itself. Our results can be applied to many types of traffic circles, including the Arc de Triomphe and the Victory Monument. Our findings concur with government implementation of traffic signals for these two examples.

55 *Using Classroom Presentations to Promote Student Learning*

Nick Willis, Whitworth University

Traditional lecture is important in the Mathematics classroom, but it often leaves little time for a deeper discussion of important concepts that come up in homework problems. I will discuss how my model of using student homework presentation and classroom lecture together enriches the student learning experience. I will discuss the benefits of student presentations and how I facilitate these presentations. Some of the benefits of this way of teaching include better student understanding of proofs, a deeper level of feedback to students from the professor, and building an atmosphere of student participation in the classroom.

56 *On the Modeling of Bonus-Malus Systems*
Ting Zhang, Simon Fraser University*

Bonus-Malus ratemaking systems are widely used in automobile insurance. Policyholders move up and down among a certain number of classes according to their historical claims. In such a system, policyholders occupying higher classes are penalized with premium surcharges while those occupying lower classes are rewarded with premium discounts.

In order to determine the relative premium (surcharge/discount rates) associated with each class in the Bonus-Malus system, mixed Poisson distributions are adopted to model the annual claim frequency, and a Markov Chain model is used to describe the trajectories of the policyholders moving in the system. In this presentation, we propose some ideas on modeling Bonus-Malus systems which would provide more flexibility than existing ones for the insurer.

Abstracts of Posters

(in alphabetical order, by presenter)

57 *A Mathematical Model of Population Growth in the Siberian Wallflower*

Katherine Carpenter, Whitworth University**
Laura Robison, Whitworth University**

The Siberian Wallflower, *cheiranthus allionii*, is a wildflower found in all regions of North America. This work proposes a mathematical model of population growth of *cheiranthus allionii*. Self-incompatibility properties possessed by this plant species, as well as dominance patterns specific to the hexaploid nature of the plant are considered in this model. The complexity of hexaploid plants, greater than that of diploid plants, increases the number of genetic possibilities thus elevating the difficulty of prediction of successful generation of seeds.

58 *Area and Volume of P-Orbital Overlap: Equations and Importance for IR Stretching*

Ryan Cloke, Gonzaga University$^{\dagger **}$
Mathew Cremeens, Gonzaga University
Tom McKenzie, Gonzaga University
Shannon Overbay, Gonzaga University

The early stages of this project are underway in an analysis of the overlap of p-orbitals of atoms of interest to organic chemists. Specifically, we are interested in analyzing the change of the area and volume of overlap in these orbitals as they change with respect to rotation, hybridization, and bond length. The first step in this process involves choosing a suitable model for the electron cloud of a generic p-orbital. Let $r = \cos(2\theta)$ in polar coordinates $(r, ?)$ denote this function. After this analysis is complete, we will turn our attention to the hydrogen-like orbital equations given by physical chemistry textbooks. Using the hydrogen-like equations will provide more realistic information for specific atoms. This analysis will be beneficial in the use of infrared spectroscopy, which is a vital tool in the characterization of many chemical compounds.

59 *Very Round Numbers*

Kaitlin Hildebrand, Whitworth University**
JoAnne Mayer, Whitworth University**

We explored very round numbers. A very round number is a number n such that all numbers that are less than n and are relatively prime to n are either prime or 1. We took this definition and examined the possible integers that satisfied the conditions of being very round. We then compiled a complete list of integers that fulfilled the criterion and attempted a proof at our lists completeness.

60 *Clique-Relaxed Graph Coloring*

William Sehorn, Whitworth University$^{\dagger **}$

We define a variation of the chromatic number of a graph G called the k-clique-relaxed chromatic number, denoted $\chi^{(k)}(G)$. We prove that $\chi^{(k)}(G) \leq \left\lceil \frac{\chi(G)}{k} \right\rceil$ for all graphs G, and we prove corollaries for outerplanar and planar graphs. We also define the k-clique-relaxed game chromatic number, $\chi_g^{(k)}(G)$, of a graph G. We prove $\chi_g^{(2)}(G) \leq 4$ for all outerplanar graphs G and give an example of an outerplanar graph H where $\chi_g^{(2)}(H) \geq 3$.

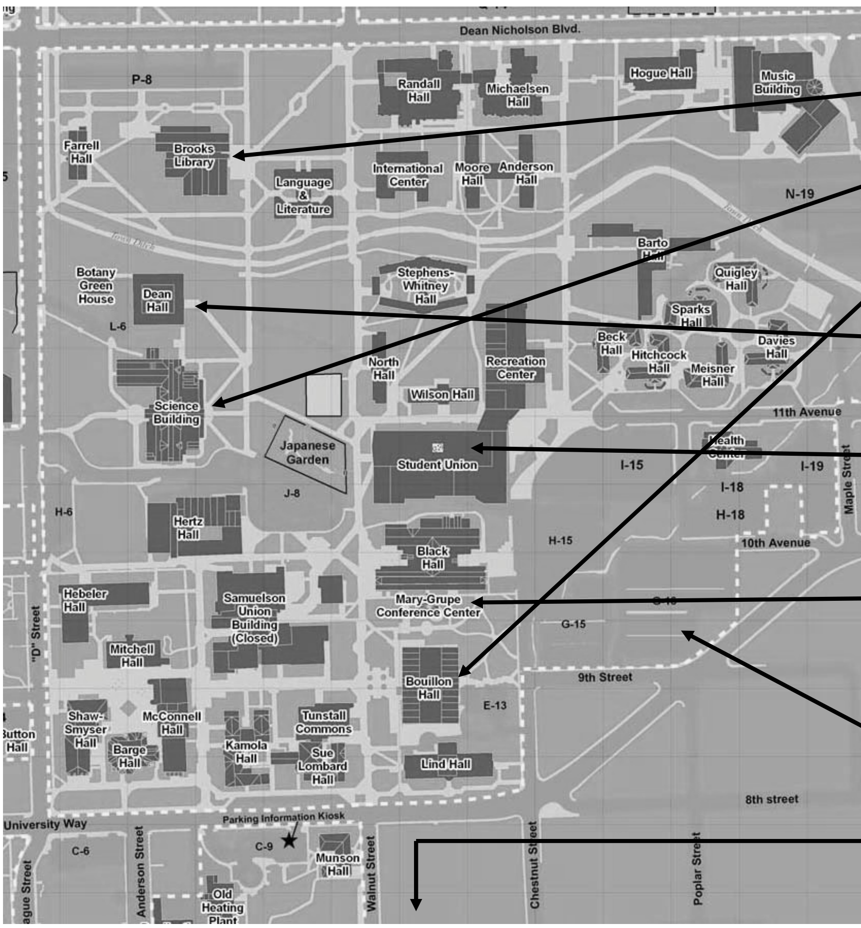
Campus Information

Internet Access: see packet insert.

CWU Safety Department Phone Number: 911

Ellensburg Police Department Emergency Number:911 (from campus phones)

Non-Emergency Number: (509) 925-8534



Minicourses:

Stein: Sage
Library Computer Lab

Andrews: Partitions
Science 115

Wagon: Mathematica
Bouillon 103

Paper Sessions/
Dean Hall

Registration/ Invited Lectures
SURC (Student Union)

Project NExT
Grupe Center

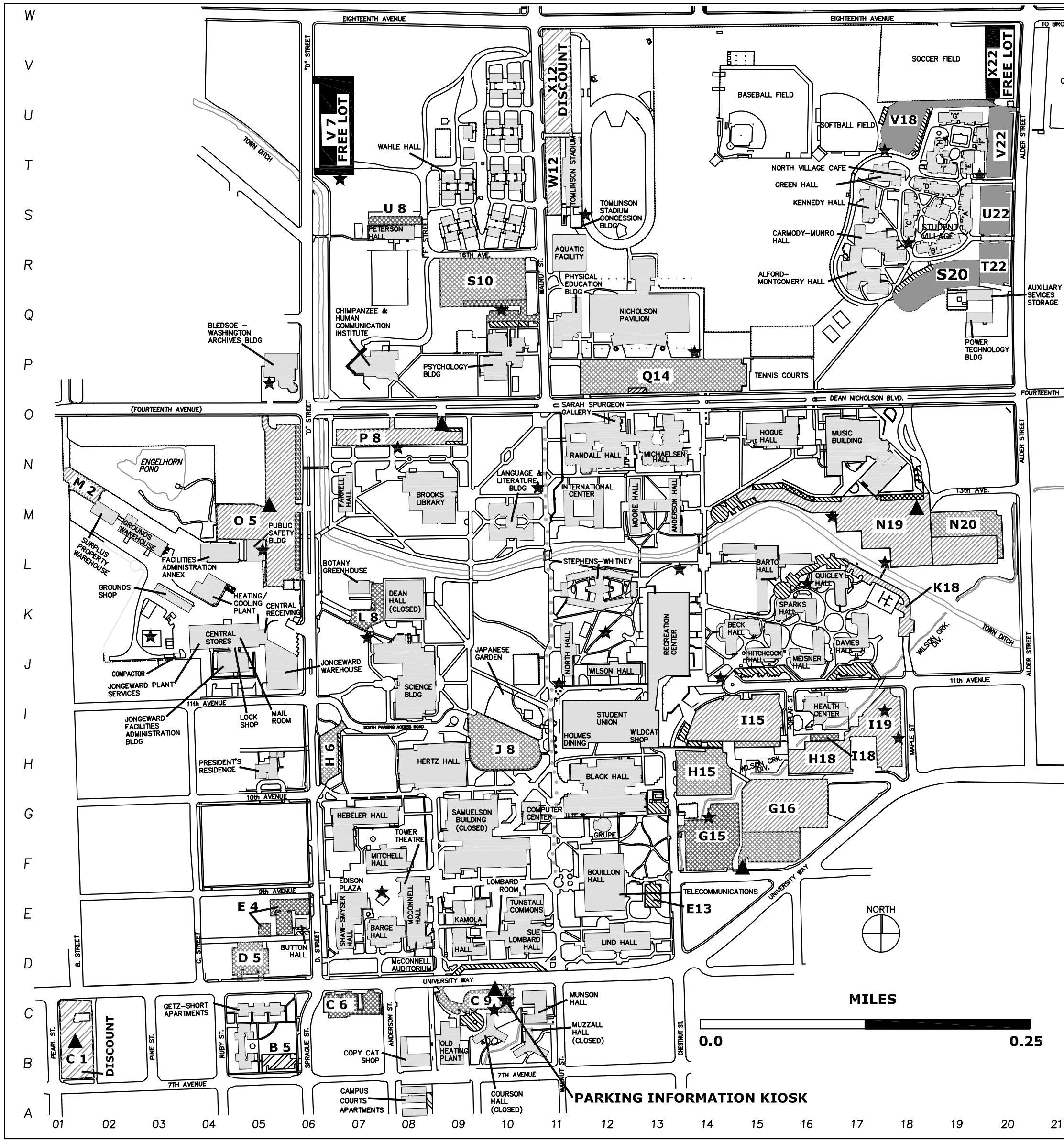
Parking:
$3/Day on Friday
Free on Saturday

Parking:
Free on street parking usually available south of 5th Ave. Do not park in any RPZ zone!

5 blocks to Main St.

~1.5 miles

Hotels:
Canyon Rd Hotels



CENTRAL WASHINGTON UNIVERSITY

ELLENSBURG, WASHINGTON

BUILDINGS NAME & LOCATION BY GRID

ALFORD MONTGOMERY HALL, R 17
ANDERSON HALL, M 13
AQUATICS FACILITY, R 11
AUXILIARY SERVICES STORAGE, Q 20
BARGE HALL, E 7
BARTO HALL, L 15
BECK HALL, K 15
BLACK HALL, G 12
BLEDSOE WASHINGTON ARCHIVES BUILDING, P 5
BOTANY GREENHOUSE, K 7
BOUILLON HALL, E 12
BROOKLANE VILLAGE, X 28
BROOKS LIBRARY, M 9
BUTTON HALL, E 6
CAMPUS COURTS APARTMENTS, A 8
CARMODY-MUNRO HALL, R 17
CENTRAL STORES, J 6
CENTRAL RECEIVING, J 6
CHIMPANZEE AND HUMAN COMMUNICATION INSTITUTE, P 7
COMPUTER CENTER, G 10
COPY CAT SHOP, B 8
COURSON HALL (CLOSED), C 10
DAVIES HALL, J 17
DEAN HALL, K 8
FACILITIES ADMINISTRATION ANNEX, L 4
FACILITIES ADMINISTRATION BUILDING, J 4
FACILITIES MANAGEMENT WAREHOUSE, J 5
FARRELL HALL, M 7
GETZ-SHORT APARTMENTS, C 5
GREEN HALL, T 18
GROUNDS SHOP, K 3
GROUNDS WAREHOUSE, M 2
GRUPE CONFERENCE CENTER, G 12
HEALTH CENTER, I 16
HEATING/COOLING PLANT, K 4
HEBELER HALL, G 7
HERTZ HALL, H 8
HITCHCOCK HALL, J 15
HOGUE HALL, O 15
HOLMES DINING, H 11
INTERNATIONAL CENTER, M 11
JAPANESE GARDEN, I 10
JONGEWARD PLANT SERVICES, J 4
JONGEWARD FACILITIES ADMINISTRATION BULDING, I 4
KAMOLA HALL, D 9
KENNEDY HALL, S 17
LANGUAGE & LITERATURE BUILDING, M 10
LIND HALL, D 12
LOCK SHOP, J 5
LOMBARD ROOM, D 10
MAIL ROOM, J 5
MCCONNELL AUDITORIUM, D 8
MEISNER HALL, J 16
MICHAELSEN HALL, N 13
MITCHELL HALL, F 7
MOORE HALL, M 13
MUNSON HALL, C 10
MUSIC BUILDING, N 17
MUZZALL HALL (CLOSED), B 10
NICHOLSON PAVILION, Q 12
NORTH HALL, J 11
NORTH VILLAGE CAFE, T 18
OLD HEATING PLANT, B 9
PARKING INFORMATION KIOSK, C 10
PETERSON HALL, S 8
PHYSICAL EDUCATION BUILDING, Q 11
POWER TECHNOLOGY LAB, Q 20
PRESIDENTS RESIDENCE & RECEPTION CENTER, H 5
PSYCHOLOGY BUILDING, P 10
PUBLIC SAFETY BUILDING, L 5
QUIGLEY HALL, L 16
RANDALL HALL, N 12
RECREATION CENTER, J 13
SAMUELSON BUILDING (CLOSED), F 9
SARAH SPURGEON GALLERY, O 12
SCIENCE BUILDING, I 8
SHAW-SMYSER HALL, D 7
SPARKS HALL, K 16
STEPHENS WHITNEY HALL, K 12
STUDENT VILLAGE APARTMENTS, S 19
STUDENT UNION, I 12
SUE LOMBARD HALL, D 10
SURPLUS PROPERTY WAREHOUSE, M 2
TELECOMMUNICATIONS, E 12
TOMLINSON STADIUM, S 11
TOWER THEATER, E 8
TUNSTALL COMMONS, E 10
WAHLE HALL, S 10
WILDCAT SHOP (BOOKSTORE), I 13
WILSON HALL, J 12

LEGEND

CWU CAMPUS PARKING LOTS
(CURRENT ONLY AT TIME OF PRINTING. REVISED 8/06)

- GENERAL CAMPUS PARKING (24 HOUR)
- GENERAL CAMPUS NON OVERNIGHT PARKING (2 A.M – 6 A.M.)
- GENERAL OR STUDENT VILLAGE APZ
- DISCOUNT PARKING LOTS
- FREE PARKING LOTS
- ON-CAMPUS RESIDENT PARKING
- FACULTY/STAFF PARKING LOTS
- TIMED & RESERVED PARKING LOTS
- CLOSED TO VEHICULAR TRAFFIC
- BLUE-LITE/EMERGENCY PHONE
- DAILY PARKING PERMIT SALES DISPENSER DISPENSERS ARE LOCATED IN LOTS: C1, C9, G16, O5, P8, N19

GENERAL INFORMATION

DISCOUNT PARKING LOTS ARE C1 AND X12.

FREE PARKING LOTS ARE V7 AND X22.

ADDITIONAL 15 AND 30 MINUTE PARKING SPACES ARE AVAILABLE THROUGHOUT THE CAMPUS PARKING LOTS.

MOTORCYCLE PARKING SPACES ARE AVAILABLE IN SOME LOTS.

DISABLED PARKING SPACES ARE AVAILABLE IN MOST LOTS.

SERVICE DRIVES ARE OFF-LIMITS WITHOUT PERMITS. SERVICE DRIVE PERMITS ARE AVAILABLE AT COURSON HALL PARKING KIOSK OR PUBLIC SAFTEY BUILDING.

WALNUT MALL IS CLOSED TO VEHICULAR TRAFFIC BETWEEN BOUILLON HALL AND DEAN NICHOLSON BLVD.

REMINDER: YOU MUST HAVE A RESIDENTIAL PARKING ZONE (RPZ) PERMIT TO PARK WITHIN THE TWO ZONES LOCATED ADJACENT TO CAMPUS DURING THE FOLLOWING TIMES:
- 8 AM TO 5 PM MONDAY THRU FRIDAY NORTH OF UNIVERSITY WAY (ZONE 1).
- 6 AM TO 6 PM MONDAY THRU FRIDAY SOUTH OF UNIVERSITY WAY (ZONE 2).

THESE PERMITS ARE DIFFERENT THAN CWU PARKING PERMITS AND PASSES. ZONE MAPS ARE AVAILABLE FROM THE CITY OF ELLENSBURG OR THE CWU PARKING OFFICE.

IF YOU ARE UNSURE OF WHERE YOU CAN PARK WITHOUT GETTING TICKETED, PLEASE CALL THE CWU PARKING OFFICE FOR CLARIFICATION: 509-963-2667

Acknowledgments

On behalf of the Pacific Northwest Section of the Mathematical Association of America, I would like to personally thank everyone who has been instrumental in making this annual meeting possible. In particular, I would like to acknowledge the following people:

Hans Nordstrom (University of Portland) served as program chair, organized the contributed paper sessions and received abstracts. He also put together this conference program booklet. Hans also provided valuable advice throughout the planning process.

Debbie Thomas (CWU Mathematics Department Administrative Assistant) handled a myriad of issues: received and processed registrations, created a master list of participants, made arrangements with food services for the banquet dinner, lunch, and various refreshments that were served during the conference. She was also instrumental in arranging rooms for conference activities. Debbie was the single most important person on whom I depended in organizing this conference. We at CWU could not have brought it off without her efforts.

Lee Sutton (CWU IT group) built and maintained the conference web page.

Stephen Glasby (CWU Mathematics Department) made arrangements for our invited speakers and worked with the organizing committee in numerous ways to prepare for the conference.

Stuart Boersma (CWU Mathematics Department) worked with the organizing committee on numerous issues including food for the banquet, lunch, and other refreshments. He created the annotated campus map on page 25.

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

James Bisgard (CWU Mathematics Department) made local arrangements for the NExT program; provided material for the conference website; worked with the organizing committee on a variety of tasks during the planning process.

James Harper (CWU Mathematics Department) organized the student reception and pizza party on Friday evening.

Jon Fassett (CWU Mathematics Department) arranged for the MAA book sale table. Worked with the committee during the planning process.

John Thurber (Eastern Oregon University) served as liaison between the local organizing committee and the section's executive committee. John gave us a great deal of valuable guidance during the planning process.

All of these people (and others not listed, as well) combined made this conference possible. My deepest gratitude goes out to all of you!

Dan Curtis
Local Arrangements Chair