Mathematical Association of America
MD-DC-VA Section, April 24 & 25, 2015
Roanoke College
Abstracts

Abstracts for the workshop and invited addresses are listed first, in chronological order, followed by faculty and graduate student abstracts, alphabetized by submitting presenter's last name. Student presentation abstracts follow, with student poster abstracts at the end (all alphabetized the same way).

Invited Addresses

FRIDAY WORKSHOP

Caren Diefenderfer, Hollins University
Meagan Herald, Virginia Military Institute
Building a Menger Sponge with Business Cards
4:00 PM, Pickle Meeting Room, Colket Center

This fall the Museum of Mathematics in New York and Queen Mary University of London sponsored the MegaMenger project. Twenty international sites agreed to start building a Level 3 model of the Menger Sponge by folding business cards, with the hope of completing the project by the end of October. Two of the sites were Hollins University in Roanoke, VA and Virginia Military Institute in Lexington, VA. We both made good progress and are continuing to build this semester. Caren Diefenderfer (Hollins), Meagan Herald (Virginia Military Institute) and a few of their students will lead this workshop. We will give a short introduction to fractals and then explain how to fold business cards to create the Menger Sponge model. Please bring 100-150 old (recyclable) business cards with you. (The cards that work the best are not shiny or flimsy.) Each pair of participants should be able to complete a Level 1 Menger Sponge during the workshop. Feel free to visit www.megamenger.com for more specifics on the October international project.

BANQUET ADDRESS

Tim Chartier, Davidson College
Linear Thinking: from bracketology to computer graphics
8:00 PM, Wortmann Ballroom, Colket Center

What's in a matrix? Enter the world of linear systems and see how matrices open the door to a diverse array of topics, from creating a March Madness bracket, to analyzing a car's aerodynamics, to rendering cinematic special effects. We'll also discuss how to engage students majoring in math and other fields to think linearly.

SATURDAY INVITED ADDRESSES

Brian Hopkins, St. Peter's University
The Symmetric Group and Fair Division: Does Knowledge Matter?
9:55 AM, Massengill Auditorium, Massengill Hall

Sports drafts and divorce settlements are examples of situations where players take turns selecting indivisible goods. Like other topics in fair division, the situation is made more interesting because people may value the goods in different ways. In this talk, we focus on the case of two players, where the machinery of permutations is surprisingly applicable. How many possible outcomes are there? In what circumstances do both players get their best possible outcomes? How can one best take advantage of knowing the other's preferences? What happens when a player's motivation switches from greed to spite, the common good, or selfless altruism? In this colorful talk, we'll sample some applied algebraic combinatorics and address these issues along with the provocative question of the title.

Will Traves, U.S. Naval Academy
Geometry: Old and New
3:35 PM, Massengill Auditorium, Massengill Hall

In 1639, a sixteen-year old Blaise Pascal generalized a result that had stood for over 13 centuries. The posters announcing his Mystic Hexagon Theorem inspired geometers to think about infinity in new ways that still resonate today. I'll describe how Pascal's work influenced modern Projective Geometry. Along the way we'll see how computer software mixes with

19th century methods to create a new environment for mathematical research. This line of ideas gives us a new way to think about straightedge and compass constructions. I'll describe recent research with David Wehlau that leverages work of Cayley and Bacharach to produce a surprising construction that checks whether 10 points lie on a cubic curve. I won't assume much mathematical background; the talk should be accessible to anyone that's ever computed the determinant of a matrix.

Contributed Faculty Papers by Author

Abdinur Ali, Norfolk State University
Chung-Chu (George) Hsieh, Norfolk State University
Mushtaq Khan, Norfolk State University
Sequential Monte Carlo methods for online network intrusion detection systems
8:10 AM, Room 207, Lucas Hall
Sequential Monte Carlo method (SMC) estimates the states of the system using observed data. It uses stochastic and recursive techniques to calculate posterior probability. The system is changing with time and the states of the system are compatible with hidden Markov model. For online cyber security detection, the SMC can be used to monitor the network traffic in real-time and detect abnormalities. The high density users are indications of abnormalities and they can be potential network security threats. In this paper, simulations were used to explore the density estimations and show the link between the performance and the number of samples used.

Bud Brown, Virginia Tech
Five families and a well: a new look at an old problem
2:15 PM, Room 207, Lucas Hall
The title problem comes from Chapter 8 of the ancient Chinese classic "Nine Chapters of the Mathematical Art." It involves solving five linear equations in six unknowns, and many scholars have described the techniques used in the "Nine Chapters" for solving this and similar problems, and shown that the techniques anticipated nineteenth-century methods by almost two millennia.

This talk is a two-part story about a feature of the problem's answer that may have previously gone unnoticed. The first part is about what happens when you look at a historically interesting problem through non-historical eyes. The second part is about a student who got excited about the problem and proved a theorem that gives the answer for n families.

E. T. Brown, James Madison University
Partial Metric Spaces and Separation Axioms
3:05 PM, Room 207, Lucas Hall
Partial metrics are a generalization of metrics which allow for non-zero self-distances. They arise naturally in computing, making them a comparatively intuitive topic for undergraduate research. Topologies generated by partial metrics are T0 but do not as a rule satisfy other separation axioms.

In this talk we will introduce partial metrics, show how they produce pathological topologies, and comment on opportunities for future undergraduate research.

Boyd Coan, Norfolk State University
Cherng-Tiao Perng, Norfolk State University
Fibonacci Numbers and Beyond
8:35 AM, Room 210, Lucas Hall
Motivated by the result of Fibonacci numbers for which the ratio of successive terms tends to a limit,commonly known as the Golden Ratio, we prove an immediate generalization for a wider class of recurrence sequences. For an application of our main result, we find a natural way to approximate an algebraic number, which is a zero for a class of polynomial

equations, by rational numbers. Since recently there seems to be renewed interests in Fibonacci numbers and related recurrence sequences, we hope that our elementary methods and results may shed some light on possible solutions for some related problems.

Caren Diefenderfer, Hollins University
The 2015 Curriculum Guide from CUPM
2:40 PM, Room 210, Lucas Hall
The Committee on the Undergraduate Program in Mathematics (CUPM) writes a new curriculum guide that presents recommendations for the undergraduate program in mathematics about every ten years. The 2015 Curriculum Guide focuses on the mathematics major. The Guide is available at
http://www2.kenyon.edu/Depts/Math/schumacherc/public_html/Professional/CUPM/2015Guide/CUPMDraft.html

The purpose of the guide is to help departments design and maintain a robust major program. This talk will discuss the Cognitive and Content Goals of the 2015 Guide and give an overview of the online document. The presenter was the lead author on the Linear Algebra report.

Joshua Ducey, James Madison University
Finite abelian groups attached to graphs
2:15 PM, Room 114, Lucas Hall
Given a graph, say simple and connected, there are several interesting matrices that can be used to encode the information contained in the graph. Algebraic invariants of these matrices can be viewed as distinguishing characteristics of the graph. One such invariant is a finite abelian group. From the adjacency matrix we get the Smith group, and from the Laplacian we get the critical group. The critical group is especially interesting, having several combinatorial and geometric interpretations. I will give examples of these groups known for several infinite families of graphs, and indicate some recent work and open questions.

Hasan Hamdan, James Madison University
A Least-Squares Approach for Modeling Variance-Mean Mixtures of Normals
9:00 AM, Room 114, Lucas Hall
In this talk, a new method for fitting the density of real-life data using variance-mean mixtures of normals will be presented. The new method is based on minimizing the least-squares distance between the empirical density of the sample and the proposed variance-mean mixture over pre-specified grid of x-values. The minimization is done by manipulating the inputs of UNMIX, an existing program that is used to estimate scale mixtures of normal. The new method is compared to the estimated mixture using the EM algorithm and the Bayesian approach.

Heidi Hulsizer, Hampden-Sydney College
Student-Produced Videos for Exam Review
9:25 AM, Room 210, Lucas Hall
Producing videos gives students the opportunity to express creativity, work in a team, and it gives students a chance to use mathematical language in a more formal setting. It is the hope that video creation will promote retention of knowledge and a deeper understanding of the material. This method of review was used in both a Differential Equations and Complex Analysis course. We will examine student attitudes toward the videos they created and their preference for either student-produced video or traditional instructor-led lecture review.

Ilhan M. Izmirli, George Mason University
A Pillar of Brobdingnag: René Descartes and Differential Calculus
3:05 PM, Room 125, Lucas Hall
On page 416 of volume I of The Correspondence of Isaac Newton edited by H. W. Turnbull et al, there appears a letter from Isaac Newton (1642-1726) to Robert Hooke (1635-1703) dated February 5, 1675 with a rather inconspicuous line, only to become one of the most often quoted statements in history of mathematics: If I have seen further it is by standing

on ye shoulders of Giants. It was indeed the works of these giants – François Viète (1540-1603), William Oughtred (1575-1660), René Descartes (1596-1650), John Wallis (1616-1703), and Isaac Barrow (1630-1677), to name a few – that helped Newton attain the mathematical maturity that would culminate in the complete development of the Fundamental Theorem of Calculus. In this paper we will look into the work of one of these giants – the "calculus" of Descartes, and see how it pertains to Newtonian calculus.

Paul Janiczek, Virginia Military Institute
Fun with Simple Paths and Circuits
3:05 PM, Room 114, Lucas Hall
Given a simple, connected, and undirected graph, we can easily determine if it has a simple circuit, a simple path, or neither. We can draw such a graph without lifting our pencil (after we've started) or retracing edges if and only if it has either a simple circuit or a simple path. This fun and engaging analytic method can put young and old minds on a path of discovery.

Dan Kalman, American University
A discrete approach to continuous logisic growth
9:25 AM, Room 114, Lucas Hall
Discrete logistic growth is easy to motivate, but leads to chaotic behavior in some cases. On the other hand, the standard continuous logistic growth model is beautifully behaved, but difficult to motivate without using differential equations. In this talk I will show that there is a natural and easily motivated discrete model that leads to the continuous logistic function. Although the success of the approach is surprising at first, it becomes beautifully transparent when analyzed with Mo"bius transformations.

Brian Lins, Hampden-Sydney College
Whose turn is it to drive?
9:00 AM, Room 207, Lucas Hall
How should the people in a carpool pick a driver each day? This is the carpool scheduling problem. I will explain what makes a solution to this problem fair, and I will describe how my own carpool switched to a fair method for choosing drivers.

Alex Meadows, St. Mary's College of Maryland
A New Twist on Wythoff's Game
9:25 AM, Room 207, Lucas Hall
Wythoff's Game is a classic mathematical game played with two piles of sticks, in which players take turns either removing sticks from one pile or removing an equal number of sticks from both piles. The last player to remove sticks wins the game. The mathematical theory, in which the Fibonacci numbers and the golden ratio arise, is still an active field of research. We propose a new way to extend Wythoff to more than two piles, using ideas from knot theory. The new variant "Wythoff Twyst" is an ongoing topic of research with undergraduate collaborators. The talk will include some ideas of how one analyzes combinatorial games, and some recent results and open problems related to this new game.

Roland Minton, Roanoke College
Transitivity, Voting, and Sports Ratings
2:40 PM, Room 125, Lucas Hall
We often assume without thinking that the transitive property holds in all situations. Examples with dice, voting, and sports will show that this is not true. Hodge theory on graph flows is used to decompose sports results into transitive and non-transitive components.

Minah Oh, James Madison University
Undergraduate Research in Finite Element Methods
9:00 AM, Room 210, Lucas Hall

In this talk, I will talk about undergraduate research projects related to finite element methods. Finite element methods is a well-known numerical method with solid mathematical theory that is used to approximate the solution to a PDE system. I will give a short review on this method and discuss past and current undergraduate research projects on this topic.

Edwin O'Shea, James Madison University
A quick tour of Byrne's 1847 "Euclid in Color."
8:35 AM, Room 207, Lucas Hall
Oliver Byrne's extraordinary 1847 edition of Elements sought to ease the pedagogical tension between visual belief and rigorous proof. In this talk I will discuss Byrne's unique place in understanding and enjoying Euclid, attempting to lend some insight into why it is not better known.

Katie Quertermous, James Madison University
Expanding Your Horizons at JMU: Math and Science Outreach to Middle and High School Girls
3:05 PM, Room 210, Lucas Hall
The Expanding Your Horizons Conference at James Madison University is an annual math and science outreach event for young women in grades 6-10 that involves hands-on workshops, speakers, and opportunities for participants to interact with college students who are STEM majors. It started in 2008 with approximately 40 student participants, and, this year, approximately 190 girls and 80 adults attended. The program was funded in part by a MAA Tensor Women and Mathematics grant in 2009-2014. In this talk, we will give an overview of the conference activities, including how they have evolved over time to increase their appeal to the participants, and will share helpful tips we have learned that can be used by others who are interested in starting a math outreach event or are already involved in a similar program.

Raina Robeva, Sweet Briar College
Boolean approximations of ODE models that capture bistability
9:00 AM, Room 125, Lucas Hall
Boolean and Polynomial Dynamical Systems Models of biological systems have emerged recently as viable companions to differential equations models. These models provide "coarse-grained" approximations of the system's dynamics and are qualitative in nature. Thus, it is not immediately clear whether such models are capable of capturing the multi-stability behavior of biological systems, which would generally depend on the values of the model parameters. The talk will use the lactose (lac) operon in E. coli as a model system for introducing several Boolean network and ODE models and constructing Boolean network approximations of delayed differential equation models. The focus will be on the ability of Boolean models to capture the well-known bi-stability behavior of the lac operon.

Jason Rosenhouse, James Madison University
Fuzzy Knights and Knaves
8:10 AM, Room 125, Lucas Hall
Logic puzzles have long been a mainstay of recreational mathematics. Non-classical logics are currently a trendy topic in mathematics, philosophy, and computer science. Perhaps, then, it is time to give some thought to what non-classical logic puzzles might be like. In particular, we shall consider what knight/knave dialogs might be like if we adopt fuzzy logic.

Hamid Semiyari, James Madison University
Approximating Solutions of Boundary Value Problems
9:25 AM, Room 125, Lucas Hall
We present a new algorithm for approximating solutions of two-point boundary value problems and prove theorems that give conditions under which the solution must exist and the algorithm generate approximations that converge to it. We show how to make the algorithm computationally efficient and demonstrate how the full method works both when guaranteed to do so and more broadly. We also prove a theorem on existence of solutions of certain multi-dimensional Volterra integral equations and use it to show that the Parker-Sochacki method of introducing auxiliary variables, used to make the new algorithm computationally efficient, can be effectively applied to these Volterra integral equations in order to approximate their solutions by means of a Picard iteration scheme. Finally, we extend the existence theorem for solutions of two-point boundary value problems and prove that the new algorithm can be modified to approximate

solutions in this case.

Wendy Hageman Smith, Longwood University
Becker Sidney Smith, Hampton Sydney College
Turbo-Charging Freshman Engagement Using a 2 or 3-Lecture Motivational Seminar on How and Why to Succeed at College Mathematics
2:15 PM, Room 210, Lucas Hall
Freshman don't arrive knowing what math courses they need to achieve their academic and career goals, or how the specific courses offered by their school's math department can help them better achieve those goals, or how to optimize their chances of success in the math courses they choose (or are required) to take. Most regrettably, too few freshmen are offered this information even after they arrive. Missed opportunities, poor curriculum choices, and academic failure are the inevitable result. We have combined research into student attitudes towards the study of mathematics (including math anxiety) with best practices for the teaching and learning of mathematics in introductory courses. The result is a brief (2 or 3 lecture) program for integration into courses that are typically a "first experience" for students of college math that orients their attitudes, expectations, and study habits towards getting the most out of their current---and likely future---coursework in mathematics. This "short-course" in the nature and value of college math, in disarming math anxiety, and in establishing sound student skills enhances student optimism and engagement exactly when they need it most. In addition to serving the needs of the students, the math program itself benefits from lower failure rates, increased enrollment in additional courses, and a greater likelihood of acquiring new majors and minors.

Eva Strawbridge, James Madison University
Modeling Fluid Dynamics around Swimming Worms
2:40 PM, Room 207, Lucas Hall
As the worms, such as nematodes, swim they cause fluid movement that has been studied experimentally but not modeled computationally on this scale. Utilizing the Navier-Stokes equation, regularized stokeslets, and the method of images, we computed the dynamics of the surrounding fluid. Our results strikingly matched experimental outcomes in various ways, including the distance particles travelled in one period of undulation, as well as qualitatively and quantitatively matching velocity fields. We then implemented this method using video data of swimming C. elegans and successfully reproduced the fluid dynamics.

Bruce Torrence, Randolph-Macon College
LCR - A New Endgame
8:35 AM, Room 125, Lucas Hall
The popular dice game Left Center Right (LCR) is a game of pure chance. There are three identical dice: on each, one side is marked L, another C, another R, and the remaining three sides are blank. Each player has three chips. The first player rolls the dice. For each L he rolls he passes a chip to the player on his left, for each R he passes a chip to his right, and for each C he puts a chip in the center of the table. Play then passes to the player to his left. If a player has three or more chips, he rolls all three dice. If a player has fewer than three chips, he can only roll as many dice as he has chips. In particular, if a player has no chips, play passes to his left (but he is still in the game, for he may still acquire chips from his neighbors). Since chips can never leave the center position, eventually all chips accumulate there. According to the official rules, the game ends when only one player has chips, and that player is the winner.

The new endgame that we propose is both simple and natural: The game ends when the last chip is moved to the center, and the person who puts it there is the winner. This allows gameplay to be extended, even when only one chip remains on the board. And it leads to a simple question with a beautiful answer: If there is only one chip left in play, what is the probability that the player holding the chip wins the game?

Celestine Woodruff, James Madison University
Numerically exploring low Rayleigh number fluid flow using the infinite Prandtl number model
8:10 AM, Room 210, Lucas Hall
The infinite Prandtl number model for convection is derived from the Boussinesq approximation of the Navier-Stokes

Equations. The infinite Prandtl number case could be used to describe the flow of extremely viscous fluids such as the Earth's mantle. The Boussinesq approximation has been studied by many mathematicians and lab scientists through analysis, laboratory experiments, and numerical experiments. Because it is not possible to study fluids with infinite Prandtl number in laboratory settings, this has only been studied via analysis and numerical experiments. Furthermore, most of the literature is focused on fluids with high Rayleigh number. Numerical experiments at high Rayleigh number take a long time to run. We instead use our second order in time scheme to look for interesting features at lower Rayleigh numbers. We also use random forcing to try to create some of the interesting dynamics that are seen at higher Rayleigh numbers.

Student Abstracts by Author

Demara Austin, St. Mary's College of Maryland
Sandpiles, Ferris Wheels, Avalanches, and more!
9:00 AM, Room 107, Lucas Hall
Imagine you are sitting on the beach scooping handfuls of sand into a pile. As you’re scooping,you observe several avalanches; large avalanches that disturb the entire pile and smaller avalanches. It turns out that this behavior can be encapsulated with a polynomial. This talk will give a brief overview of the Abelian sandpile model on undirected graphs, as well as the avalanche and toppling polynomials on the modified wheel graph.

Onyebuchi Ekenta, Washington and Lee
Runs in Permutations
9:25 AM, Room 110, Lucas Hall
A run in a permutation is a sequence of numbers in the permutation, each separated from the next by a fixed number of steps and each differing from the next by a fixed amount. The length of the fixed separation is called the distance and the fixed difference is known as the rise. For a given rise and distance, we compute the number of permutations which contain exactly k runs with that rise and distance.

Zach Enix, Virginia Military Institute
Leo Pineiro, Virginia Military Institute
Josh Grant, Virginia Military Institute
Using Bayesian Statistics to Locate Downed Planes
9:00 AM, Room 110, Lucas Hall
Before the Air France crash in 2009 search efforts for planes lost at sea were typically not optimally efficient due to lack of sufficient technology. Since then, there have been several new approaches developed to assist in such search efforts. Our research is focused on creating a better method to find downed planes in the ocean. We have developed a general model that can be applied to any disappearance of a plane at sea. In this model we use Bayesian Statistics and SPSS Statistics to analyze past flight data and find probabilities of possible search areas. Once the search area has been determined, the model determines which areas the plane is most likely in, using Bayes’ Theory. After an area is searched, if the wreckage is not found, the model will locate the grid area to search next. With the addition of accurate ocean current data, the time required to locate a missing plane could be improved.

Jonathan Gerhard, James Madison University
Conjugacy Classes of GSp(2n,p)
2:40 PM, Room 110, Lucas Hall
The finite matrix group GSp(2n,p) is the subgroup of GL(2n,p) consisting of matrices that preserve an antisymmetric bilinear form up to scalar multiple. For n = 2,3,4, we look for representatives of all conjugacy classes. In GL(2n,p), the characteristic polynomial and some additional partition data completely determine a conjugacy class. However, in

GSp(2n, p), this is still not enough to uniquely identify a conjugacy class in every case. In this talk, we will present some of our results, our techniques used to gather those results, and our plans for future research.

Olivia Goldman, St. Mary's College of Maryland
Anna Steinfeld, St. Mary's College of Maryland
Modeling the Ebola Epidemic in Sierra Leone, Guinea, and Liberia
2:15 PM, Room 107, Lucas Hall
Ebola Virus Disease is currently an epidemic spreading throughout multiple African countries. While the countries are working to control the spread of Ebola, this disease is killing 72% of the infected population. Epidemics occur when the reproduction rate of the disease, R_o greater that 1. The average R_o for Sierra Leone, Guinea and Liberia is about 1.87. We create simple SIR and SEIR models to show the relationships between the susceptible population, the exposed population, the infected population, and the removed population. These models show us the worst case scenario for the most affected countries when the majority of the population is infected.

Hayley Harris, George Mason University
Prime Labelings of Generalized Petersen Graphs P(n,1)
8:10 AM, Room 114, Lucas Hall
A prime labeling of a graph *G* with *n* vertices is an assignment of the numbers *1, 2 , … , n* to the vertices of *G* such that adjacent vertices have relatively prime labels. In this talk, we show that the generalized Petersen graph *P(n,1)* is prime for all even $4 \leq n \leq 2 \times 10^9$. The basis for the labeling scheme is a conjecture related to the Goldbach Conjecture.

Alexandra Jolly, Longwood University
Geometry and Billiards
3:05 PM, Room 110, Lucas Hall
This expository talk focuses on the geometry involved in a game of billiards. I will discuss the general idea of a billiard path and the conditions that must be met in order to qualify a path as a billiard path. Additionally, I will discuss periodic paths and how to find such a path in several geometric figures.

Abu Kebbie-Anthony, St. Mary's College of Maryland
An Exploration into Variational Analysis for Data Denoising
8:10 AM, Room 110, Lucas Hall
Image analysis has been a topic of discussion and research for years. Among these topic, the subject of denoising images comes up often and several different techniques have been developed for the purpose of data denoising. One of these techniques is that of variational analysis. In this exploration, we will use the calculus of variations to derive the Euler-Lagrange equation for the 1-D case and use discretization techniques to differentiate and integrate noisy functions. In doing so, we will examine the disadvantages and advantages of using this method to denoise data.

Victoria Kelley, James Madison University
Linear Analysis of a Straight Rod With a Constitutive Relation
9:25 AM, Room 107, Lucas Hall
Starting with a straight rod under tension, we are studying the perturbations in twist and bend using the Kirchhoff Rod Model. Additionally, we can include the effects of drag approximated by resisted force theory. Finally, this model can inform us about the response of internal forces compared to external ones. This work has applications to the study of worm locomotion, bacterial flagella, and DNA.

Elizabeth Mosher, St. Mary's College of Maryland
Katherine Kessler, St. Mary's College of Maryland
Sophie Kessler, St. Mary's College of Maryland
No Need to Fear, Linear Algebra is Here!
2:40 PM, Room 107, Lucas Hall

Threatening objects enter our borders daily. To tighten security we want to be able to identify a threat early. For our project we explored ideas using linear algebra and vector calculus to identify the location of objects in an image as a first step towards this bigger problem. In our talk we will share our technique and results.

Samantha Parsons, Roanoke College
Protecting Confidentiality and Scientific Progress Through Synthetic Data and Mediator Servers
8:35 AM, Room 110, Lucas Hall
How can scientists perform statistical tests on sensitive data and preserve confidentiality at the same time? Synthesizing data is a method for providing confidentiality of data given to the public while simultaneously providing access to information contained in the data to scientists. A model is built from the raw data that captures statistical information from which simple random samples are taken and released to the public instead of the raw data itself. This method is powerful because inferences made on synthetic data will have similar results to inferences performed on the raw data and no sensitive information is released. We look into the fundamentals of synthetic data and go through a method for creating an accurate model.

Nicolas Peek, Virginia Military Institute
Min-Hung Chung, Virginia Military Institute
Ling-Erh Wang, Virginia Military Institute
Eradicating Ebola
2:40 PM, Room 114, Lucas Hall
In this paper, we present a mathematical model to examine the most efficient way to stop Ebola. In this model, we consider the spread of the disease, the quantity of the medicine needed, possible feasible delivery systems, locations of delivery, and the speed of manufacturing of the vaccine and/ or medicines. To construct our model, we use GLEAMviz and MatLab programs, in conjunction with a system of differential equations, to predict how Ebola spreads in future. We find that Ebola is prevalent in three African countries, such as Guina, Liberia and Sierra Leone. [9] Moreover, we also discover working with United States government is optimal situation for vaccine production. [15] Our final model data indicates that in order to distribute vaccines efficiently, the World Health Organization is the best option for collaboration. Therefore, if we assume 95% effective rate for our vaccine, Ebola is curable.

Ethan Rarity, George Mason University
Prime Labelings of Generalized Petersen Graphs P(n,k) for $n \leq 50$
2:15 PM, Room 110, Lucas Hall
A prime labeling of a graph *G* with *n* vertices is an assignment of the numbers *1, 2, ... , n* to the vertices of *G* such that the labels on adjacent vertices are relatively prime. In this talk, we explore a general labeling scheme for arbitrary values of *n* and *k* and show that this scheme yields prime labelings of *P(n,k)* for even $n \leq 50$ and odd $3 \leq k < n/2$.

Katie Sipes, James Madison University
Locomotion of C. elegans in various viscosities
8:35 AM, Room 107, Lucas Hall
Viscosity is a measurement of a fluid's resistance to the rate of deformation. An example of a liquid with high viscosity is tree sap, or a homogeneous mixture of mud. Both of these liquids run very slowly when acted upon by gravity. In contrast, water has a very low viscosity and flows readily. So how does a liquid's characteristics effect the locomotion of a swimming organism? Do higher viscosities change the dynamics that an organism implements in order to move? The Reynolds number is defined as the ratio of inertial to viscious forces and is given by (rho V L)\mu where rho is the fluid density, V is characteristic velocity, L is the characteristic length of the system, and mu is kinematic viscosity. In particular, I am interested in measuring these different scales in a system where the worm, C. elegans, is swimming in fluids of different viscosities. We will compare these measurements to different modes of locomotion.

Anna Steinfeld, St. Mary's College of Maryland
Jared Saltzberg, St. Mary's College of Maryland

Maps and Mirrors
3:05 PM, Room 107, Lucas Hall
Gauss's Theorema Egregium implies that there is no local isometry between the sphere and plane. As a result, mapmakers have been forced to choose which geometric properties of the sphere they would like to preserve when creating images of the Earth, often at the cost of severely distorting others. In this presentation, we discuss how classical map projections can be induced by mirror surfaces, establishing new relationships between optical properties and cartographic ones.

Shuyan Zhan, Randolph-Macon College
China's Population & One-Child Policy
8:10 AM, Room 107, Lucas Hall
China is currently having a contracting age pyramid. This age structure is usually attributed to the "One-Child Policy", which generally allows only one child per family in the country. Many are concerned about what the future population will be. Is it possible to predict the future population of China under the current policy? We built a matrix model simulating the growth of the population from the year of 2000 to 2010. The model has considerable accuracy in predicting the population of older age groups of year 2010, though we have uncovered evidence of bad data for younger age groups.

Student (Poster) Abstracts by Author

Angie Davenport, James Madison University
Behavior of Chlamydia Infection Over Time
2:10 PM, Rooms 217/227, Lucas Hall
A mathematical model was constructed to study the disease dynamics in a population with three classes of individuals: asymptomatic infectious, symptomatic infectious, and susceptible. Differential equations were proposed from this model and were integrated using Euler's method. We found that after approximately 5.5 years 32% of the population was in the class asymptomatic infected and could continue infecting others while unaware of their own status. This steady state was reached regardless of the initial population size of infected individuals. As a result we also considered condom usage and its efficacy in lowering this apparent steady state.

Joseph Gills, Longwood University
Mean Curvature Zero Surfaces in Three-Dimensional Lie Groups
2:10 PM, Rooms 217/227, Lucas Hall
A translation surface in a three-dimensional Lie group *G* is a surface that is generated from two curves ˛
$\alpha : \mathbb{R} \to G$ and $\beta : \mathbb{R} \to G$ by using the group operation of *G* to "multiply" α and β together. Namely, one has the parametric surface S parametrized by $r: \mathbb{R}^2 \to G,$ where $r(u) \star r(v)$ and $\star$ is the group operation of *G*. We investigate translation surfaces in the three-dimensional Heisenberg group and the three-dimensional group Sol3, where the groups are equipped with a left invariant (Riemannian or Lorentzian) metric. Building off of the work of P. Piu and A. Sanini we focus on the case where our generating curves are integral curves of left invariant vector fields and/or geodesics and we present partial classification results on mean curvature zero surfaces of the indicated form.

Cassie Hartley, James Madison University
Analyzing Error Associated with Modeling a Swimming Worm
2:10 PM, Rooms 217/227, Lucas Hall
This research examines a method of modeling the fluid movement associated with a swimming 1 mm long nematode (C. elegans). By modeling the worm as a sine curve, sin(2πx – ωt), the induced fluid flow around the worm can be studied using the method of regularized stokeslets. As with any numerical method, there is an error associated with this modeling process. This error is the focus of my research. I compute the arc length of the worm using multiple methods to examine whether this has any impact on error in this modeling process. I compare the output of each in order to study sources of error in our calculations of the movement of the artificial worm. I found that the two methods yielded different results.

Ebony Hitch, Salisbury University
Developing Proficiency in Grade 6 Common Core Statistics
2:10 PM, Rooms 217/227, Lucas Hall
National Assessment of Education Progress (NAEP) results indicate that middle school students have some difficulty finding the mean and median. Students at all grade levels have considerable difficulty knowing how to use statistical measures of center appropriately (Zawojewski & Shaughnessy, 2000). The purpose of the study was to explore and develop students' thinking about graphical representations of data and finding appropriate measures of center. Our main research question revolved around how students' proficiency in regard to Grade 6 Common Core Mathematics Standards about statistical measures of center should be developed. The entire research project consisted of seven weekly one-hour sessions in addition to pre and post assessment interviews over a ten week period. Four students fully participated in the project as we recorded each session to analyze student learning in terms of the Five Strands of Mathematical Proficiency. Initially, most of the students lacked conceptual understanding when it came to finding typical values and when it comes to comparing statistical measures. We focused ourinstructional tasks on displaying data, understanding mean, and measures of center. At the conclusion of the project, students gained conceptual understanding when it came to finding the best statistical measure to represent a typical value. Students gained procedural fluency and strategic competence in selecting and constructing data displays while also gaining adaptive reasoning skills when explaining their processes. This research helped students begin to reason conceptually about measures of center and how the skewing the data affects these values.

David Johnson, James Madison University
Quantum computing, Shor's algorithm, and their effect on security
2:10 PM, Rooms 217/227, Lucas Hall
Cryptography has been a topic of interest for humanity for thousands of years. Currently, we rely on the AES and RSA to keep our data secure. Unfortunately for our current security schemes, quantum computing will drastically change the face of security in the near future. While quantum theory has been around for 100 years, it was not until 1998 when the first 2 and 3 qubit (quantum bit) quantum computers were developed. My poster will introduce the RSA algorithm and some of the basics of quantum theory, including quantum entanglement and superposition, as they related to quantum cryptography. It will also outline Shor's algorithm for factoring integers on a quantum computer, which could shatter RSA, and thus our current state of security, with ease.

Ryan Lenhart, Hood College
A Proposition for Increased Historical Integration into Secondary Mathematics
2:10 PM, Rooms 217/227, Lucas Hall
Adopting mathematical history into a secondary curriculum could significantly improve student comprehension and level the playing field for teachers and students working to meet today's high standards. This project uses an analysis of student learning styles and suggests changes that can be made by looking into mathematical origins for greater comprehension. Three lesson plans are given for three secondary math topics.

Michaela Martinez, Ferrum College
Modular Origami and Mathematics
2:10 PM, Rooms 217/227, Lucas Hall
We explore three activities in the teaching resource book Project Origami by Thomas Hull: origami trigonometry, the modular star, and the modular Menger sponge. We found that the exact side lengths of the common right triangles are not always easily represented. For the modular star, we find the exact radius of the star, that is the distance from the center to a tip. Modular origami is when multiple sheets of paper are used for one project. For example, 3,456 business cards are used to create a paneled level two modular Menger sponge.

Brian Penko, Hood College
The Onion-Shaped Dome in Russian Architecture
2:10 PM, Rooms 217/227, Lucas Hall

This project focuses on the relationship between mathematics and architecture through an examination of the onion-shaped dome used prominently in Russian architecture. The most famous of these structures is the Cathedral of the Intercession of the Virgin by the Moat, more commonly known as Saint Basil's Cathedral. We discuss the history of Russian architecture as well as a general history of the geometry of the onion-shaped dome with an examination of why and how it was used in Russian architecture.

Jonathan Romero, James Madison University
Acoustic Modeling of a Rocket Plume in a Flame Trench
2:10 PM, Rooms 217/227, Lucas Hall
High levels of noise causes vibrations in materials which can cause damage to nearby objects. Rockets are among the highest noise-producing systems, having the potential to cause damage to themselves and their payload. Since the demise of the U.S. Space shuttle program, the International Space Station (ISS), an artificial satellite in low Earth orbit, is periodically resupplied by commercially-operated spacecraft awarded contracts by NASA. The Antares rocket, belonging to Orbital-ATK, launches from the Wallops Flight Facility (WFF) in Virginia. The research goal of this project is to analytically model the aeroacoustics (flow induced noise generation) of this rocket's plume through a flame trench. The method involves modeling flow using a computational fluid dynamic software (CFD), conducted using OpenFOAM (an open-source CFD software package developed by OpenCFD.) The results of the CFD modeling can be interpolated and analyzed using acoustical analogies. The method is to be tested on the existing design of the rocket plume flame trench.
Pending positive results, the research will be used to make amends to the shape and other parameters of the duct that have the potential to mitigate noise.

Zev Woodstock, James Madison University
Architectural Acoustic Oddities & Asymptotic Behavior of Repetition Pitch
2:10 PM, Rooms 217/227, Lucas Hall
The quad at James Madison University (Virginia, USA) exhibits an uncommon, but not unique, acoustical oddity called Repetition Pitch. When someone stands at certain places on the quad and makes a punctuated white noise (claps, for example) a most unusual squeak is returned. This phenomenon only occurs at these specific places. A similar effect has been observed in other locations, mostly notably Ursinus College (Pennsylvania, USA) and the Chateau de Chantilly de la Cour (France). This poster will discuss Repetition Pitch, the effect responsible for these phenomena and the mathematical models describing the asymptotic behavior of this phenomenon.