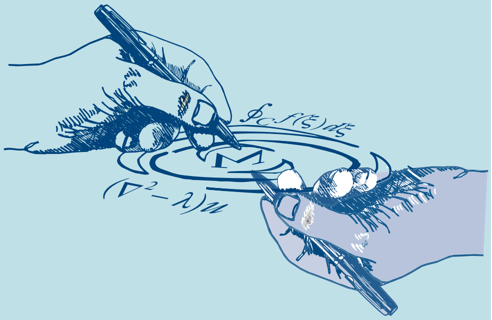

Spring 2007

Reckonings

Reckonings: (n. pl.)
1. Computations or summations
2. Acts of thought or reasoning
3. The newsletter of the Department of Mathematical Sciences at the University of Delaware

Chair's Message

Peter Monk

Despite the best efforts of the hiring committee, the staff, the faculty and the Dean's office we were unable to appoint a permanent chair for the Department last year. So I find myself serving for a second year as Interim Chair. We are currently searching again for a permanent chair, this time from within the Department.

Besides the ongoing search for the Chair, we have also continued our search for the Hollowell Chair of Mathematics Education. The Department is entrusted with the important responsibility of educating future high-school mathematics teachers via our Bachelor of Arts in Mathematics Education (the XMS program). This is the largest degree program in our Department, and we hope also to offer a Bachelor of Science in this area soon. The Hollowell Chair will lead our Mathematics Education program, and will coordinate our program with the Mathematics Educators (K-8) in the College of Human Services, Education and Public Policy (CHEP) and the University outreach program in the Mathematics & Science Education Resource Center (MSERC).

From its inception, MSERC and the Department have worked closely to improve mathematics education in the University and state. For example, this year, at the request of the Director of MSERC, Dr Kathy Hollowell, we have added several courses for graduate students in CHEP to help teachers become "highly qualified". Unfortunately, this year also marks Kathy's retirement from MSERC and our Department. She and her husband David (Executive Vice President & Treasurer of the University) donated the Hollowell Chair to the Department for which we are duly very grateful. Kathy has always been a passionate advocate of Mathematics Education in the state and has been very influential, via MSERC, in providing help to in-service mathematics teachers at all grades. On behalf of the Department, I wish David and Kathy the best of good fortune in retirement. We all look forward to working with her replacement at MSERC, Dr. Jon Manon.

The senior hires mentioned above are not the only recruitment activity in the Department. We have hired a second UNIDEL post-doc, Dr Dejun Xie from the University of Pittsburgh, who will work on Mathematical Finance. In addition we have also initiated a search for an Assistant Professor in Mathematical Biology to join the Department. This search, which we hope will continue next year, will help the Department to take part in major initiatives in the life sciences that are now a central thrust of the University research mission. Thanks to the efforts of several faculty in

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Finite Geometries

Gary Ebert

Finite geometry is similar to the geometry you studied in high school, except (as the name implies) that there are only finitely many points on a line, finitely many lines in a plane, and so on. Classical examples arise by considering finite dimensional vector spaces over finite fields. In particular, there is no notion of betweeness, distance, or angular measure. That is, they are combinatorial objects. Techniques often used in studying finite geometries include group actions, elementary number theory, linear algebraic methods, finite field arithmetic, and combinatorial counting.

Historically, finite geometries were used in the construction of experimental designs (for instance, testing varieties of seed corn under different soil conditions), and in the construction of certain error-correcting codes (the Hamming codes, for example). Today, finite geometry is mostly studied as an abstract discipline in its own right, rather than as a construction tool in other disciplines.

One of the emphases in modern finite geometry is "Segre's point of view", popularized by the famous Italian geometer Beniamino Segre. Basically, the idea is to characterize geometric objects that have been defined algebraically by purely combinatorial properties. For instance, consider the classical finite projective plane $\pi = PG(2, q)$ defined over the finite field $F = GF(q)$, where necessarily q is some prime power. That is, if $V = V(3, q)$ is a 3-dimensional vector space over F, then the *points* of π are the 1-dimensional subspaces of V and the *lines* of π are the 2-dimensional subspaces of V. The Dimension the Department (Professors Driscoll, Pelesko, Rossi, and Schleiniger), the Department has played an important role in a successful grant proposal by the Department of Biological Sciences to the Howard Hughes Medical Institute for undergraduate education in quantitative biology. In partnership with Biological Sciences and Chemical Engineering, we have proposed an exciting new undergraduate major "Bachelor of Sciences in Quantitative Biology" and hope it will be provisionally approved this year.

The new faculty in Mathematical Biology will find active collaboration at the undergraduate level, as well as several current research programs in Mathematical Biology within the Department including research on tear films by Professors Braun, Cook and Driscoll (recently awarded a National Science Foundation grant), and on surface bio-physics by Professor Edwards (supported by a grant from the National Institute of Health). Undergraduates are also involved in biomathematics including a project to model communication amongst ants (two students working with Professor Rossi in our MEC Lab.).

Research in the Department is central to our mission of educating graduate students. We understand that the assessment and strengthening of graduate programs across the campus is to be one of the main administrative challenges facing the University in the coming year. Of course the main purpose of our graduate program is to educate new generations of scholars who are well trained for jobs in academia or industry. This involves both regular coursework, fundamental research via the writing of a PhD thesis and training in teaching. Graduate students are supported financially by a variety of means including teaching assistantships (these students are an important resource for undergraduates taking calculus for example), research assistantships (typically from grants to faculty in support of their research programs), and fellowships. I am delighted to announce that this year is the first year we shall offer the "Stakgold Fellowship" donated by our emeritus chair Professor Ivar Stakgold. The goal of this fellowship is to attract the best and brightest to teaching by offering a teaching assistantship with an augmented stipend.

Graduate student research is an important and invigorating component of research in the Department. One aspect of preparation for a research career is learning how to present results at conferences, seminars and workshops. Attending such meetings exposes graduate students to cutting edge research, and helps them to network for research collaboration and for finding employment after graduation. An important way we can fund graduate student travel is via donations to our "Graduate Enrichment Account" (which also helps to fund local graduate student seminar expenses). I would like to thank those of you who have donated to this much appreciated account. If you are interested in this activity, please see our website: http://www.math.udel.edu/alumni/makegift.html

Again this year, I would like to express my thanks to Professor David Edwards who has served as Associate Chair of the Department (responsible for teaching) this year. He and the staff have been enormously busy this year as we transition to a new on-line system of class scheduling and enrollment called UDSIS. It's fair to say that the transition has been challenging both for the Department and for our students. I would also like to thank the office staff who have helped so much with every aspect of Department administration.

Peter Monk, Interim Chair

Theorem from linear algebra then implies that any two distinct lines of meet in a unique point (so there are no "parallel" lines). A *conic* C in is defined to be the set of points induced by the nonzero vectors that are mapped to the scalar 0 by some non-degenerate quadratic form on V.

It turns out that a *conic* C in π has $q+1$ points, no three of which are collinear. Segre showed that when q is odd (that is, a power of an odd prime), any set of $q+1$ points in $PG(2, q)$ with no three collinear is necessarily a conic, thereby giving a purely combinatorial characterization of this algebraically defined object. It should be pointed out that this result does not hold when q is even (that is, a power of 2). In this case, the $q + 1$ tangent lines to C, one at each of its points, all pass through some point N, called the *nucleus* of the conic. This makes conics in $PG(2, q)$, for q even, very different from the familiar circles or ellipses in the Euclidean plane.

The National Security Agency is now the primary funding agency in the United States for researchers in finite geometry, and I have been fortunate enough to have received funding from NSA for most of the last decade. My current grant is entitled "Ovoids and Spreads in Polar and Projective Spaces." A *polarity* of a classical projective space $PG(d, q)$ is a mapping of order two that interchanges points and hyperplanes, such as the mapping that interchanges a 1-dimensional subspace with its "orthogonal complement" (a subspace of codimension 1) with respect to some non-degenerate bilinear, or hermitian, form on the underlying vector space. Polarities are fundamental mappings for geometers.The isotropic points of such a polarity (those contained in their polar image) form what is called a *classical polar space*, and the totally isotropic subspaces of maximum dimension are called the *generators* of the polar space.

An *ovoid* is a set of points in a polar space that meets each generator in exactly one point, while a spread is a collection of mutually disjoint generators that partition all the points of the polar space. Ovoids and spreads can be thought of as dual objects, and knowledge of the ovoids and spreads present can greatly help in understanding the polar space. There are many classical polar spaces, depending on the field $GF(q)$ and the underlying bilinear, or hermitian, form, for which it is unknown if ovoids and/or spreads exist. If it is known that such objects do not exist, then one is interested in finding good upper and lower bounds (as well as examples) on the size of partial ovoids/spreads that are *complete* in the sense that they are not contained in any larger ovoid/spread.

My current NSA project is concerned with these problems. Finally, it should be mentioned that many times computer packages, such as MAGMA, can be used to help find such objects and to identify patterns that might be used in various classifications.

Challenges in Parallel Mathematical Computation

Louis F. Rossi

Those of us who analyze and develop algorithms for solving mathematical problems often find ourselves at the interface between mathematics and other disciplines. However, the term "interface," implying a sharp boundary, is deceptive because the gap between mathematical discoveries in numerical analysis and full scale simulation can be vast in many situations. For instance, it is one thing to solve the Navier-Stokes equations in a periodic box, and quite another to simulate the flow around a commercial jetliner. However, with the advances in computer technology, larger and more aggressive computations have become readily accessible to mathematicians seeking to demonstrate a new technique on a challenging problem.

One of the most exciting technological developments in mathematical computation has been the widespread availability of low-cost, efficient clusters of computers. A cluster of computers can be nothing more than a group of desktop computers connected through a network, or it could be a dedicated collection of CPUs working across a dedicated high-speed network. In the last decade, the software and hardware has improved to a point where it has been possible to take off-the-shelf computers and network hardware, and build a modest cluster on a modest budget. Four years ago, the Profs. Braun, Driscoll, Monk and myself earned an NSF Scientific Computing Research Environments Mathematical Sciences (grant SCREMS 03-22583) grant for just this purpose, and the result is our 48 CPU cluster, named WOPR in a nod to the supercomputer featured in the classic 1980's science fiction film. The WOPR cluster consists of twenty-four dual Opteron CPU motherboards with a gigabit ethernet interconnect. None of these components are specially designed for parallel computation, but working together as a dedicated cluster, they become a powerful tool for mathematical computation.

Designing and implementing parallel algorithms introduces all kinds of new mathematical problems and challenges. The ease at which one can distribute work efficiently across many CPUs is called scalability. As we all learned in grade school mathematics, if one person can paint a room in four hours, four painters working together can paint it in one hour. This class of problem is called embarrassingly parallel because it requires no communication between the workers. For an embarrassingly parallel mathematical problem, one could divide it into 48 equal pieces, give one piece to each CPU on the WOPR, and have an answer in one forty-eighth the time required to do it on a single CPU.

My problems are far from embarrassingly parallel. My algorithms focus on solving the two dimensional Navier-Stokes equations written as the vorticity dynamics equations:

$$\frac{\partial\omega}{\partial t} + (\vec{u}\cdot\nabla)\omega = \frac{1}{Re}\nabla^2\omega$$

where $\vec{u}$ is the velocity field and ω is the vorticity or the $\hat{z}$ component of the curl of $\vec{u}$. Re is the Reynolds number, a known dimensionless ratio representing the balance between inertial and diffusive forces in the fluid. One of my research foci is vortex methods, naturally adaptive algorithms that solve fluid flow problems by representing ω as a linear combination of moving basis functions. The velocity field $\vec{u}$ can be recovered from ω via the Biot-Savart integral:

$$\psi = \frac{1}{4\pi}\iint \omega(\vec{s}-x)\log(\vec{s})d\vec{s},$$

$$\vec{u} = \begin{bmatrix} \frac{\partial\psi}{\partial y} \\ \frac{\partial\psi}{\partial x} \end{bmatrix},$$

where ψ is called the streamfunction because lines of constant ψ correspond to material paths followed by fluid particles. The mathematical structure reveals the computational difficulty. To solve the evolution equations for ω, one must find $\vec{u}$, one must find ψ, and to find ψ one $\vec{u}$. To find ψ must integrate over the whole domain. This integration requires communication. In other words, every bit of vorticity must know something about every other bit of vorticity. Rather than painting a room, the analogy here is more like building a house where the product of one worker affects others so that they must communicate with one another to achieve a common goal. A variety of mathematical challenges come with the availability of more CPUs.

Sending data from one CPU to another requires much more time than performing a few floating point operations on the same amount of data, so one must scale the algorithm carefully. The amount of work done by one CPU in a scaled algorithm is referred to as the grain size. The finer the granularity, the easier it is to break up the algorithm across massively parallel computer architectures. This means that communication requirements are small. Coarse grained computations require lots of communication. On the WOPR and many other clusters, this is even more complex because CPUs on different motherboards must pass data over the gigabit ethernet network, but CPUs on the same dual motherboard pass messages much more efficiently via shared memory. The delays associated with message passing is often referred to as network latency. Fortunately, we use message passing libraries that are aware of the physical configuration of our computer and uses its properties to reduce network latency, but often rewriting algorithms in clever ways can reduce computation times considerably.

Another mathematical challenge associated with parallel mathematical computation is load balancing. In a scaled algorithm, one CPU may require more time than another to finish a grain of work, so CPUs may sit idle. This is analogous to the roofer sitting idle waiting for the carpenters to finish framing a house. Ideally, one would like to keep all CPUs busy on th‹e problem to make the most of available computing resources. Unfortunately, it many problems, it is not possible to know a priori how long a single task will take, and this problem is compounded by the unpredictabilities of network latency. One paradigm that has worked well for me is the master-slave algorithm. In it, one CPU is the

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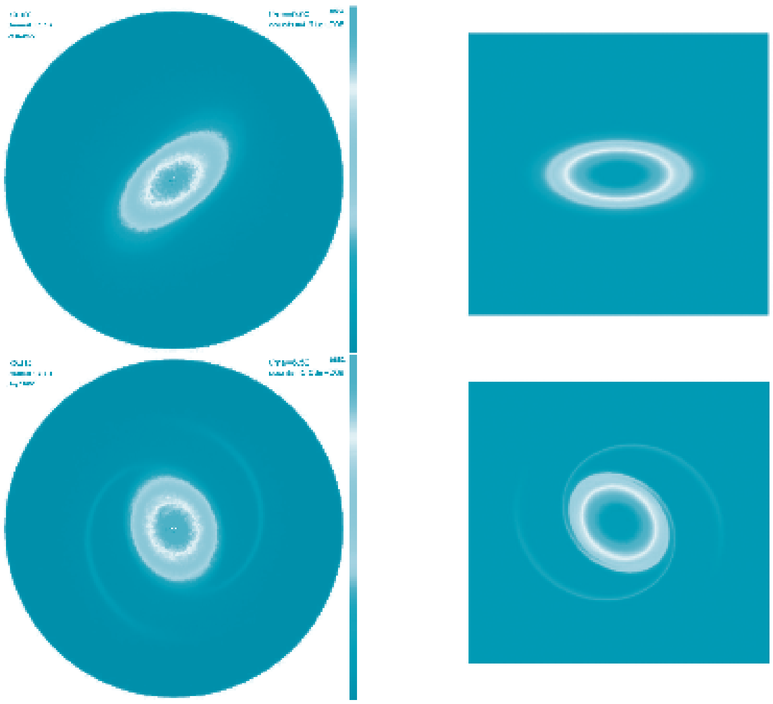

Figure 1: Vortex dynamics and plasma compared. Electron column experiments (left) are compared to vortex computations (right). Starting from nearly identical states (top), the electron column rapidly ejects filaments and the core axisymmetrizes. The electron columns rotate in the opposite direction of the positive vorticity but are otherwise isomorphic.

master and maintains a list of work to be done. One grain of work is given to each slave by the master. When the work is completed by a slave, the results are passed back to the master who then gives the slave a new grain of work to do. This keeps all the CPU's loaded at all time, but it requires one program, the master, to coordinate the computation.

Even when using standardized message-passing libraries, parallel implementations can become much more complex when compared with a serial computation, and one often wonders whether the parallel and serial algorithms are the same. Recently, I have begun to collaborate with Stephen Siegel, a colleague in the Computer and Information Sciences Department, who has written a code analyzer called Spin that studies the correctness of parallel implementations relative to the serial algorithm. For instance, Spin can produce detailed reports on whether the serial and parallel algorithms will produce strictly identical mathematical results. If not, it will identify where the mismatches occur and one can then study whether the differences are numerically significant.

When properly programmed, a cluster like the WOPR can perform challenging calculations quickly and effectively. A recent example includes an investigation with Travis Mitchell from the Department of Physics and Astronomy. Prof. Mitchell performs experiments on trapped electrons which are governed by equations that are isomorphic to the 2D Navier-Stokes equations. Together, we hope to understand the fundamental instabilities associated with elliptical regions of vorticity (or charge in the plasma), and the combination of high performance computation and experimental exploration has proven essential in our investigation as we uncover a rich mathematical structure underlying these simple dynamical questions.

From the Editor

Dear Department Alumni, Students, and Friends,

It is my pleasure to distribute our third edition of Reckonings. As in our previous two issues, you'll find an update on the department from our chairman, a collection of news items highlighting the events and milestones of the past year, and profiles of new faculty and current students. In addition, you'll find three articles explaining some of the current research projects being carried out by our faculty. Professor Guyenne has contributed a fascinating article on the reconstruction of fluid surfaces and the implications of new reconstruction techniques for computer vision. Professor Ebert has contributed an article titled "Finite Geometries" that may make you reconsider what you thought you knew about the meaning of the word "geometry." Finally, Professor Rossi tackles the challenges present in the world of high performance parallel computing in his article, "Challenges in Parallel Mathematical Computation." Here, you'll not only learn about the departments new 48 CPU "WOPR," but also about the difficulties inherent in efficiently programming a large parallel machine.

I would like to thank all of the contributors to this newsletter, but especially Gary Ebert, Philippe Guyenne, Peter Monk, Lou Rossi, Gilberto Schleiniger, and Anja Sturm. I'd also like to thank Elizabeth Dunkle from UD's Office of Publications for all of her help with the design and layout of this and past newsletters.

I'd like to encourage everyone to regularly check the department's home page (www.math.udel.edu), where you'll find up-to-date news about the department and its activities. If you have news you'd like to share, either on the web page or in future editions of Reckonings, please feel free to send me an email at pelesko@math.udel.edu. I look forward to hearing from you.

Best wishes,

John A. Pelesko

Brief News Items from the Math Department

Conference in honor of Professor Gilbert's 75th birthday held at the University of Florida

Professor ***Robert P. Gilbert*** was honored on the occasion of his 75th birthday with a conference held at the University of Florida. The conference theme, "Inverse Problems, Homogenization and Related Topics in Analysis," celebrated Prof. Gilbert's long and distinguished record of major contributions to mathematical analysis.

Professor's Braun, Cook, and Driscoll receive NSF mathematical biology grant

Professor's ***Richard Braun***, ***L. Pamela Cook***, and ***Tobin A. Driscoll***, have received a grant from the National Science Foundation to study mathematical models of human tear films. This grant provides support for two graduate students and makes possible collaboration with Dr. Ewen King-Smith of Ohio State University's College of Optometry and Dr. Petri Fast of Lawrence Livermore National Laboratory.

Professor Hsiao named to editorial board of Advances and Applications in Fluid Mechanics

Professor ***George Hsiao*** was named to the editorial board of a new journal, *Advances and Applications in Fluid Mechanics.* The first issue of this journal appeared in January 2007. The journal consists of original research papers and survey articles related to all fields of fluid mechanics. His appointment to the board of this new journal reflects Prof. Hsiao's lifelong contributions to the field.

Professor Cai named to editorial board of International Journal of Mathematical Education

Professor ***Jinfa Cai*** was named to the editorial board of a new journal, *International Journal of Mathematical Education: Policy and Practice.* The first issue of this journal appeared in March 2007. The journal publishes original research papers and survey articles in mathematics education at all levels, with a focus on addressing issues related to educational policy and instructional practice.

Professor Braun named to editorial board of Math-in-Industry Case Studies

Professor ***Richard Braun*** has been named to the editorial board of a new journal, *Math-in-Industry Case Studies.* This electronic research journal is published by the Fields Institute and aims to meet the publication needs of mathematicians who work on problems that are important to industry. The first issue is expected to appear in the third or fourth quarter of 2007.

Professor Xiang named an Editor-in-Chief of the Electronic Journal of Combinatorics

Professor ***Qing Xiang*** has been named one of seven Editors-in-Chief of the Electronic J*ournal of Combinatorics.* This journal was started over ten years ago and covers all areas of combinatorics. Currently, the journal publishes about 100 papers per year, including regular papers, notes and surveys.

UD Students earn Meritorious Rating in 2007 Mathematical Contest in Modeling

Two teams from the University of Delaware earned a Meritorious Rating in the annual Mathematics Competition in Modeling. One team consisted of ***Andrew Seagraves***, ***Hadi Fattah*** and ***Gloria Amakobe***. The other consisted of ***Tapan Patel***, ***Evan Lebois***, and ***Don Knieriem***. Both teams were coached by Professor ***Louis Rossi***. The meritorious rating is the second highest designation for an entry. Congratulations to both teams on their outstanding achievement.

(Photo from left to right: Seagraves, Fattah, Amakobe, Patel, Lebois, and Knieriem.)

Math Department hosts its first UD Math Alumni Reception

On April 29, 2006, the Math Department hosted its first Alumni Reception. UD alumni from classes stretching from '51 to '03 gathered together with math faculty, staff, and current graduate and undergraduate students in the department. Professors ***Driscoll, Pelesko*** and ***Schleiniger*** led alums on tours of our computer classrooms and our Modeling Experiment and Computation laboratory. Research posters were on display from recent student research symposia. A photo album of the event may be found online at: http://www.math.udel.edu/news/alum06/alumday.html

Professor Cai wins Transformational Initiative Grant

Professor ***Jinfa Cai*** has earned a College of Arts and Sciences Transformational Grant to develop a peer mentoring program to foster a smooth transition from DelTech's Associate Degree Program students to the University of Delaware. Peer mentors will work with transfer students one-to-one over the summer to introduce them to university life and the math department curriculum.

Georgia Pyrros receives Excellence in Undergraduate Academic Advising Award

Instructor ***Georgia Pyrros*** was selected by the Faculty Senate to receive the 2006 Excellence in Undergraduate Academic Advising Awards. She received her award at the Arts and Sciences' Honor's Day ceremony. Award recipients have a brick bearing their name placed in the Mentors' Circle adjacent to Memorial Hall.

Professor Li elected as fellow of the Institute of Mathematical Statistics

Professor ***Wenbo Li*** has been elected a fellow of the Institute of Mathematical Statistics. In the award letter the director says "Fellowship is a way of honoring the outstanding research and professional contributions of our members, contributions which help keep IMS in a leading role in the field of statistics and probability."

Professor John A. Pelesko wins top Arts & Science teaching honors

Professor ***John A. Pelesko*** has earned the College of Arts and Sciences 2006 Outstanding Faculty Teaching Award. The College of Arts and Sciences Teaching Award is based on student and peer evaluations, alumni testimonials, number and range of courses offered, involvement in individual instruction, quality of advisement and mentoring, demonstrated commitment to student welfare and development, and acknowledged reputation in teaching. This award recognizes Professor Pelesko's long-time dedication to applying modern and effective teaching techniques in his classes, and his community outreach to high school teachers and students.

Professor Ray Goodrich passes away

We are saddened to learn that ***Ray Goodrich***, Professor of Mathematics at University of Delaware from 1971-1984, passed away recently. Following his retirement from the University of Delaware, he moved Ann Arbor, Michigan. His areas of research included applied mathematics, differential equations and integral equations. He is survived by his wife, Suzanne.

3D Fluid Surface Reconstruction

Philippe Guyenne

Modeling and reconstructing timevarying 3D fluid surfaces is a challenging problem and has drawn considerable attention in recent years. Applications are numerous in fluid mechanics but also in computer graphics and computer vision. Examples of applications include: data assimilation for validation of existing fluid models, prediction of longtime dynamics of fluid flows, integration of reconstructed fluid surfaces into animations and film footage to reproduce realistic phenomena, etc.

Fluid surface reconstruction is a challenging problem for essentially two reasons: First, accurately measuring 3D fluid surfaces is di cult because their features can be highly varying in space and time, and the measuring device should not be intrusive to the fluid. An accurate reconstruction usually requires using a prominent measuring system and collecting a large amount of data. Secondly, the evolution of fluid surfaces is governed by complex physical mechanisms, and it is not evident how to incorporate such mechanisms into surface reconstruction methods. Mathematically, the evolution of a fluid surface is described by a system of nonlinear partial differential equations that must be solved numerically in most cases.

Many previous approaches for reconstructing fluid surfaces in computer vision have used a single or a pair of cameras. These methods have sought to take advantage of fluid optical properties and attempted to extract the shape of fluid surfaces from the captured images. Recent studies have shown that methods based on the fluid refractivity property produce more accurate reconstructions that the ones based on the reflectivity property. However, refractivitybased methods break down in the presence of strong refraction distortions or camera miscalibration. Furthermore, both reflectivity and refractivitybased reconstruction methods are numerically unstable. Another common problem with existing methods is that they attempt to capture the geometry of fluid surfaces without considering their spatial and temporal consistencies with fluid dynamics principles.

Jingyi Yu (Assistant Professor, Department of Computer and Information Sciences, University of Delaware) and I have recently been awarded a joint NSF grant for our research in view of developing a method for accurately reconstructing 3D fluid surfaces from sampled data.

Our method consists of two components: a fluid surface acquisition method and a fluid surface reconstruction method. Data acquisition is performed using a light field camera array that can simultaneously capture different views of a 3D fluid surface. A known pattern is placed beneath the surface and each camera observes a distinct time-varying distortion pattern. We can then accurately measure a sampled fluid surface by analyzing these distortions. The next step is to find the optimal surface that obeys the fluid dynamics and matches the sampled data. The reconstructed surface is obtained by solving the full nonlinear Euler equations for 3D free-surface flows. I am working with graduate student Liwei Xu on developing and implementing a numerical model to efficiently compute solutions of these equations. The light field camera array is being set up in the Graphics and Imagery Laboratory of Prof. Yu.

It is anticipated that surface reconstruction in such a deterministic way has many potential applications. For example, as mentioned earlier, for validation of existing wave models in oceanography, coastal and ocean engineering. In particular, this method can be extended to large-scale laboratory experiments for 3D wave measurements. Not only can it track fluid surface motion, it can also be used to predict internal fluid flow properties or set proper initial flow conditions.

Dr. David Hallenbeck (1941-2007)

Y. J. Leung and Gilberto Schleiniger

This past April we lost a dear colleague and friend with the untimely passing of Professor David Hallenbeck. David served in the Department of Mathematical Sciences for over 30 years before his retirement in 2003. His invaluable contributions to the profession and to the University included an active research career, dedication to teaching, and administrative service.

David served as interim chair of the Department during the last year and a half before his retirement. His temperament, efficiency and organizational skills proved to be true assets. He conducted the Department's business with extreme efficiency, and probably holds the record for the shortest faculty meetings in the history of the Department – something much appreciated by all of us, his colleagues. It was not that he had nothing to say, or that he neglected important departmental matters; it was because he was always extremely well prepared and efficient in leading those meetings. If the business at hand could be taken care of in 15 minutes, that's how long the meeting would last. Before David served as interim chair of the Department he served as Director of Undergraduate Studies. Those who served as chairs before him, Drs. Pam Cook and Ivar Stakgold, valued his advice, reliability, competence and collegiality. And those of us who were privileged to have him as a friend and colleague will miss him dearly.

He is well known for his contributions to Complex Analysis, in particular to univalent functions and related areas. The author or co-author of 59 papers in refereed journals, he was also co-author (with Tom MacGregor) of the book "Linear Problems and Convexity Techniques in Geometric Function Theory." One of his papers (with Brickman, MacGregor and Wilken), "Convex hulls and extreme points of families of starlike and convex mappings," published in 1973 in the prestigious Transactions of the American Mathematical Society, has been widely cited and is one of several seminal papers which laid the foundation for the application of functional analysis to function theoretic problems. Their use of the theory of extreme points and support points in convex analysis to develop extremal problems in complex analysis has been incorporated as a standard chapter in many modern books on classical function theory.

David served in the US Army until he was injured during a rock climbing incident while stationed in Colorado. After discharge from the Service he went on to study at SUNY Albany as an undergraduate, and continued his graduate work there. He was the first PhD student that came out from a then budding mathematics department which has now become a premier center for mathematical analysis.

David was an accomplished athlete who ran the Boston marathon in 2 hours and 47 minutes – a nontrivial feat. Typical of his commitment to everything he undertook, he trained for the Boston marathon for one year running 16 miles a day, 6 days a week. During the cold winter days in Albany (NY), he would run miles in the tunnels that connect the buildings of the SUNY Albany campus. He was also a serious student of chess.

David was also a genuine naturalist. His knowledge of birds and love for birding made him a valuable resource for the community of birders on the East coast; many admired him for his passion and deep knowledge. It has been said that he was one of the people who knew most about falcons in the United States. Talking about peregrine falcons, Dr. Bill Seegar, chairman of the board of directors of Earthspan, a non-profit, environmental science organization, said, "He knew as much if not more about the bird's behavior and activities on the island than we did." Dr. Seegar was referring to his research team and Assateague Island. Dr. Seegar continued, "Dave was an accomplished scientist, a meticulous observer, a wonderful note taker and knew his birds, and not just falcons and hawks. In fact we often quote Dave's notes and observations on the predation of shorebirds by the adult peregrine falcons."

This excerpt from the Johns Hopkins Magazine (02/1997) shows the respect Dr. Seegar had for Dave's knowledge of birds: "At Assateague, Seegar angles his truck inland from the beach. Ahead on a dune a tall man carrying a pair of binoculars is waving. 'That's Dave Hallenbeck,' says Seegar. 'He probably knows as much about falcons as anyone.' When Hallenbeck is not teaching math at the University of Delaware, he walks the beach, neck craned backward, in search of falcons."

Dr. Mike Yates, a research biologist and director of Earthspan, and co-investigator of the peregrine falcon survey at the Assateague Island, MD/VA said, "Any other person frequenting the places Dave did during our survey would have been not only an unwelcome distraction but a detriment to our survey results. But Dave's intellect and skills enabled him to become part of the landscape and he never affected either the behavior of the peregrines or our survey's efficiency. If anything, he increased our efficiency. When we would enter the area and spot Dave, it became mandatory that we pay him a quick visit. He would recount to us in short order every peregrine present, including its relative location, age and sex, and whether is was one we'd already color marked. His information was invariably correct."

David had many loves and was passionate about whatever he did, but his greatest love was undeniably his family. He and his wife Kasia have two beautiful children: Alex and Michelle. Anyone who visited the Hallenbecks' home could not help but to note the wonderful family environment they created. Alex and Michelle learned to love reading, math, music, chess, nature and sports. David's decision to take early retirement was a fortunate one, as it allowed him to dedicate himself to his wife and children during the last few years of his life. His example will no doubt inspire Kasia, Alex and Michelle to continue to grow, support and love each other, and to achieve great success in their endeavors. We look forward to having Alex as a student at UD -- he will be a freshman chemical engineering student this coming fall semester, in the honors program.

We will always remember David as an accomplished mathematician, a trusted colleague, a model parent, an honorable man, and a dear friend.

Contributions to the memorial David Hallenbeck Fund are appreciated and will be used to support the department's graduate student seminar series.

Checks should be made payable to the University of Delaware/David Hallenbeck Fund and mailed to:

David Hallenbeck Fund
Office of University Development
Evans Hall
University of Development
Newark, DE 19716

UD Math Sciences hosts the 23rd annual workshop on Mathematical Problems in Industry

The Department of Mathematical Sciences is proud to be hosting the 23rd annual workshop on mathematical problems in industry. This is the fifth time this workshop will be held at the University of Delaware and hosted by the department. This week-long meeting, scheduled for June 11 through June 15, brings together leading applied mathematicians, scientists and engineers from academia, industry and government laboratories. During the workshop, engineers and scientists from industry interact with the academic participants on problems of interest to their companies. The result is a lively, highly interdisciplinary research collaboration linking top quality mathematics with important scientific and technological problems.

This year, we are expecting over 60 participants from institutions worldwide. Hosting this meeting is one of the many ways our department continues to serve the professional community. More information can be found at: http://www.math.udel.edu/MPI/

New Faculty

The Department of Mathematical Sciences continues to hire new faculty to replace retirements and to add strength in new areas. In this newsletter, we are pleased to introduce our three most recent additions to the department.

Dr. ***Cristina Bacuta*** received her Ph.D. in Mathematics Education from Texas A&M University in 2001. Cristina also holds a Master of Science in mathematics from Texas A&M University and a Bachelor of Science Degree from Alexandru Ioan Cuza University in Iasi, Romania. Her research interests lay in the area of mathematics teacher education. Specifically, she is interested in developing methods to improve the teaching of calculus and methods to integrate technology in the classroom. Cristina and her mathematician husband, Constantin, are the proud parents of two teenage daughters. Their elder daughter is now a freshman at the University of Delaware studying accounting and economics. Cristina enjoys traveling, hiking, and spending time with her husband and children.

Dr. ***William Cuckler*** received his Ph.D. from Rutgers University in 2006 under the supervision of Professor J. Kahn. He did his undergraduate work at the University of Illinois at Urbana-Champaign. Bill is a specialist in combinatorics and graph theory. His thesis work focused on the use of probabilistic methods in combinatorics. Bill joins us as our first Unidel Postdoctoral Fellow. This new program aims to bring outstanding young mathematicians to the department to enliven and enrich the department's research expertise. Since arriving at UD, Bill has been collaborating closely with Professor Felix Lazebnik on a variety of problems in graph theory. Bill is originally from Napierville, Indiana, a suburb of Chicago. Bill is an avid athlete and regularly plays tennis, basketball, and enjoys hiking. He is joined in Delaware by his fiancé, who is studying economics here at UD. They'll be married in August of 2007.

We're pleased that ***Patricia Schwarzkopf*** has rejoined the Department of Mathematical Sciences after a brief hiatus. Patricia received her Master of Arts in mathematics from the Ohio State University in 1987. Her research interests include mathematics education and the use of technology in the classroom. She is especially interested in developing new and effective strategies for communicating mathematics to non-math majors. In her classes, Patricia draws on a variety of innovative techniques, including group learning and the novel use of technology. Patricia is the mother to two young boys, ages 6 and nine. In her spare time, Patricia enjoys an active outdoor lifestyle. She enjoys running, waterskiing, tennis, and golf.

Featured Graduate Student: Regan Beckham

Regan Beckham hails from Hope, Arkansas, which he notes is generally recognized as home of the world's largest watermelon. He attended the University of Central Arkansas where he received his Bachelor of Science in Applied Mathematics in 2001. After finishing his undergraduate degree, Regan remained at Central Arkansas and completed a master's degree in Mathematics Education. Regan arrived at the University of Delaware in the fall of 2002 where he began working towards his doctorate in applied mathematics.

Upon his arrival at UD, Regan quickly became involved in a research project with Professor Phillip Broadbridge. This project built on techniques Regan had mastered as an undergraduate. In particular, he investigated the use of symmetry methods for the solution of non-linear partial differential equations. Upon the departure of Professor Broadbridge, Regan began working with his Ph.D. supervisor, Professor John A. Pelesko, on mathematical models of micro- and nanoelectromechanical systems. His first paper, recently submitted to the Journal of Differential Equations, applies symmetry techniques to the analysis of mathematical models of a particular class of microscale devices. Regan plans to finish his dissertation and graduate in December of 2007.

During his time at UD, Regan has become acknowledged as an exceptional teacher. For the past several years, Regan has been teaching courses in calculus and differential equations at the Charter School of Wilmington (CSW). This is part of an outreach effort begun by the department several years ago and allows talented high school students to take advanced mathematics courses while still in high school. Regan relishes the challenge presented by this opportunity and notes "Teaching at CSW has allowed me to work with young, talented students. I get the opportunity to push them beyond the normal high school experience and to help them become mature students, ready for the rigors of college, at an early age."

For his performance as a teacher, Regan has received two prestigious awards. In 2004, Regan received the Pyrros Memorial Teaching Award. This year, Regan was honored at UD's Honor's Day Ceremony as the recipient of the 2007 Excellence in Teaching Award for graduate students. This is a university-wide award whose winners are noted for deep commitment to high quality intellectually rigorous teaching and the positive lasting impact they make on their students.

We congratulate Regan on his outstanding achievements in both research and teaching and wish him the best of luck as he finishes his dissertation and with all of his future endeavors.

Department of Math Sciences
University of Delaware
Ewing Hall
Newark, DE 19716