

Mathematics at UMW

Fall 2008

a newsletter of the Department of Mathematics at the University of Mary Washington

Chair's Message

Greetings from the UMW mathematics department! After six years as chair of the department, Debra Hydorn stepped down last spring and turned the reins over to me. Dr. Hydorn did an exceptional job at creating a very student-centered environment in the department. We have seen a steady increase in the number of departmental activities for students, and our enrollments are very healthy. We are very thankful for her contributions over the past six years.

The spring was an exciting time with lots of changes. First, the department was looking to hire a new applied mathematician to join us this fall. We are very happy to welcome Dr. Jangwoon "Leo" Lee who comes to us after completing his graduate studies at Iowa State. You can read more about Dr. Lee in this newsletter. The spring also found the faculty around campus engaged in an entire overhaul of the general education curriculum. I was very active in this endeavor and I am happy that our department is offering several first-year seminar courses this fall as part of this new general education requirement, as well as a large number of courses that will meet the new requirement in quantitative reasoning.

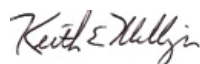
We have also been seeing changes right under our feet, literally. Trinkle Hall was re-carpeted this summer and we expect some major renovation to occur in the basement next year. The

campus is ever-changing and we invite alumni to come back to see what's been happening. Stop by when you're in town.

The department continues to have more and more students engaged in both independent study courses and undergraduate research projects. Last year, four students graduated with honors and a **record 21 students enrolled in independent study courses** with our faculty. We also had five students participate in summer research programs, as well as a handful of students work as interns in a variety of settings. You can read more about our students' accomplishments in this newsletter. We have also created a display in the hallway outside the office suite that showcases many of the accomplishments of our majors over the previous several years.

In this newsletter I have included a short section on alumni news. We continue to be very proud of the accomplishments of our students and hope that you keep us updated on your achievements after leaving Mary Washington.

Best wishes for a successful year!



Keith E. Mellinger, chair

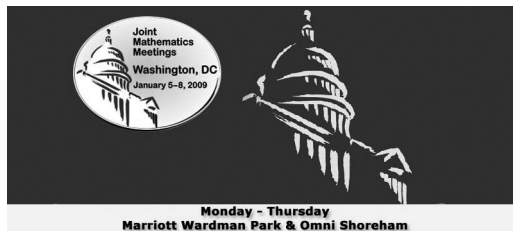


Welcome to Leo Lee

The department is very happy to welcome Dr. Jangwoon "Leo" Lee who starts as an assistant professor with us this fall. Dr. Lee is originally from Korea, and he received his Ph.D. in applied mathematics from Iowa State University in Ames, Iowa, this past summer. His research is in numerical analysis, an applied area of mathematics that is used extensively in industry. We are excited about the diversity that Dr. Lee's expertise brings to the department and look forward to him offering a 400-level course in applied mathematics in the coming years. On a more personal note, Leo has two boys, ages 3 and 6, and is an avid tennis player.

Professional Meetings in Our Own Backyard

Joint Mathematics Meetings – Washington, D.C.



In January 2009, the annual Joint Mathematics Meetings, which brings together members of all the major national societies of mathematicians, will be held right in our own backyard – Washington, D.C. This is a terrific opportunity to check out what happens at a professional meeting, and it will also open your eyes to the many and varied uses of mathematics. These meetings feature very large book sales, technology displays, and large invited lectures – which have seating for thousands! There also are a plethora of smaller, more specialized talks with topics ranging from how to teach subtraction to the new theorems about stable splittings of classifying spaces of compact groups – yes, it can be that complex! There will also be events specifically tailored for undergraduate students. Don't miss your opportunity to attend a meeting this nearby. Next year, it'll be in San Francisco.

Regional MAA meeting – UMW



The Maryland-D.C.-Virginia section of the Mathematical Association of America will hold its spring 2009 meeting right here at the University of Mary Washington. The event, set for April 17-18, 2009, will attract several hundred mathematicians from the area to our campus. This is a great opportunity to present results of undergraduate research projects, honors projects, summer internships, etc. at a regional meeting of a professional organization, without ever leaving town! In addition to presenters, we will need many students to help with the organization of the meeting and to keep things running smoothly the day of the event. Dr. Helmstutler and Dr. Mellinger are the local organizers, so please talk to them if you are interested in helping out.



Alumni News

Jessica Duet '07 won the New Teacher of the Year award for both Massaponax High School and Spotsylvania County. **Jenny Stovall '05** earned a master's degree in mathematics at the University of Delaware and just finished her first year as a professor at Montgomery College in Maryland. **Kenneth Tsang '07** has been working at Northrop Grumman IT as an operations research analyst. He will be attending George Mason University in August to pursue a graduate degree in operations research. **Amanda Passmore '05** graduated with a master's degree in financial mathematics from Florida State University. She now works at HRH Consulting as an actuary analyst. **Brett Townsend '06** just completed his master's degree in applied mathematics at Montana State University. He is transferring to Wesleyan University in Connecticut to work on a Ph.D.

A large number of our graduates are engaged in very successful careers at the Naval Surface Warfare Center at Dahlgren, Va. They include **Amanda Matthews, Damian Watson, Keith Manion, Josh Hickland, Ginny Bach, Daniel Bowers, Rebecca Dolphin Moffitt, Chris Moffitt, Diana Tisinger, Sarah Morris, Danna Bowman, and Sarah Healey**. Many other alumni are currently in graduate programs at VCU, GMU, ODU, and UVa.

New First-Year Seminar Courses

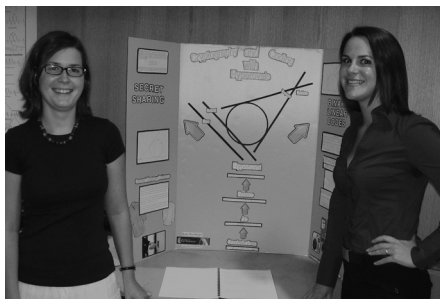
The department is excited about offering two courses that satisfy the new general education requirement for a first-year seminar. The first course, titled "Mathematical Chaos," is a freshmen-level version of our Math 411 – Chaotic Dynamical Systems. The course was originally developed by Dr. Edmunds but is now taught by both Dr. Edmunds and Dr. Sumner. The course introduces first-year students to the mathematics of modeling physical systems and to some of the real analysis concepts that our majors typically do not see until their junior or senior year.

The second FSEM course, titled "Pirates, Liars, and Pigeons: not your typical math course" was developed by Dr. Helmstutler and Dr. Mellinger. This course focuses on the art of problem solving and introduces students to a variety of problems from many and varied areas of mathematics, including number theory, combinatorics, graph theory, algebra, and logic. Problems are chosen so that no prerequisites are necessary, and the students present written and oral solutions to problems both individually and in small groups.

Both of these courses have been taught several times and should be considered excellent FSEM offerings for freshmen interested in the mathematical sciences. The department is hoping to offer more FSEM courses in future semesters. Ideas for future courses include cryptography and the relationship between mathematics and art.

Summer Research

We have seen a great increase in the number of students participating in summer research projects over the past several years, and 2008 was no exception. First, the department again participated in the Jepson Summer Science Institute with two research teams led by Dr. Debra Hydorn and Dr. Keith Mellinger.

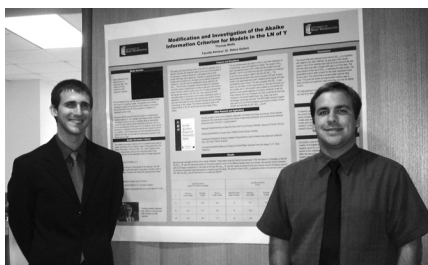


The first team consisted of Katie Hunsberger and Catherine Castleberry, who worked with Dr. Mellinger on two projects in coding theory and cryptography. The students learned about

finite projective planes and objects in these planes known as *hyperovals*. Hyperovals are very similar to the conic sections in the real plane – they have unique tangent lines and no three points are collinear. The students investigated methods for using the geometry of hyperovals to build both secret sharing schemes and error-correcting codes.

Catherine concentrated on the secret sharing schemes. In such a scheme, a secret is divided into several pieces of information which are then distributed to several people. The only way the secret can be recovered is if a specified number of people collaborate and put their pieces of information together. Several different secret sharing schemes were developed and their security was analyzed as part of the project.

Katie, by contrast, focused her efforts on the error-correcting codes. The idea behind coding theory is to detect and hopefully correct any errors that might occur during the transmission of a given message. As a result of the digital revolution, binary linear codes (strings of 0s and 1s) have recently gained popularity with widespread applications in computers, cell phones, and other forms of data transmission. As part of the project, three different infinite families of linear codes were constructed and each such code was developed using techniques that, surprisingly enough, rely on the geometry of hyperovals. The research team hopes to submit an article for publication later this academic year.



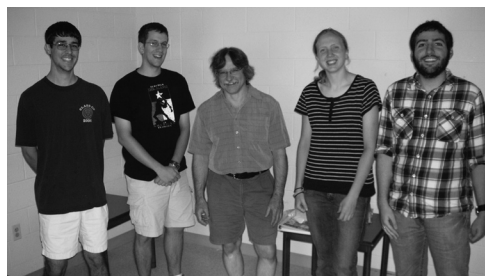
The second research team, consisting of Dr. Hydorn together with students Jon Stallings and Tom Wolfe, focused its energies on some problems in mathematical statistics.

Jonathan Stallings worked with Dr. Hydorn on developing improved confidence ellipses for GPS positioning. Jonathan used improved estimates of the eigenvalues of the sample covariance matrix to generate new estimates of the population covariance matrix. These new estimates were then used to generate confidence ellipses for the average latitude and longitude. He wrote a program to conduct simulations of the effectiveness of the new confidence regions in capturing the true position under various eigenstructures and sample sizes. His results show that the new confidence ellipses are as effective as the sample confidence ellipse in capturing the true position, while generally producing ellipses with slightly smaller areas. Improved estimates of the error involved in using GPS units and other tools for identifying location will make their application more reliable.

The project that Thomas Wolfe worked on, also with Dr. Hydorn, involved developing a measure for selecting a best model among a set of competing models, with some in terms of Y and some in terms of $\log Y$. Tommy first derived the distribution of Y when $\log Y$ has a normal distribution, and then he derived the Akaike Information Criterion (AIC) for regression models in $\log Y$. He also wrote a program to investigate the effectiveness of his AIC in identifying the correct model from a collection of four possible models. Tommy's results show that the new AIC is more effective in general than the coefficient of determination (R -squared) in identifying the correct model. His results also show that the percentage of correct identifications improves for larger samples and decreases with an increase in the random variability added to the model. Model selection is an important tool in many scientific applications as researchers use mathematics to understand biological and other phenomena, and AIC is one of the most used model selection tools.

A Summer REU at Lafayette College

By Billy Ella



For two months of the summer, I participated in the Research Experience for Undergraduates (REU) program at Lafayette College in Easton, Pa. The REU was sponsored by the National Science Foundation, so there were seven fellow math students from all over the country, ranging from Florida to Maine. We were separated into three different groups studying with an adviser on the topics of finite geometry, cellular automata, and voting theory.

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My group studied voting theory and how to create a new system with a combinatorial structure called “dice.” We first learned a bit about voting theory and dice on their own and then were given free rein to explore the combination of the two. Though we had daily meetings as part of the team setup, we were allowed to think about whatever we wanted, so we ended up exploring very different areas of the field. Thus one other team member and I spent the first part of the summer learning about the dice and creating computer programs to help us understand their behavior. The latter half of the REU was spent exploring different properties the dice had, making conjectures as to how they would behave, and then proving various results about them. The end result of this project will be submitting a research paper to a journal, so I found this to be a very valuable mathematics experience outside of the classroom.

As part of the program, we were provided with apartment-style housing and a stipend for our efforts. Beyond work, we participated in a variety of outside activities. On the math side of things, we heard lectures from many different visiting speakers, took a road-trip to Rutgers University to give presentations and learn about graduate school, and flew on a trip to Madison, Wis., for the week-long Mathfest conference.

On the purely fun side, we took hiking trips, learned indoor rock-climbing and racquetball, played ultimate Frisbee, and had various parties and movie nights with the professors. This program was a great life experience for me, and I made a lot of new friends along the way. I can’t imagine a better summer job, so I strongly urge anyone thinking about an REU to apply.

Faculty receive achievement awards



In the spring of 2008, Debra Hydorn and Jeff Edmunds were recognized for their work by receiving Faculty Achievement Awards from the Dean’s office. Dr. Edmunds was recognized

for his work in the development of our now-annual High School Calculus Tournament. The tournament began in 2007, and the department hopes that it will continue to grow in the coming years. It is held just before area high school students head out to take the advanced placement exam and serves as a good warm-up for them. Dr. Hydorn was recognized for earning a grant from the American Statistical Association. The grant will help fund the development of biostatistics teaching materials and was earned in collaboration with Dr. Kathy Loesser-Casey and Dr. Alan Griffith, both of the UMW Department of Biology. We congratulate Dr. Edmunds and Dr. Hydorn for their very noteworthy achievements.

Putting Their Skills to Work - Summer Internships



Naval Research Enterprise Intern Program (NREIP) at the Naval Research Laboratory

By Jacob Farinholt

This past summer, I had the opportunity to intern at the Naval Research Lab’s Center for High Assurance Computing Systems.

It was a great opportunity to experience first-hand a career in research mathematics. This internship focused on research in quantum information and quantum computing. Although I had no prior experience in either field, I was able to use my background in algebra and analysis to help make new discoveries about two very important sets of quantum channels used in communications. Not only was I constantly applying what I already knew, but I was literally getting paid to learn about other branches of mathematics and physics.

In addition to doing research, I was able to attend weekly lectures on quantum field theory and monthly presentations by notable researchers in the field of quantum information systems. I also had the opportunity to spend a day at NIST, where I was able to meet and speak with some top researchers in quantum physics. I watched them perform entanglement and quantum key distribution experiments.

The NREIP is sponsored by the American Society for Engineering Education and offers a very decent stipend. This internship was a wonderful experience, and I would strongly encourage anyone who is interested in a career in research mathematics to consider applying to the Naval Research Enterprise Intern Program. If there are any questions about the internship, please feel free to contact me at jfari6vh@umw.edu.



Mathematics Summer Employment Program at the National Security Agency

By Christine Exley

For 12 weeks in the summer of 2008, I possessed the amazing opportunity to intern for the National Security Agency as part of the Mathematics Summer Employment Program. Possessing a Top Secret/SCI/TK clearance, I worked as part of a two-person research team on a classified project supported by two NSA employees. We used both empirical testing and mathematical theory – in particular, the manipulation of statistical implications – to develop strategies to improve upon specific data recovery techniques that exploit foreign communications. We programmed these strategies into Perl scripts that will be

incorporated into an automated processing system at the NSA. In addition to weekly presentations and notes, we presented a final talk to our peers, mentors, supervisors, and other interested parties at the agency. Our work will also be documented in a summarizing technical paper.

I cannot say anything else about my experience except that I discovered the true extent to which mathematicians protect our country every day. If you are interested in applying to the NSA for a summer internship, you must hurry as the deadline is Oct.15. To apply online or to get more information, on the Web go to: NSA.gov > careers > student programs.

If you are interested in increasing your chances of acquiring this internship, here are my recommendations (although no guarantee to their accuracy):

- 1) Your math knowledge is the most important – your real analysis grades matter.
- 2) Computer science knowledge will certainly help. (Although I had none, so as long as you can think logically and are willing to learn computer programming it can work out.)
- 3) You need to be able to show the NSA that you can successfully work both on a team and individually.
- 4) All paper work that you ever receive from the NSA – with or without a deadline – complete as soon as possible!



Safety Engineering at the Naval Surface Warfare Center

By Phil White

From June through August, I participated in an internship in safety engineering at the Naval Surface Warfare Center in Dahlgren, Va. I received an interim security clearance and drove to a secure naval base each day, where I had to present my ID card to gain entry.

I was selected for the internship largely because of my math background, but I found that the work I did had very little to do with mathematics. Most of my duties involved categorizing and preparing documents for a woman who held the title of Principal for Safety for a missile system deployed on numerous Navy ships.

The internship provided me with some valuable insight into the “real world” and gave me some ideas about where I would like to work in the future. Additionally, having an internship like mine tends to look pretty good on paper. Another great thing about this internship is that the government is often a strong proponent of continuing education for its employees. I was allowed to complete three computer-based training courses on safety engineering free

of charge, and many of the workers on base are actually required to complete a certain amount of training each year.

Regardless of whether or not I ever do safety engineering again, obtaining a background in a totally new subject that isn't taught in schools was definitely a positive benefit for me.

Finally, by talking to my co-workers and through on-base “technical briefs” that are open to NSWC employees, I found out about some exciting things going on around the base, a few of which I'm not allowed to repeat. One neat thing I learned that I am allowed to share is that Dahlgren is conducting research on nanotechnology; probably the most fascinating experience I had at work was listening to a scientist conducting some of that research discuss his findings. It was really great to get experience working at Dahlgren. I was exposed to a number of things that you can't really learn about anywhere else in the world, and that made Dahlgren a valuable experience for me.

2008 Honors in Mathematics

Four of our students graduated with honors in mathematics this past year. Their projects were quite diverse, from mathematics education to mathematical physics.



Roberto Palomba worked with Dr. Konieczny. Roberto's thesis, *S_n -normal Semigroups of Partial Transformations*, looked at how one can generalize the notion of a normal subgroup, and then it applied the concept to certain types of semigroups. Roberto is now a graduate student in the Department of Finance and Risk Engineering at Polytechnic University in New York.



Our 2008 Oscar Schultz winner, **Liz Liskom**, completed the first honors thesis in mathematics education. Under the guidance of Dr. Mellinger, Liz looked at the popular software *The Geometer's Sketchpad* and investigated how the software can be used to demonstrate, explore, and discover theorems in Euclidean geometry. Liz developed a series of “sketches,” as they are called, to be used in a high school classroom. She is pursuing a master's degree in mathematics at the University of Connecticut and plans one day to become a high school teacher.



Juliette Zerick completed the first-ever joint honors thesis between mathematics and computer science. Under the advisement of Dr. Jeff Edmunds and Dr. Ernie Ackermann from computer science, Juliette wrote a thesis titled *Computational Characterizations of*

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Basin Boundaries. In it, she looked at certain algorithms used in fluid dynamics together with computer graphics methods, and she used them to analyze the boundaries created by studying certain dynamical systems. Juliette won a prestigious National Defense Science and Engineering Graduate Fellowship which will support her graduate work at the University of California, Davis this fall.



Katharine Mulrey worked with Dr. Chiang to complete a thesis titled *Differential Geometry and its Applications to Einstein's Equations*. In it, Katie gave a broad introduction to the concepts in differential geometry necessary to formulate Einstein's field equation in general relativity. She developed the differential geometry principles and notation of vectors, tensors, manifolds, metrics, Christoffel symbols, and curvature. Her thesis ended with examples of how general relativity is used in scientific and mathematical research. Katie starts a graduate program in physics at the University of Delaware this fall.

Outside the Classroom

The faculty have been involved in quite a bit of professional activities outside the classroom. **Yuan-Jen Chiang** published a paper in the *Journal of Geometry and Physics* and gave a departmental colloquium at American University in March. In July, Dr. Chiang spent a week in Poland attending the Ninth Conference on Geometry and Topology. Dr. Chiang will be on sabbatical this fall taking a much needed break and spending some more time on her research.

Keith Mellinger delivered the keynote address "Teaching our Students to Think" at a ceremony last May for the winner of the Webber Award, a state-wide award in Delaware for mathematics educators. Dr. Mellinger was active in his research on optical orthogonal codes, publishing two papers on the topic and advising a project in which students built a database to hold all of the known information on such codes. The project was part of **Stephen Davies'** computer science course on applications of databases.

After the time offered by a sabbatical last year, **Gary Collier** has been able to make headway on his book on metric spaces. He tested his book this past year in his classes and the book is in its final stages.

For the past five years, **Debra Hydorn** has coordinated the assessment of student-written papers submitted to an annual competition run by the Virginia Junior Academy of Science. Several faculty members from the department have been readers for the competition, and we appreciate Dr. Hydorn's contributions to this very worthwhile endeavor. She enjoyed a much needed sabbatical last spring and spent time working on an intermediate-

level statistics textbook as well as some consulting projects.

Last October, **Jeff Edmunds** traveled to his alma mater in Tucson, Ariz., to give an invited lecture at the Conference on Mathematical Modeling and Analysis of Populations in Biological Systems.

As part of our last Fall Speaker Series, **Janusz Konieczny** gave a delightful talk on Gödel's incompleteness theorem. His research article on automorphisms of semigroups appeared in the journal *Communications in Algebra*, and Dr. K. remained active as both a reviewer and referee of current mathematical research this past year.

At the Joint Mathematics Meetings in San Diego last January, **Randall Helmstutler** gave a talk detailing the work he completed with alumnus Roberto Palomba during the Summer Science Institute of 2007. Dr. Helmstutler earned a Jepson Fellowship for the coming academic year which affords him a 50 percent teaching reduction. He plans to spend the time working on a book which looks at topology from the "categorical point of view."

Marie Sheckels, who just completed her first year as chair of the education department, continues to be very involved in the preparation of grants to support a variety of educational opportunities for high school and middle school teachers working in the Fredericksburg area. To date, Dr. Sheckels' efforts have brought in hundreds of thousands of dollars in grant money to support these projects. In 2008, she was appointed to the Board of Directors for the Rappahannock Region Association of Teachers of Mathematics.

Suzanne Sumner remains active in the development of a university-level teaching center at UMW. Over the past year, she has been involved in a large number of presentations at conferences and workshops, promoting the development of the teaching program at UMW. Despite all the time she spends on these endeavors, she found time to submit two joint papers to professional journals.

Gallery



Math Party



Pi Day



Graduation



Spring Picnic

Gallery continued



Graduation



UNIVERSITY OF
MARY WASHINGTON

Department of Mathematics
1301 College Avenue
Fredericksburg, VA 22401-5300

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