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

University of Alaska Southeast
Juneau, Alaska

June 23-25, 2011

Program of the 2011 Meeting of the MAA, Pacific Northwest Section

Thursday, June 23

7:45	**Project NExT Packet Pickup**	
8:00	**Project NExT Meeting**	*Egan 221/222*
12:00	**Registration Packet Pickup** (until 5:00)	*Egan 221/222*
2:30	**Minicourse 1: Quantitative Reasoning**	*Egan 223*
2:30	**Minicourse 2: Mathematical Modeling**	*Egan 224*
2:30	**Panel Discussion: Transition from High School to College**	*Egan 225*
5:30	**Project NExT Dinner and Discussion**	*Noyes Pavillion*
8:00	**Public Lecture: John Adam** *Mathematical patterns in nature*	*Egan 112*
9:00	**Reception**	*Egan 221/222*

Friday, June 24

<table>
<tr><td>8:00</td><td rowspan="5">Registration & Packet Pickup
Egan 221/222</td><td colspan="2">Executive Committee Meeting
Fireweed Room, Mourant Building</td></tr>
<tr><td>9:00</td><td rowspan="3">Student Posters & Book Sales
Egan 221/222</td><td>Invited Lecture: David Bressoud
Issues of the transition to college mathematics
Egan 112</td></tr>
<tr><td>10:30</td><td>Contributed Talks
Egan Wing Classrooms</td></tr>
<tr><td>12:00</td><td rowspan="2">Lunch
Mourant Cafeteria</td></tr>
<tr><td>12:15</td><td>Business Meeting
Fireweed Room</td></tr>
<tr><td>1:30</td><td colspan="3">Contributed Talks
Egan Wing Classrooms</td></tr>
<tr><td>3:15</td><td colspan="3">Outing: Mendenhall Glacier
Pickup outside Egan Wing</td></tr>
<tr><td>6:00</td><td colspan="3">Social Hour
Fireweed Room (Mourant Building)</td></tr>
<tr><td>7:00</td><td colspan="3">Banquet and Section Awards
Mourant Cafeteria</td></tr>
<tr><td>8:00</td><td colspan="3">Invited Lecture: David Bressoud, The truth of proofs
Egan 112</td></tr>
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Saturday, June 25

9:00	**Student Posters & Book Sales** *Egan 221/222*	**Invited Lecture: Karen Seyffarth** *Colourful Graph Theory* *Egan 112*
10:15		**Contributed Talks** *Egan Wing Classrooms*
12:30	**Outing: Whale Watching** *Pickup outside Egan Wing (box lunch provided)*	

Program of Contributed Talks

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 complete information. An asterisk ($*$) indicates which of the contributers listed is/are make the presentation; a double asterisk ($**$) indicates the contributer is an undergraduate student.

Sessions

- *Junior Faculty Talks*: This session is intended to showcase research interests of non-tenured faculty, particularly those new to the section, who are early in their careers as mathematical researchers.
- *Topics in Mathematics Education and Teaching*: Talks in any area of mathematics education including examples of effective classroom techniques and other "teaching gems".
- *Current Research in Algebra, Geometry and Topology*: Many of the most important results in modern mathematics occur in the intersections of Algebra, Geometry, and Topology. This session welcomes presentations on new results in these areas and their overlap. Bonus points will be awarded for results with applications in other areas.
- *General Talks*: The goal of the general research session is to exhibit current research in pure and applied mathematics and mathematics education by faculty in the Northwest and by colleagues elsewhere. Mathematical talks on any topics of interest to section members are welcome.

Contributed Talks
Friday Morning

	Topics in Education & Teaching *Egan 218*	Algebra, Geometry & Topology *Egan 224*
10:30–10:45	*Using problems to challenge future teacher understandings* [7] **Jackie Coomes** **Eastern Washington U.**	*Algebraic generalizations of the pigeonhole principle* [2] **Arie Bialostocki** **U. of Idaho**
10:50–11:05	*The "zeroing factors principle" in college algebra* [30] **Gregg Waterman** **OIT**	*Closed surfaces and the character variety* [6] **Eric Chesebro** **U. of Montana**
11:10–11:25	*The Calculus Concept Inventory* [19] **Scott L. Peterson** **Oregon State U.**	*The topology of tile invariants* [11] **Mike Hitchman** **Linfield College**
11:30–11:45	*Advantages and disadvantages of using web based assessment software in mathematics classes* [1] **Hamid Behmard** **Western Oregon U.**	*Leavitt path algebras with coefficients in an arbitrary unital ring* [17] **Jennifer Nordstrom** **Linfield College**
11:50–12:05	*Using R for linear algebra* [10] **Christopher Hay-Jahans,** **U. of Alaska Southeast**	*Finite dimensional division algebras over fields* [14] **Kelly McKinnie** **U. of Montana**

Contributed Talks
Friday Afternoon

	Topics in Education & Teaching *Egan 218*	**Algebra, Geometry & Topology** *Egan 224*
1:30–1:45	*An interdisciplinary program for undergraduates in quantitative ecology* [4] **Megan Buzby** **U. of Alaska Southeast**	*A brief introduction, and new results, on intrinsically knotted graphs* [15] **Ramin Naimi** **Occidental College**
1:50–2:05	*A prize for the best open-source mathematics textbook* [25] **Albert Schueller** **Whitman College**	*Cayley-Sudoku tables and loop theory* [28] **Michael B. Ward** **Western Oregon U.**
2:10–2:25	*An inquiry-based introduction to game theory course* [18] **Jennifer Nordstrom** **Linfield College**	*Artin groups and their many hats* [20] **Valerie Peterson** **U. of Portland**
2:30–2:45	*Contextualized intermediate algebra* [9] **Mark A. Fitch** **U. of Alaska Anchorage**	*Symplectic perspective in dynamics* [13] **Chris Lee** **U. of Portland**
2:50–3:05	*Distributed exams* [26] **Colin Starr** **Willamette U.**	

Contributed Talks
Saturday Morning

	Junior Faculty *Egan 218*	**General** *Egan 224*
10:15–10:30	*Mathematical modeling of stochastic processes in cell motility* [5] **Hannah Callender** **U. of Portland**	*On an extremal property of the incenter* [3] **Arie Bialostocki** **U. of Idaho**
10:35–10:40	*Some projects in computational and mathematical neuroscience: from single cells to brain regions* [23] **Michael Rempe** **Whitworth U.**	*First digits of numbers in sequences* [24] **Kenneth A. Ross** **U. of Oregon**
10:45–11:00	*An introduction to cube complexes* [21] **Valerie Peterson** **U. of Portland**	*Expected loss: a new take on gambler's ruin* [8] **Curtis Feist** **Southern Oregon U.**
11:05–11:20	*Multiplier sequences* [22] **Andrzej Piotrowski** **U. of Alaska Southeast**	*The Dirichlet problem and the Fundamental Theorem of Calculus* [29] **Gregg Waterman** **OIT**
11:25–11:40	*The sum of the reciprocals of the amicable numbers* [12] **Dominic Klyve** **Central Washington U.**	*Applying bayesian methods for replenishing items with seasonal intermittent demand* [16] **Meike Niederhausen** **U. of Portland**
11:45–12:00		*Delannoy Numbers* [27] **Colin Starr** **Willamette U.**

Minicourse Descriptions

Quantitative Reasoning in the News

Stuart Boersma, Central Washington University
Caren Diefenderfer, Hollins University

Quantitative literacy is necessary for a well functioning democratic society. However, many educated adults remain functionally innumerate. Many mathematics departments at our colleges and universities have been asked to help address this problem by teaching quantitative reasoning courses. These courses vary greatly in content and pedagogy, are often considered "terminal" courses, and are frequently used to "teach" remedial algebra skills.

As dedicated and passionate teachers of mathematics, we should use these courses to give our students the tools they need to think for themselves, ask intelligent questions of experts, and to confront authority with confidence. Newspapers can provide a surprisingly wide variety of study materials for a quantitative reasoning course.

In this minicourse, the presenters will describe the mechanics of using newspapers for a quantitative reasoning course and the participants will work through a variety of case studies associated with media articles.

About the Instructors: Stuart Boersma received his B.S. from The University of Puget Sound, Ph.D. from Oregon State University and is currently Professor of Mathematics at Central Washington University. He was Department Chair at CWU from 2004-2007 and chair of the Pacific Northwest section of the MAA from 2005-2006. Currently, he is the chair of SIGMAA-QL, the Mathematical Association of America's special interest group on Quantitative Literacy, and a Governor of the MAA.

Together with Bernie Madison, Shannon Dingman, and Caren Diefenderfer, he has been designing and teaching introductory college level quantitative reasoning courses based on the critical reading of newspaper articles. In addition to these QL courses, he enjoys teaching vector calculus, topology, and cryptology courses.

Stuart enjoys writing expository papers for undergraduates and received the 2005 Trevor Evans Award for one of his Math Horizons papers. His most recent publications have appeared in Math Horizons, SIURO, Primus, and Numeracy.

Caren Diefenderfer received her A. B. (1973 - summa cum laude) in the first coed class at Dartmouth College, and her M.A. (1975) and PhD (1980) from University of California at Santa Barbara. Currently Dr. Diefenderfer is a professor of mathematics at Hollins University, where she joined the Hollins University mathematics faculty in 1977. Her two terms as chair of the mathematics and statistics department at Hollins were preceded by a term as chair of the division of natural and mathematical sciences.

Professor Diefenderfer has been involved with the AP Calculus program since 1969, when she took the AB exam as a high school senior. She served as Chief Reader for AP Calculus from 2004-2007. She also has a long-standing relationship with the Mathematical Association of America (MAA). She was the Secretary of the MD-DC-VA

Section, was Chair of SIGMAA QL, the quantitative literacy special interest group of the MAA, is currently Chair of SIGMA TAHSM, the special interest group on teaching advanced high school mathematics, serves on several MAA committees, and has been a consultant and speaker at numerous institutions who are interested in learning about Quantitative Literacy/Reasoning.

Professor Diefenderfer sings with her church choir, is a member of the Bahama Mamas (a female steel drum band), loves to swim and enjoys reading fiction. She lives with three baseball enthusiasts; her husband, David, and her two sons, Mark and Joseph.

Teaching Mathematical Modeling through Patterns in Nature

John Adam, Department of Mathematics & Statistics, Old Dominion University

This mini-course is intended for those who teach, or plan to teach a course in mathematical modeling. This presentation identifies some of the underlying mathematical and physical principles undergirding some of the common and not-so-common patterns in the natural world around us. The word pattern implies an underlying scientific and mathematical basis for describing and explaining what we see (to some degree, at least). Indeed, mathematics has been called the science of patterns. I am convinced that the beauty of nature can be further revealed by mathematics, and the beauty of mathematics is revealed in nature, if we are prepared to study it, and further, that this can be a source of fascination for students, at any academic level - nature is a resource for teaching mathematics, and it's free! Examples will be taken from a senior/first-year graduate level course taught by the presenter, possibly supplemented by some basic principles of "Guesstimation".

Since the ability to see is dependent on the light that reaches our eyes, it is perhaps not surprising that several of the examples considered in this mini-course come from the field of atmospheric optics. We will examine some ray-theoretic models of rainbows, ice-crystal halos (including circum-horizontal and circum-zenithal arcs) and "glories", and along the way discuss a model of some shadow-related phenomena, namely crepuscular and anti-crepuscular rays. Fermat's Principle of Least Time and the Euler-Lagrange equation enable us to discuss many of these and other phenomena in mathematical terms, and in particular, mirages and what I refer to as the "mirage theorem". By condensing the relevant fluid dynamical equations we will examine the idealized behavior of linear waves on the surface of puddles, ponds, rivers and oceans, and the delightful "ship-wave" patterns that are readily noticed from the air. Time permitting, we may also look at the importance of dimensional analysis in modeling, certain types of cloud pattern, a mathematical model of river meanders, the Fibonacci "Golden Angle", models of bird eggs, tree 'tumors', to name but a few possible topics.

About the Instructor: Please see Invited Speakers page.

Panel Discussion

The Transition from High School to College

Organizer: Jill Dumesnil, University of Alaska Southeast

It is understood that the levels of awareness vary for what constitutes appropriate mathematical preparation for college bound high school graduates. This panel discussion is intended to address this issue. Among others, topics discussed will explore answers to questions such as: What is the best way to prepare high school students for college level mathematics? Can middle school teachers help the cause? Should high school students enroll in mathematics courses taught at colleges/universities? Do dual credit mathematics courses taught at colleges/universities benefit students who enroll in them? Should dual credit courses be taught at high schools? Do AP courses serve college bound students well? etc.

All who are interested in this subject are invited. Moreover, all who have any of the above questions, or others, or believe they have answers to any of these questions through experience and/or research are encouraged to participate in this discussion.

UAS Planned Outings

Mendenhall Glacier

Friday, June 24. Bus leaves Egan Classroom Wing at approximately 3:15 and returns 5:30 p.m.

This outing includes options of a tour of the Visitor's Center and several short, self guided nature walks on trails that are classified as easy - relatively flat trails. Raised boardwalks provide an opportunity for viewing bears lounging around or feeding on salmon - if the fish are running.

Transportation to and from the glacier will be provided. Family members are welcome too.

Whale Watching Cruise

Saturday, June 25. Bus leaves Egan Classroom Wing at 1:00 and returns 4:00 pm.

This cruise will be free, with boxed lunches provided. Family members are welcome too.

Invited Speakers

John Adam
Department of Mathematics & Statistics, Old Dominion University

Mathematical Patterns in Nature

Abstract: What aspects of nature do you notice when you are outside during the day? Whether we live in the country, suburbia or the city, it is probable that we will notice a variety of trees, different types of clouds, birds and flowers, or waves on bodies of water (or at least puddles!). This presentation will include many color photographs of naturally-occurring patterns. Such patterns can be fascinating, intriguing, and frequently very beautiful, and are exhibited. For example, in rainbows, ice crystal halos, sundogs, waves, sunflowers and daisies, pinecones, spider webs, clouds, trees, river meanders, mountain shadows, glitter paths and sunbeams, to name but a few! Only the most elementary of mathematical features will be identified in this general talk, but the patterns are accessible to anyone with a love of nature, and a willingness to look up, down or around! [It is recommended that this not be done, however, while driving or operating heavy machinery :)]. So: when you are outside, look for patterns, look for the way that the light displays what you see, and bask in the mathematical beauty of nature, at no matter what scale.

Brief Biography: John Adam is the Designated University Professor of Mathematics (for excellence in teaching) at Old Dominion University. He has held teaching and research postions at University of Sussex; University of St. Andrews; concurrent positions at New University of Ulster and Dublin Institute of Advanced Studies; he was a Fulbright Scholar and Visiting Professor in the Department of Mechanical Engineering at University of Rochester; and, since 1984, has been at Old Dominion University. His areas of interest and research have included a wide range of fields, including wave theory, astrophysics, mathematical physics, mathematical biology, applications of mathematics to medicine, and meteorological optics.

He has more than 95 publications in a wide variety of journals and has published four books, including *Mathematics in Nature: Modeling Patterns in the Natural World*, winner of The Association of American Publishers Mathematics and Statistics Professional/Scholarly Award and one of Choice's Outstanding Academic Titles for 2004. Another book, *Guesstimation: Solving the World's Problems on the Back of a Napkin*, co-authored with Lawrence Weinstein, presents "an eclectic array of estimation problems that range from devilishly simple to quite sophisticated and from serious real-world concerns to downright silly ones." In his latest book, *A Mathematical Nature Walk*, John "presents ninety-six questions about many common natural phenomena–and a few uncommon ones–and then shows how to answer them using mostly basic mathematics."

John Adam was the winner of the 2007 Outstanding Faculty Award for the State of Virginia, the Commonwealth's highest honor for faculty at Virginia's public and private colleges and universities, recognizing recognize superior accomplishments in teaching, research, and public service.

David Bressoud
Department of Mathematics, Statistics and Computer Science, Macalester College

Issues of the Transition to College Mathematics

Abstract: Over the past quarter century, 2- and 4-year college enrollment in first semester calculus has remained constant while high school enrollment in calculus has grown tenfold, from 60,000 to 600,000, and continues to grow at 6% per year. We have passed the cross-over point where each year more students study first semester calculus in US high schools than in all 2- and 4-year colleges and universities in the United States. In theory, this should be an engine for directing more students toward careers in science, engineering, and mathematics. In fact, it is having the opposite effect. This talk will present what is known about the effects of this growth and what needs to happen in response within our high schools and universities.

The Truth of Proofs

Abstract: Mathematicians often delude themselves into thinking that we create proofs in order to establish truth. In fact, that which is “proven” is often not true, and mathematical results are often known with certainty to be true long before a proof is found. I will use some illustrations from the history of mathematics to make this point and to show that proof is more about making connections than establishing truth.

Brief Biography: David Bressoud is the DeWitt Wallace Professor of Mathematics at Macalester College and President of the Mathematical Association of America. He served in the Peace Corps, teaching math and science at the Clare Hall School in Antigua, West Indies before studying with Emil Grosswald at Temple University and then teaching at Penn State for 17 years. He chaired the Department of Mathematics and Computer Science at Macalester from 1995 until 2001. He has held visiting positions at the Institute for Advanced Study, the University of Wisconsin-Madison, the University of Minnesota, Universit Louis Pasteur (Strasbourg, France), and the State College Area High School.

David has received the MAA Distinguished Teaching Award (Allegheny Mountain Section), the MAA Beckenbach Book Award for *Proofs and Confirmations*, and has been a Pólya Lecturer for the MAA. He is a recipient of Macalester’s Jefferson Award. He has published over fifty research articles in number theory, combinatorics, and special functions. His other books include *Factorization and Primality Testing*, *Second Year Calculus from Celestial Mechanics to Special Relativity*, *A Radical Approach to Real Analysis* (now in 2nd edition), *A Radical Approach to Lebesgue’s Theory of Integration*, and, with Stan Wagon, *A Course in Computational Number Theory*.

David has chaired the MAA special interest group, Teaching Advanced High School Mathematics as well as the AP Calculus Development Committee and has served as Director of the FIPSE-sponsored program *Quantitative Methods for Public Policy*.

Karen Seyffarth

Department of Mathematics and Statistics, University of Calgary

Colourful Graph Theory

Abstract: Graph colouring has a long history, and provides a rich source of interesting problems, often with practical applications. In it's simplest form, graph colouring is concerned with assigning colours to the vertices of a graph G so that adjacent vertices receive different colours, and such that the total number of colours used is minimum. This minimum is the *chromatic number* of G, denoted $\chi(G)$. Arguably, the most famous graph colouring problem is the *Four Colour Problem* which asks whether or not every planar graph is 4-vertex-colourable (c1852), i.e., whether or not $\chi(G) \leq 4$ for any planar graph G. Often, the Four Colour Problem is stated in an equivalent form: can the countries of any map be coloured with four colours in such a way that any two countries that share a border receive different colours?

One of my current interests is a variation on the chromatic number called the *distinguishing chromatic number*, first introduced in a 2006 article by Karen Collins and Ann Trenk. A colouring of the vertices of a graph G is *distinguishing* provided no automorphism of G, other than the identity, preserves the colours of the vertices. Thus a distinguishing colouring of the vertices of a graph is a way of destroying the symmetries of the graph. The *distinguishing chromatic number* of G, denoted $\chi_D(G)$, is the minimum number of colours required to colour the vertices of G so that the resulting colouring is distinguishing. I will be presenting some results concerning the distinguishing chromatic number, and providing many examples to illustrate these results. In addition, I will discuss the related concept of the *distinguishing number* of a graph, which involves labelling the vertices of a graph so as to destroy nontrivial automorphisms, but not requiring the labels on adjacent vertices to be distinct. Determining the distinguishing number of a graph turns out to be a generalization of the problem *The Blind Man's Keys* posed by Frank Rubin in a 1979 issue of the *Journal of Recreational Mathematics*.

Brief Biography: Karen Seyffarth is an Associate Professor in the Department of Mathematics and Statistics at the University of Calgary, in Alberta, Canada. She received her Ph.D. from the Department of Combinatorics and Optimization at the University of Waterloo in 1990, and arrived at the University of Calgary in 1992, after completing a post-doctoral fellowship at Simon Fraser University.

Karen's research is in the area of combinatorial mathematics, with a focus on graph theory. Her research programme encompasses a variety of problems that involve graphs with well defined structure, such as planar graphs, graphs with fixed diameter or maximum degree, graph products, and line graphs. She has published articles about path and cycle covers of graphs, dominating sets in graphs, and constructions of graphs with fixed diameter and maximum degree. Recently, her interest has been directed towards graph colouring. This is a rich and diverse area in graph theory, ideal for experienced researchers and students alike.

Karen's passion for graph theory stems from the fact that many problems can be simply and elegantly stated, yet the solutions to some of these problems involve complex and sophisticated techniques. The beauty lies in the fact that even though the solutions may not be readily accessible, the problems themselves are often easily accessible. One of the prime examples of this is the famous Four Colour Problem, which is thought to date back to the 1850s, and whose correct solution, the Four Colour Theorem, did not emerge until 1976. Many graph-colouring-type problems provide wonderful opportunities to experiment and explore mathematics without becoming overly burdened with terminology and notation.

Karen gave her first conference presentation at the *Thirteenth Conference on Numerical Mathematics and Computing* at the University of Manitoba while still an undergraduate student, and has delivered many research talks since then. She has held research grants from the *Natural Sciences and Engineering Research Council of Canada*, and is currently supervising three graduate students. Karen has also been the Managing Editor for the e-Journal *Contributions to Discrete Mathematics* since 2007.

Outside of mathematics, Karen is an enthusiastic hiker and an avid runner. She ran her first marathon in 2001, and has since completed 10 more, including the Boston Marathon in 2006. Her PB in the marathon is 3 hours, 36 minutes, 48 seconds.

Abstracts of Contributed Talks

(in alphabetical order, by presenter)

1 *Advantages and disadvantages of using web based assessment software in mathematics classes*
Hamid Behmard, Western Oregon University

In recent years, use of online assessment software is becoming more widespread. One reason for this is budget cuts and lack of funds for graders. In this talk we consider two of the widely used web based assessment software, Web Assign and MyMathLab. We consider the following aspects:

1. A short introduction on different aspects of these software,
2. Advantages and disadvantages of using these two software in relation to students' learning,
3. Cost effectiveness,
4. Ease of use from the point of view of students and instructors,
5. Some statistics on the number of departments and students using the online assessment software.

We conclude the talk by explaining some of the methods that we use in our department to make these software more effective.

2 *Algebraic generalizations of the pigeon hole principle*
Arie Bialostocki, University of Idaho

The Erdős-Ginzburg-Ziv Theorem states that within a sequence of $2n-1$ integers we can always find n integers whose sum is divisible by n. This 1961 theorem can be viewed as a generalization of the pigeon-hole principle. We will survey some older generalizations and directions of research as well as new developments and open problems.

3 *On an extremal property of the incenter*
Arie Bialostocki, University of Idaho

Among the over 3500 documented centers of the triangle, the incenter might be the most interesting one, as recently, using a computer about 200 theorems have been discovered about it. In our talk we will survey some background and present an extremal property of the incenter due to my late wife published in 2011.

4 *An interdisciplinary program for undergraduates in quantitative ecology*
Megan Buzby, University of Alaska Southeast

As a graduate student at Colorado State University, I helped run a one to two year interdisciplinary program for undergraduates, funded by NSF. The main goal of this program was to introduce a small group of primarily mathematics and biology students to interdisciplinary research via problems in quantitative ecology. In this talk I will describe the program structure, background of the students, content, delivery, and outcomes after the initial semester and summer session.

5 *Mathematical modeling of stochastic processes in cell motility*
Hannah Callender, University of Portland

Cell motility is an essential process in the life cycle of many organisms, as it plays a crucial role in a variety of areas such as embryonic development, wound healing, the immune response, and cancer cell metastasis. Here I will present a mathematical model to describe the early dynamics of focal adhesions, which are protein complexes the cell uses to adhere to and move through its surroundings. The interactions which take place in the development of these adhesions are best modeled as stochastic processes, due to the low numbers of participating reactants. I will discuss our use of a stochastic simulation algorithm to model key interactions within focal adhesions and share results from our sensitivity analysis of model parameters. These efforts will help determine the necessary components and the role of each (with a particular emphasis on the activation of integrin receptors) in the growth and fate of the focal adhesions.

6 *Closed surfaces and the character variety*
Eric Chesebro, University of Montana

In the eighties, Culler and Shalen developed a procedure for using the $\mathrm{SL}(2,\mathbb{C})$-character variety for a 3-manifold to construct essential surfaces in the manifold. Since then, their techniques have been carefully studied and are critical in the proofs of several famous theorems. Most of the investigation of the Culler-Shalen machinery has focused on the case when the associated essential surface has non-empty boundary. Here we give a new characterization of when associated surfaces have empty boundary.

7 *Using problems to challenge future teacher understandings*
Jackie Coomes, Eastern Washington University

We will explore problems used in a problem-solving course for future secondary mathematics teachers. The purpose of these problems are to challenge preservice teachers to understand school mathematics at deeper levels, develop mathematical habits of mind, and to make connections between mathematical ideas. We will discuss criteria for these types of tasks and ways to develop them, as well as common issues in the mathematical understandings of future and current secondary mathematics teachers.

8 *Expected loss: a new take on gambler's ruin*
Curtis Feist, Southern Oregon University

The classical Gambler's Ruin problem shows that in a zero sum betting game with the odds against the gambler, the gambler's probability of ruin (i.e., of losing his initial stake before raising it to some set amount) increases monotonically as the size of his bets decreases. In this talk, we introduce time into the problem by setting a maximum number of bets, thereby mimicking the idea that many gamblers will set a limit to their time of play. In this case we will see, perhaps surprisingly, that the gambler's expected loss (which is now the analog of his probability of ruin) does *not* simply increase as size of bet decreases.

9 *Contextualized intermediate algebra*
Mark A. Fitch, University of Alaska Anchorage

Contextualization is the technique of teaching one topic in the context of another, typically more appealing, subject. This project is a standard Intermediate Algebra course taught in the context of aviation for students who are mostly piloting, air traffic control, airplane mechanics, or aviation business majors. With interdepartmental support, this course was designed during a spring and summer session. Continued design, long-term implementation, and formal assessment are ongoing. Early indications are that the contextualization, matched with career-related teaching styles, led to increased interest by the students and instructor and to higher than average student performance compared with other students, regardless of major.

10 *Using R for linear algebra*
Christopher Hay-Jahans, University of Alaska Southeast

R is a powerful public domain computational statistics platform that is gaining popularity among applied and research statisticians. What may not be known outside of statistical circles is that this product has extensive capabilities in linear algebra. Examples of using R on some routine, but tedious, calculations typically encountered in an elementary linear algebra course are given, along with suggestions on how to tackle the steep learning curve that comes with R.

11 *The topology of tile invariants*
Mike Hitchman, Linfield College

In the last 10 years tile invariants have been developed and employed with great success to solve tiling questions with ribbon tiles in the integer lattice. In this talk we explore connections between tile invariants and the second homotopy module of a 2-complex associated to a tile set.

12 *The sum of the reciprocals of the amicable numbers*
Dominic Klyve, Central Washington University

Perfect numbers are numbers equal to the sum of their proper divisors. Amicable numbers are related – two numbers are amicable if each is equal to the sum of the other's divisors. To date, no one knows whether there are infinitely many amicable numbers. In this talk, we take on a related question, namely: What is the sum of the reciprocals of the amicable numbers? We will find both an upper and a lower bound on this sum.

13 *Symplectic perspectives in dynamics*
Chris Lee, University of Portland

In 1918, Emmy Noether formalized the connection between symmetries of physical systems and conserved quantities. To a symplectic geometer, Noether's theorem is a statement about group actions on manifolds that behave nicely with respect to a choice of symplectic form. In particular, conserved quantities corresponding to symmetries are collected by a smooth function, called the moment map of the action. The classification of (some of) these so-called Hamiltonian actions has provided a useful tool in understanding integrable systems and other topics motivated by mathematical physics. This brief overview will present simple physical systems from the symplectic point of view as well as recent results exploring the relation between the dynamics of the geodesic flow and the classification of symplectic cones.

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

In this talk I will discuss some of the basic open questions in the field of finite dimensional division algebras. In particular, I will discuss techniques for studying division algebras when the center of the division algebra is the function field of a (sometimes familiar) geometric object.

15 *A brief introduction, and new results, on intrinsically knotted graphs*
Noam Goldberg, Occidental College**
Thomas Mattman, CSU Chico
Ramin Naimi, Occidental College*

A graph is Intrinsically Knotted (resp., Intrinsically Linked) if every embedding of it in 3-space contains a nontrivial knot (resp., link). We will give a brief and partial survey on IK and IL graphs and present some recent results and open questions. The talk will require very little technical background

16 *Applying bayesian methods for replenishing items with seasonal intermittent demand*
Meike Niederhausen, University of Portland *
Gary Mitchell, 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? In this talk we focus on applying Bayesian methods to reordering policies. These allow us to update parameter values in models at every time step and take into account the absence of a demand event as data instead of only updating when there is a demand event.

17 *Leavitt path algebras with coefficients in an arbitrary unital ring*
Jennifer Firkins Nordstrom, Linfield College

Leavitt path algebras provide nice algebraic analogs to graph C^* algebras. In particular, significant theorems in the study of C^* algebras such as the Gauge Invariant Theorem and the Cuntz-Krieger Uniqueness Theorem have analogs in the context of Leavitt path algebras. These theorems for Leavitt path algebras, the Graded Uniqueness Theorem and the Cuntz-Krieger Uniqueness Theorem, are well-known for Leavitt path algebras over a field, and have recently been shown to extend for Leavitt path algebras over a commutative ring. Given a directed graph E we define a method for constructing a Leavitt path algebra $L_R(E)$ whose coefficients are in an arbitrary unital ring. We extend the Graded Uniqueness Theorem and Cuntz-Krieger Theorem to Leavitt path algebras with coefficients in an arbitrary unital ring. Furthermore, we show that if K is a field and R is a K-algebra, then $L_R(E) \cong R \otimes L_K(E)$ as R-algebras.

18 *An inquiry-based introduction to game theory course*
Jennifer Nordstrom, Linfield College

Game Theory is an exciting and accessible topic for non-mathematics students. It is a natural topic for introducing students to the role of mathematics in decision-making; improving their ability to deal with quantitative concepts; and improving their ability to convert qualitative situations into quantitative ones. The discovery-based delivery of this material can be an effective means of engaging students, developing their quantitative skills, and building confidence with quantitative analysis. I will describe some of the interactive activities used in my course, emphasizing how they can facilitate the goals of a quantitative reasoning course.

19 *The Calculus Concept Inventory*
Scott L. Peterson, Oregon State University

In this talk Scott will give a short history of the Calculus Concept Inventory (CCI), we will then look at a few of the questions on the CCI, and finally look at some results and implications.

20 *Artin groups and their many hats*
Valerie Peterson, University of Portland

A right-angled Artin group is a group given by a finite presentation whose only relations are commutators of the generators. While interesting algebraic objects in their own right, Artin groups also appear in a variety of other fields. In this talk, we discuss some of the properties of right-angled Artin groups that make them useful in topology, geometry, and geometric group theory.

21 *An introduction to cube complexes*
Valerie Peterson, University of Portland

Topologists often work with **simplicial complexes**: spaces built (in nice ways) from triangles, tetrahedra, and their higher dimensional analogues. Here, we introduce a similar object built from squares, cubes, and their higher dimensional analogues, called (perhaps unsurprisingly) a **cube complex**. Not only fun to draw, cube complexes appear quite naturally in robotics, topology, geometry, and geometric group theory (among many other fascinating areas, to be sure). In this talk, some of the speaker's favorite cube complexes will be introduced, along with an abundance of pictures.

22 *Multiplier sequences*
Andrzej Piotrowski, University of Alaska Southeast

Let $Q = \{q_k\}_{k=0}^{\infty}$ be a basis for $\mathbb{R}[x]$. A sequence of real numbers $\{\gamma_k\}_{k=0}^{\infty}$ is called a *Q-multiplier sequence* if the following property holds for all polynomials in $\mathbb{R}[x]$; if $\sum_{k=0}^{n} a_k q_k(x)$ has only real zeros, then $\sum_{k=0}^{n} a_k \gamma_k q_k(x)$ has only real zeros. Known results and unresolved questions pertaining to Q-multiplier sequences will be surveyed.

23 *Some projects in computational and mathematical neuroscience: from single cells to brain regions*
Michael Rempe, Whitworth University

Biology, and neuroscience in particular, has benefited tremendously from both quantitative and qualitative mathematical modeling. Thanks to some groundbreaking work in the mid-twentieth century, the complex electrical properties of neurons can be accurately modeled using a reaction-diffusion system of differential equations. In this talk I will present two projects that build on this fundamental framework. For the first project I developed an adaptive numerical method to solve the reaction-diffusion system on complex branching structures like those seen in real neurons. This approach is much more efficient than non-adaptive methods because it focuses computational effort only on regions where there is activity.

For the second project I will present a biologically-based mathematical model of the brain regions involved in human sleep. The model accounts for several features of human sleep and demonstrates how particular features depend on interactions between a circadian pacemaker and a sleep homeostat. I use a dynamical systems approach to analyze the mathematical mechanisms in the model. This analysis yields insights into potential biological mechanisms underlying sleep.

24 *First digits of numbers in sequences*
Kenneth A. Ross, University of Oregon

For each positive integer a, let $D(a)$ denote its first digit. The following questions will be discussed. Given a sequence (a_k) of positive integers, do the long-term relative frequencies

$$\lim_{n\to\infty} \frac{1}{n} \#\{1 \le k \le n : D(a_k) = d\}$$

exist for $d = 1, 2, 3, \ldots, 9$? If so, what are their values? Sequences discussed include $a_k = r^k$ for a positive number r, $a_k = k^m$ for a positive integer m, and $r_k = k!$.

25 *A prize for the best open-source mathematics textbook*
Albert Schueller, Whitman College

Many people in our section, (e.g. Rob Beezer (UPS), David Guichard (Whitman College)), across the nation, and the world, are developing open-source (e.g. creative commons) textbooks in mathematics. Technological advances have dramatically eased the production and distribution of such texts. However, the processes of editing, peer review, assessment, and revision have lagged and still reside largely within the domain of traditional commercial publishers. A rationale and plan for creating an open-source textbook prize will be presented with the hope of developing a broad base of support within the section (and later nationally). In the brief discussion afterwards, ideas for how to fund the prize program will be solicited.

26 *Distributed exams*
Colin Starr, Willamette University

In hopes of relieving some of the pressure of and focus on exams, I attempted a “distributed exam” model in my Number Theory course in the Spring of 2010. Each week’s homework assignment included one or two proof-based “exam problems.” Students were allowed – encouraged – to collaborate on the homework problems, but forbidden to collaborate on the exam problems. The exam problems were due with the homework. The in-class portion of the exams then consisted primarily of calculation-type problems and one or two relatively simple proofs. In this talk, I will discuss the advantages and disadvantages of this system.

27 *Delannoy Numbers*
Colin Starr, Willamette University*
John Caughman, Portland State University
Chuck Dunn, Linfield College
Nancy Neudauer, Pacific University

Lattice chains and Delannoy paths represent two different ways to progress through a lattice. We use elementary combinatorial arguments to derive new expressions for the number of chains and the number of Delannoy paths in a lattice of arbitrary finite dimension and, in the case of an $n \times n \times \cdots \times n$ lattice, demonstrate a new proof of an interesting connection between the two numbers.

28 *Cayley-Sudoku tables and loop theory*
Michael B. Ward, Western Oregon University*
Kady Hossner, Western Oregon University**

A published undergraduate research project by the speaker and his students on group tables arranged so as to have Sudoku-like properties (see Cosets and Cayley-Sudoku Tables, *Mathematics Magazine*, April 2010, pp. 130-139) leads to an unexpected connection to loop theory and a 1939 theorem of the famous group theorist Reinholdt Baer. In this talk, we explain the connection.

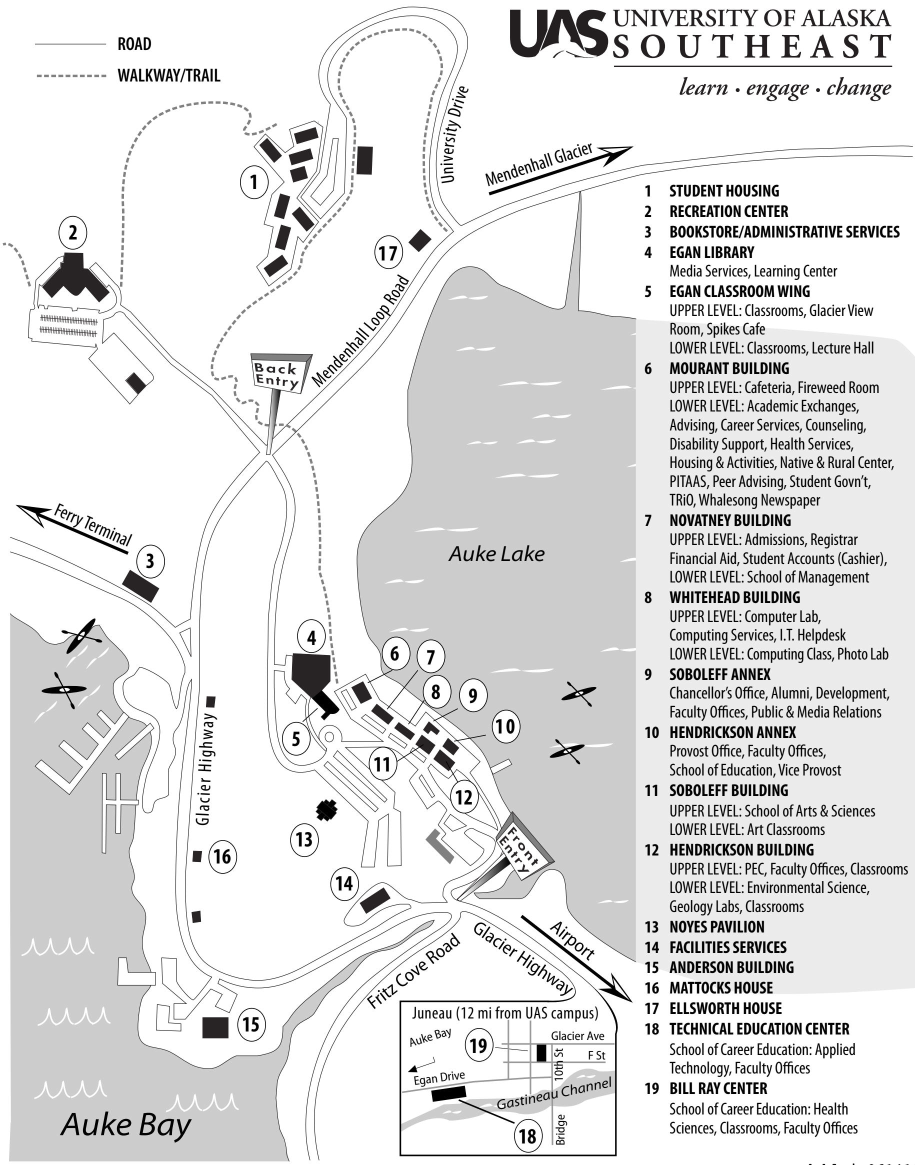
29 *The Dirichlet problem and the fundamental theorem of calculus*
Gregg Waterman, Oregon Institute of Technology

One of the classical boundary value problems in analysis is the Dirichlet problem. We will look at the solution of of this problem in a half plane, and attempt to gain insight into the solution method by looking carefully at the Fundamental Theorem of Calculus. The only prerequisite necessary is integral calculus.

30 *The "zeroing factors principle" in college algebra*
Gregg Waterman, Oregon Institute of Technology

Students often tend to view basic algebra as a confusing array of methods for solving seemingly unrelated problems. We will look at a unifying principle for solving a variety of problems that students face in a traditional College Algebra course.

Campus Map



1 **STUDENT HOUSING**
2 **RECREATION CENTER**
3 **BOOKSTORE/ADMINISTRATIVE SERVICES**
4 **EGAN LIBRARY**
Media Services, Learning Center
5 **EGAN CLASSROOM WING**
UPPER LEVEL: Classrooms, Glacier View Room, Spikes Cafe
LOWER LEVEL: Classrooms, Lecture Hall
6 **MOURANT BUILDING**
UPPER LEVEL: Cafeteria, Fireweed Room
LOWER LEVEL: Academic Exchanges, Advising, Career Services, Counseling, Disability Support, Health Services, Housing & Activities, Native & Rural Center, PITAAS, Peer Advising, Student Govn't, TRiO, Whalesong Newspaper
7 **NOVATNEY BUILDING**
UPPER LEVEL: Admissions, Registrar Financial Aid, Student Accounts (Cashier),
LOWER LEVEL: School of Management
8 **WHITEHEAD BUILDING**
UPPER LEVEL: Computer Lab, Computing Services, I.T. Helpdesk
LOWER LEVEL: Computing Class, Photo Lab
9 **SOBOLEFF ANNEX**
Chancellor's Office, Alumni, Development, Faculty Offices, Public & Media Relations
10 **HENDRICKSON ANNEX**
Provost Office, Faculty Offices, School of Education, Vice Provost
11 **SOBOLEFF BUILDING**
UPPER LEVEL: School of Arts & Sciences
LOWER LEVEL: Art Classrooms
12 **HENDRICKSON BUILDING**
UPPER LEVEL: PEC, Faculty Offices, Classrooms
LOWER LEVEL: Environmental Science, Geology Labs, Classrooms
13 **NOYES PAVILION**
14 **FACILITIES SERVICES**
15 **ANDERSON BUILDING**
16 **MATTOCKS HOUSE**
17 **ELLSWORTH HOUSE**
18 **TECHNICAL EDUCATION CENTER**
School of Career Education: Applied Technology, Faculty Offices
19 **BILL RAY CENTER**
School of Career Education: Health Sciences, Classrooms, Faculty Offices

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Internet Access

The Egan Classroom building is equipped with wi-fi and a computer lab is available in Whitehead 208. Conference participants may access the UAS network with the following guest account:

User name: uas.pnwmaa
Password: pnwmaa

Acknowledgements

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:

John Pugh (UAS Chancellor) generously contributed most of the money for this meeting. This not only kept registration costs down, but it also provided for some fun outings and great food.

Christopher Hay-Jahans (UAS Mathematics) developed a beautiful webpage and helped out with most facets of the meeting.

Chris Hallstrom (University of Portland) arranged all the contributed paper sessions and put together the program.

Chuck Dunn (Linfield College) arranged all the invited speakers and helped out with the overall program.

Jill Dumesnil (UAS Mathematics) coordinated all the meals and organized the professional development opportunity for teachers.

Megan Buzby (UAS Mathematics) coordinated all the Project NExT local activities.

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

Andrzej Piotrowski (UAS Mathematics) arranged the transportation for the meeting.

Carol Young (NANA Management Services) kept us fed throughout the meeting.

Jolene Troupe (UAS administrative assistant) helped with all the paperwork and was invaluable throughout the year.

All of these people (and others not listed!) made this meeting possible, so I thank you very much!

Brian Blitz
Local Arrangements Chair