Critical Points

A newsletter of the Mathematical & Statistical Sciences Department at UCD

INSIDE

What's happening in the department? Our Chair has the answers...

n-Dimensional Space by Mike Jacobson, Chair

Aside from the budgetary woes we currently face in Colorado and at UCD in particular, there are many positive items to report on as we start off another year. Many of these items are included in this newsletter. Within the faculty there is a sense of rejuvenation and excitement. We completed a banner year for the graduate programs having 7 doctoral students and 11 Master's students finish during the last 12 months. I'll note, as further indication of the impact the department is making in graduate education, that we expect that to graduate 11 doctoral students and 6 Master's students during the next 12 months.

We have started revitalizing our undergraduate programs, proposing a more flexible general curriculum which will offer a less confusing route to graduation but maintain some of the distinctive features of our program – such as the Math Clinic. With this reorganization, the recent influx of new faculty and a greater concentration on innovative instruction, we feel confident that there will be a broad appeal with the student body – and help to recruit students into the mathematical and statistical sciences.

We are in the midst of significantly updating our website, which will comply with the soon to be released UCD branding. Our aim will be to make the site more appealing and informative to students. If you are ever in the area, please drop in and say hello. I also invite you to keep in touch by submitting a note to our newsletter. We are including updates of alums and will continue to highlight your accomplishments in our future issues. Of course we hope that you find the newsletter interesting and that it helps you maintain a connectivity with fellow alums, the department and UCD. Also, keep sending in your solutions for the Newsletter Puzzler, which can be found on the back page of each issue.

Finally, on behalf of the department, I want to express our gratitude to those of you who have helped support us through your generous donations. Your thoughtfulness is greatly appreciated by students and faculty alike, and your contributions help enable many important activities in the Department.

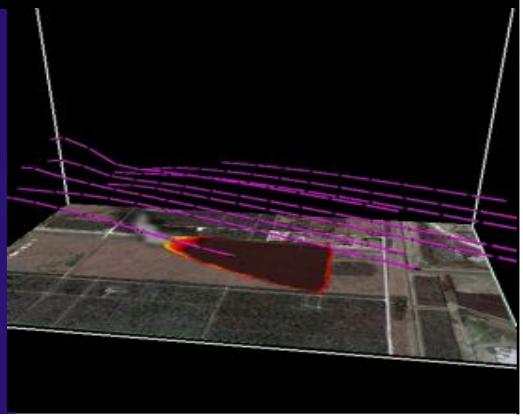
Thank you,

Michael S. Jacobson, Chair
Department of Mathematical & Statistical Sciences
University of Colorado Denver

JAN MANDEL

WAVELENGTHS

With multiple grants from the NSF, Jan Mandel has been busy. He is part of a team that has acquired the Front Range Consortium MRI supercomputer, which was listed as number 31 in the Top 500 list of fastest computers in the world. When Professor Mandel is not solving large-scale problems, you will find him teaching, advising students, running seminars, or developing unique ways to model the potential spread of wildfires.



You have been at UCD for quite a while, what changes have you seen here?

When I came to UCD in 1986, our PhD program was just about to be approved. Our computer network on site consisted of several green-screen, text-only terminals on the 6th floor of the CU Bldg. At the time, graphical UNIX workstations (much like what we use now, but much slower and costing about the same as a luxury sports car then) were the standard at research universities. But, we had some early parallel computers (a 20 processor Sequent and an Intel Hypercube) across campus to work on from those terminals. There was great excitement, a sense of growth, a steadily increasing number of new graduate students, and increasing grant funding.

What was your field originally?

My undergraduate degree was in computer science and mathematical methods in economics, and my MS thesis was in discrete optimization. My PhD advisor was doing aggregation methods in economics. Multigrid methods, which are conceptually similar but applicable to numerical partial differential equations, were just starting. I had the luck to do some early work in these methods and then in the related domain decomposition methods. My work was mostly in theory, numerical, and functional analysis. But I also created some new algorithms, which have became quite popular. In the 1990s, I was a co-principal investigator (Co-PI) of a large grant with faculty from several CU-Boulder departments on coupled physics simulations (such as air flow interacting with an elastic aircraft, which is now routine). My part was applying domain decomposition methods. It was an invaluable experience in how interdisciplinary research and science funding work on a larger scale.

How did you get to work on wildland fires and in statistics?

In 2003, an opportunity presented itself to put together a large group proposal on computer science in coupling wildland fire and weather simulation. I did not know much about either, but I understood that the first step to attaining funding is to assemble the right team of mathematicians and scientists. This group was able to compose a visionary proposal, which anticipated the state of the art of modeling ten years ahead of time. It soon turned out that in order for this project to be most successful, I needed to retool my research in probability and statistics, as well as learn more about meteorology and physics.

You do a lot of computer programming and a lot of different things for a math professor!

In order to make the wildfire project real, I had to start a professional software development group. We have now released the wildland fire simulator WRF-Fire as a part of the Weather Research Forecasting model (WRF), which is a standard, widely downloaded software. We continue to cultivate the WRF-Fire user base. When Loren Cobb joined the department, we found excellent synergy between fire and epidemic simulations as well as between computational mathematics and statistics in general. I could not have done any of this without the software skills I have learned in my consulting, nor without my hard-working students, postdocs, and co-workers.

As a faculty member and a grant-funded researcher, how hard is it to obtain grants to support your research and your students?

It was very hard to start, and sometimes harder to continue. The funding environment keeps changing and you must keep running just to stay in place. When I came to the United States in the late 1980s, the great push for science and technology that started with the Sputnik shock had died down, and grants that had been previously awarded without much difficulty were no more. Proposal writing was well on its way to becoming an extremely time consuming and frustrating task. Competition for these research awards has become increasingly tougher. My senior colleagues helped me get started by including me as a Co-PI in some proposals, where I could make original contributions. But, it still took me years to be awarded my first grant.

Visualization provided by J. Mandel, J. Beezley, A. Kochanski, V. Kondratenko, and B. Sousedik (2010), submitted to AGU.

Faculty Spotlight: Loren Cobb

Modeling societies & cultures to keep the peace abroad

You recently spent fifteen years working in some of the most troubled countries of Latin America as a freelance mathematician. What were you up to?

In 1993 the Defense Modeling & Simulation Office asked me to design a socio-political simulation of a fictional country just emerging from a civil war with ethnic cleansing and massive refugee camps. My simulation was to support a large five-nation civil-military-police exercise in United Nations peacekeeping, which took place in Buenos Aires. It was the first in a successful and on-going series. Many Latin American militaries have now qualified to participate in UN operations, and they serve all over the world. This raises their professionalism tremendously. I am very proud of the fact that no Latin American military that trains and serves with the UN has ever overthrown its own government. That is quite a change for some countries in South America.

But how can mathematics have anything to say about ethnic relations, refugees, or civil war?

This is one of the great frontiers of applied mathematics, just waiting to be explored. We can now map ethnic densities, just like population densities, and show their movements. When one ethnicity is singled out for discrimination, violence, and worse, then its members tend to retreat into separate communities for self-defense, or flee to neighboring countries. Nations can fall into civil war if this polarization and violence crosses a critical threshold, and recovery from civil war includes both reversing this process and depolarizing politics.

What about poverty, gross inequality, oppression, Marxist revolutionaries, and right-wing death squads? Is there a mathematical theory of death squads?

You bet there is! Death squads appear whenever wealthy landowners perceive a lack of protection from government, and they disappear when the Rule of Law is asserted by a healthy judicial system. The ungoverned and poorly governed zones of Latin America are hotspots of organized crime, juvenile gangs, and would-be revolutionaries. Poverty and inequality fuel this process, as do the atrocities committed by death squads. The dynamics are complex, but not unmanageable.

Isn't it dangerous to travel in these areas?

Not really. It's an acceptable risk. Still, three colleagues of mine were once kidnapped and held hostage by the FARC for five years in Colombia. This year I visited Bogotá and interviewed two defecting FARC guerillas, one of whom had once guarded those hostages. These young men were recruited from rural families into the FARC at nine years of age, and were armed soldiers by age 11.

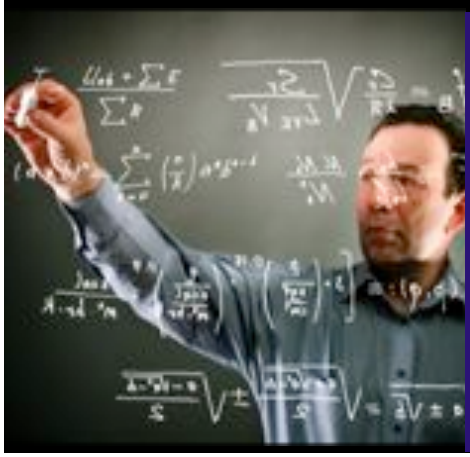
The few lucky ones escape when they finally understand the brutal system they are caught up in; almost all the rest are dead by age 25, from combat or from being shot while trying to escape. Life is truly dangerous for them, not so much for me.

How did your peacekeeping work with the United Nations evolve into national strategic consulting?

Through embassy channels in 1998, Bolivia asked the USA for someone to create a mathematical model of their vicious cycle of poverty, corruption, and narco-trafficking. That task came to me, much to my delight. We designed a high-level policy exercise to go with the model, called *NationLab*. Variations on that theme were picked up by eight other nations, which really kept me jumping. The ground rules and initial scenario are set by the host nation, but everyone plays: the government, the legislature, the political opposition, and radical entities. Each week-long exercise typically goes ten to twenty years into the future of the country, with the model helping to show the quantifiable consequences of their social and political decisions. In El Salvador, former guerillas from the FMLN were major players. In one case, in Ecuador, the training audience was the entire cabinet and national security council. This is a high-octane game, to put it mildly.

This kind of career is not what most students of mathematics imagine. What can you say to them?

Jump in, the water is hot! As a mathematician or statistician, there may be no better way to make a difference in the lives of the poor and oppressed, or in the political health of entire nations.



RANDOM VARIABLES

FACULTY AND STUDENTS ACCOLADES

Recent faculty and student outstanding achievements:

- ***Roxanne Byrne*** - the *Faculty Council Distinguished Service* Award
- ***Jan Mandel*** - both the *CLAS* and *UCD* campus-wide award for *Excellence in Research and Creative Work*
- ***Gary Olson*** - the *CLAS Teaching Excellence Award (*Non-Tenure-Track Faculty)
- ***Bedrich Sousedik*** - the *CLAS Outstanding Doctor of Philosophy* Award

What's new with the faculty?

Faculty News

Weldon Lodwick – Prof. Yurilev Chalco Cano, research mathematician from the Chilean federal University of Tarapaca, Arica, Chile (the northern-most city in Chile, 5 km from Peru) is spending his yearlong sabbatical with our department. Although born in Peru, his PhD is in optimization from the State University of Campinas (known in Brazil as UNICAMP), which has a premier mathematical research program with a global reputation. Prof. Chalco Cano was a student of the renowned Prof. Marco Rojas Medar.

Prof. Chalco Cano, current PhD student Oscar Jenkins, and Dr. Lodwick are working on questions dealing with optimization of interval-valued functions, interval orders, interval derivatives, and fuzzy differential equations. Prof. Chalco Cano is a regular attendee and lecturer in our weekly seminar gatherings of the optimization group.

Prof. Lodwick has this to add about his experiences: "When I was in Chile, over our summer (their winter) in 2008 attending a math conference, after the conference banquet at the end of the meetings, a group of about 10 professors gathered at an after-hours place. Three Chilean professors of the ten of us were more or less equidistant from the center of the group when one of the three started with a joke. Immediately the second followed suit, immediately followed by Professor Chalco Cano. Then the round of jokes entered its second phase without a pause between jokes. This continued without stop or pause in between the howls of laughter. Two hour later, with tears running down my cheeks, we closed the establishment down leaving the patrons wondering what sort of esoteric mathematical research we did."

Julien Langou – Cédric Bourrasset visited us for 3 months from May through July. Cédric is an exchange student from French Ecole Polytech' Clermont-Ferrand which is a five-year Engineering School in France. Cedric will enter the 5th year this Fall. Clermont-Ferrand is a city in Auvergne of about 410,000 inhabitants surrounded by volcanoes. Cédric was supported by NSF grant CCF 811520 and worked as a Graduate Research Assistant for Dr. Langou in the context of the PLASMA project. Cédric assisted Prof. Langou in his research on algorithms for numerical linear algebra adapted for multicore architectures.

Luckily for Cédric, he was able to enjoy his time in Colorado and took

the opportunity to experience some additional activities including: using Dr. Langou's wife's guitar to play rock music and his scooter to ride Denver's streets, burning CPU cycles of any 48-core machines around, learning line dancing with Prof. Lynn Bennethum and attending a punk-rock show with graduate student Matt Nabity.

Relevant links:

http://en.wikipedia.org/wiki/Clermont-Ferrand

http://www.polytech-clermontferrand.fr/index-a.html

http://icl.cs.utk.edu/plasma/

FACULTY Q&A WITH ROXANNE BYRNE

LAUDED PROFESSOR & DEPARTMENT HISTORIAN

When Roxanne Byrne first began her work at UCD as an Assistant Professor in the early 70's, she knew she'd found a home. Luckily for the department and the manifold students she's educated over the years; her home here has been steady even while the department has seen a multitude of change. The effects of her teaching and service have been outstanding and continue to thrive in the minds of her current and former students.

When Professor Roxanne Byrne came to the Mathematical & Statistical Sciences Department in 1972, it wasn't the unified department we know today. It was actually two departments in two different colleges: one in the College of Engineering (the Applied Math program), and one in the College of Arts & Sciences. There have been many changes throughout the years but Professor Byrne's commitment to her students has not waned.

Professor Byrne actually began her career at UCD one decade earlier...as a student. At that time the university was called the University of Colorado's Department of Correspondence and Extension. The entire campus was then housed at what is currently the Hotel Teatro just down the street from our present home in the CU Building.

A department where change is constant.

The department through the years

When Roxanne began teaching at UCD, there was only an undergraduate program. Then in the early 80's with the addition of both Zenas Hartvigson and Rich Lundgren, the graduate program began. Zenas believed in using technology to assist students to better understand theories and concepts. He spent hours meticulously compiling sheets for students and faculty on how to use *Derive* and calculators and eventually began the MERC Lab. Once Professor Lundgren began the graduate program, additional excellent faculty with a passion to teach soon followed. Today, in addition to a passion for teaching, many of the faculty are dedicated to research as well. The enthusiasm for both has become an integral part of our department.

One of the benefits Roxanne remembers from a time when the university was not as cohesive and integrated was how much additional autonomy the departments had. Today the department maintains its ingenuity in its program offerings and research opportunities. However, Professor Byrne remembers a time when there was much less interaction between the departments and the college, leading to a feeling of perhaps more freedom but less of a connection between resources and minds.

When asked about how the department now compares to when she first began, Roxanne's first inclinations led her to respond that it was smaller on every level. Not just in the number of faculty and students, but in the number of programs and research possibilities for faculty and students. The benefit to this growth is that now students are more involved. On a typical day walking through the department, one sees students and faculty continuously collaborating. If anyone doubts this, the constant sound of chalk and dry erase markers on the boards as well as the heavily used Linux computers prove this wonderful consequence of additional minds and opportunities. The addition of speciality areas has meant more diversity in the courses offered as well as more diversified faculty areas of interest. One aspect of the current department (specifically here at UCD) which Roxanne appreciates is how supportive the faculty are of each other and how wonderful this environment is for all parties involved. Functioning as a cohesive unit is important to the faculty and staff here and you see the positive effects of this daily.

What's in store for Roxanne after UCD?

Retirement and the future

While Professor Byrne is currently on phased retirement, she is beginning to think about her plans for the future. Some activities she is looking forward to include planting fruit trees, and making wine and cheese on her property out on the eastern plains near Pueblo. Professor Byrne is also looking forward to having a big garden, traveling, and maybe even taking cooking classes.

Before Roxanne was allowed to go back to her office where I could no longer hound her with questions, I had one more for her. Did she have any final thoughts for the department? She replied that she hopes that the department keeps its cohesiveness and continues to work for solutions when difficult times arise. Luckily for us all, she is confident in this and with her years of experience and knowledge; I am as well. *-Lindsay Hiatt*

Alumni Spotlight: **Shoshana Rosskamm**

What have you enjoyed most about the program?

Having received both my BS and MS here at UCD, I can say that I've really enjoyed the professors and the atmosphere. Also the research opportunities have been outstanding. Here at UCD we have the Math Clinic, which is a very original idea. Because of my involvement with the Math Clinic, I have been awarded more opportunities for research, including working as an RA for Francis Newman at Anschutz.

In addition to working on your MS degree you have been involved in research at both Anschutz Medical Campus and National Jewish Hospital. What have you been working on with these institutions?

I have been working in the Department of Radiation Oncology at Anschutz with lung imaging. There are different types of imaging, one being radiographs. I noticed that different textures (used to diagnose diseases such as cystic fibrosis (CF)) could be seen more easily by removing the ribs from the image. I came up with a textural method to find where the ribs are in an image and then subtract them away so you can see a clearer picture of the lungs. As a result of this research, I was able to publish an abstract last year along with Francis Newman on this method.

Also, more than a year ago I began using textures to diagnose CF and sarcoidosis in lung CT scans. Using a computer program to run texture analysis, we can determine whether the image shows these diseases or normal tissue. Ultimately, we'll be able to give the program a CT scan of any patient, and the computer program will analyze the scan and respond with whether the patient has CF or sarcoidosis, and if so, how much of the lung displays the disease. We've trained the computer to distinguish between these diseases, which is very exciting.

At National Jewish I've been working with lung CT scans as part of the COPDGene study headed by National Jewish and Brigham and Women's Hospital in Boston, which was given $37 million in funding for this research. Currently they are planning on looking at 10,500 patient scans, which is extremely cumbersome. If they have a computerized approach to analyze the scans, not only can they be more efficiently studied, but the computer will provide much more consistent results. The computer will also be able to more accurately measure the progression of emphysema (a lung disease related to COPD) over time in patients. In particular, I've been working on diagnosing centrilobular emphysema vs. normal patients. We have found some additional surprising results which we hope to have published soon!

Your area of mathematics (image processing) is very specialized. What was your thesis about?

My thesis evaluated 28 CF, sarcoidosis, and normal patient CT scans. I looked for different areas in the scans that looked like either of the two diseases or a normal region. Once we located these regions we extracted various textures and quantified them. This led to each image having a number set representing a particular texture. Then I used statistical classification methods to build models to classify CF, sarcoidosis, and normal lung scans. Using this procedure on other scans, I found that the computer program was able to correctly identify 94% of normal scans, 96% of CF, and 82% of sarcoidosis. I hope to eventually improve the method to more accurately detect sarcoidosis but am happy with these initial results.

You decided to go to Rutgers this fall and are receiving a fantastic scholarship. What other schools and offers did you consider?

I was looking for a biomedical imaging program and for a school where there was current research in biomedical imaging. Because of my research experience here at UCD, I was hopeful that I would be accepted into an Ivy League program. After applying and being accepted into programs at Columbia, the University of Pennsylvania, Rutgers, and Princeton, I had to make a tough decision. Columbia offered a Presidential Fellowship and an IGERT Fellowship together providing funding for 5 years, Penn offered a Benjamin Franklin Fellowship, Princeton offered me their top research fellowship (the Upton Fellowship), and Rutgers offered a Presidential Fellowship as well. Choosing was very difficult, but Rutgers had the research infrastructure I was looking for in a place I knew I would be happy to live. After also receiving an NSF Fellowship I was guaranteed full funding for 5 years. This meant that I could make my decision based on choosing an advisor whom I felt would be a good fit for me. My future advisor at Rutgers, Dr. Anant Madabhushi, has very high expectations. I do as well and am excited about the challenges and future.

Congratulations to our Math Modeling Competitors!

Members of the Meritorious Award Team include (L to R): L. Rosenberg, M. Aminian, and M. Rendon. Also pictured: Prof. Gary Olson.

The team of Lee Rosenberg, Manuchehr Aminian, and Michelle Rendon earned their second straight Meritorious Award in the 2010 COMAP MCM/ICM Math Modeling Competition. This ranking placed them in approximately the top 14% of teams competing in worldwide competition. In addition, only 1% of teams receive the highest honor of Outstanding meaning only 6 solutions were rated higher than our team's solution.

Our second team of Janelle Noel, Yonas Getachwa, and Trevor McElhaney competed for the first time this year. They received a ranking of Honorable Mention which places them in approximately the top 40% of solutions worldwide. Congratulations to all our undergraduates and special thanks to our faculty who supported them throughout this endeavor including Lynn Bennethum, Loren Cobb, Mike Ferrara, Mike Kawai, Julien Langou, Jeff Larson (PhD student), Gary Olson, and Stephanie Santorico.

How to donate.

Acute Angles

Support from private individuals as well as federal grants enables our department to continue to expand and conduct important research in the field of mathematics.

There are several ways of helping the department by donating to one of our three gift funds. These funds help support departmental activities and to maintain its level of mathematical activity, on campus, in the community, nationally and internationally. Donations can be made by check, credit card, or direct deposit. Contributions can be made once or multiple times. Here is how you can help ensure the department continues it's goals of education and research:

1. *Mathematics Department Fund #0321063* – This fund is for general purpose support of department activities, for example funding speakers, special events – such as bringing CALCULUS: The MUSICAL to campus – and helping cover general support for the mathematics community.
http://www.cufund.org/giving-opportunities/fund-description/?id=3793

2. *J. R. Lundgren Graduate Travel Fund #0321650* – This fund is to support University of Colorado Denver, Department of Mathematical & Statistical Sciences student travel to mathematics conferences.
http://www.cufund.org/giving-opportunities/fund-description/?id=6994

3. *Mathematics Department Entertainment Fund #0321602* – This fund is for general purpose support of department entertainment activities. In particular it offers the department the chance to purchase alcohol for particular departmental events. NOTE, if donating to this fund, you must indicate that you are aware that these funds might be used to purchase alcohol.

To donate to this fund, you need to "donate to #1" and then in the comment box – state that you want to donate to Mathematics Department Entertainment Fund #0321602 AND you must indicate that you are aware that these funds might be used to purchase alcohol.

ALUMNI UPDATE

What's new? Have you moved or taken a new job? Please let us know! Contact Lindsay Hiatt at lindsay.hiatt@ucdenver.edu with information on where you currently live, what industry you work in, and how we can best contact you with future information (such as new volumes of *Critical Points*). It would be most helpful if you could provide us with a current email and mailing address.

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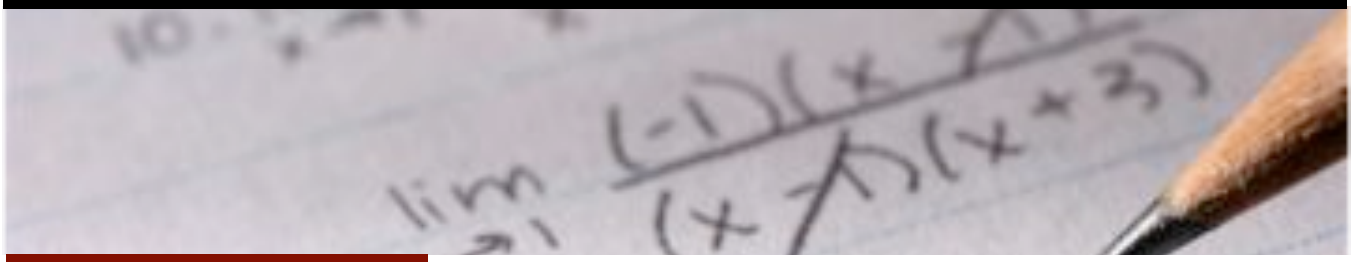

CALENDAR:

AUGUST
5-7: AMS & MAA Joint National Meeting (MathFest) Pitttsburg, PA

OCTOBER
7-8: NCTM Regional Conference
http://www.nctm.org/conferences/

7-9: GK-12 Rocky Mtn Regional Conference

8-9: STEMapalooza! @ CO Convention Center

DECEMBER
4: W. L. Putnam Math Competition
13-18: Finals Week
18: Commencement

THE PUZZLER by Stan Payne

Suppose that A is a real, n by n symmetric matrix with A^3 = A^2 + A - I.

Show that A is invertible and in fact A is its own inverse.

Think you can solve it? Email your solution to stanley.payne@ucdenver.edu

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