

**University of Washington VIGRE Grant
Annual Report for 2005-2006
Loyce Adams, VIGRE Director**

Building on the strong foundations created by our first VIGRE grant, the three mathematical sciences departments at the University of Washington have closely collaborated to create an even richer and more stimulating environment for their students. During the second year of our new grant, VIGRE has funded numerous undergraduate research projects in all three departments, K-12 outreach activities to local schools, 34 graduate fellows who have created exciting new activities through cross-departmental committees, two graduate summer schools, travel for students to attend conferences and workshops, and our second VIGRE Distinguished Lecturer (Steven Strogatz of Cornell). The impacts have included an increase (over pre-VIGRE) in the number of majors in the mathematical sciences, better success in recruiting top graduate school candidates, a higher level of involvement by faculty in VIGRE-related efforts, and a palpable feeling of excitement among our students.

Our VIGRE website at <http://www.ms.washington.edu/vigre/> contains detailed information on our activities.

Undergraduate Projects. During 2005-06, VIGRE funded 33 undergraduate quarter-long projects generally supervised by faculty. This number is comparable with the 33 quarter-long undergraduate projects we funded in 2004-05. We are continuing to interest and engage undergraduates in research.

Tom Duchamp (Mathematics) and Werner Stuetzle (Statistics) jointly supervised David Kaplan on *Geometry of High Dimensional Data*. James Zhang (Mathematics) worked with Jerome Drescher on the *Computational Aspects of Non-commutative Geometry*. Nathan Kutz (Applied Mathematics) worked with Norris Berry on *Controlling and manipulating Bose-Einstein condensates* and with Joel Nishimura on the *Dynamics of optical parametric oscillators*. Bernard Deconinck (Applied Mathematics) supervised Nate Bottman on an investigation of the *Stability of nonlinear waves*. Another undergraduate, Firat Kiyak, working with Bernard Deconinck created a software package, SpectrUW, that finds the spectra of linear operators. This software is freely available at <http://www.amath.washington.edu/hill>.

Tatiana Toro and Virginia Warfield in Mathematics and two graduate students (Chris Kissel, Math and Randy Boucher, Amath) supervised eight undergraduates to help local public school teachers and their students conduct evening Math Fairs. This project involved several weeks of working with the teachers and students in their classrooms to understand a variety of math puzzles. The hope is this will become a self-sustaining activity sponsored by the Mathematics Department in the near future. A complete list of these projects is available on our website.

Undergraduate Mathematical Sciences Seminar. As part of our efforts to involve undergraduates across the spectrum of the mathematical sciences, in 2004-2005 we initiated a broadening of our undergraduate seminar (formerly the ACMS seminar) to appeal to students across all three departments. The new seminar is called the Undergraduate Mathematical Sciences Seminar, and it is organized and run by a committee of VIGRE graduate students. The 2004-2005 committee created a template for running a successful seminar that would keep undergraduates engaged and provide an opportunity for graduate students to develop their leadership skills. The template helps ensure high levels of attendance and uniformly well-received talks. The seminar gives one credit under the supervision of the ACMS director, Werner Steutzel of Statistics. This seminar was very successful and the template was again used in 2005-2006. Topics in 2005-2006 included: *Numerical Modelling of Extracorporeal Shock Wave Therapy Using Finite Volume Methods* by Kirsten Fagnan (grad student Amath), *Robust Pairwise Covariance Matrix Estimation* by Kjell Konis (grad student in Stat), *Sphere Packing and Error Correcting Codes* by Matthew Kahle (grad student in Math), *Oil, Earthquakes, and Terrorism: some days in the life of a Statistician* by Tim Hesterberg (Insightful Corporation), *A Career in Statistics* by Fritz Scholz (Boeing Company), *Analysis of Calving Seismicity of Taylor Glacier, Antarctica* by Josh Carmichael, (UW Geophysics grad student), and a day of undergraduate research talks organized by the Undergraduate Projects Committee and given by VIGRE sponsored undergraduates. A complete list is available from our website.

Graduate Student Travel. We feel very strongly that our graduate students, and even undergraduates, benefit enormously by travelling to conferences and workshops. They can present their own research to experts in the area, make informal contacts with faculty and students from other universities, and begin to form the networks of personal connections so important for professional development. Normally funds for student travel are severely limited, but VIGRE has enabled us to support many more students on such trips since with VIGRE funds we can leverage support from individual grants. Typically, we fund around 50 or so trips yearly with VIGRE funds. Trips this year included conferences on Algebraic Geometry and Physics, Supercomputing, Arithmetic-Algebraic-Symplectic Geometry, Statistics (NIPS in Vancouver), Matrix Eigenvalue problems, a PIMS-MITACS meeting, and special Banff conferences. VIGRE also has funded students to visit colleagues and work on joint projects. For example, Jason Slemons (Applied Math) is working on a problem recommended by Parlett at Berkeley for his thesis. He periodically visits Parlett (trips leveraged by other money) and Parlett visits Seattle.

Graduate Fellow Committees. One outcome of the third-year review of our previous VIGRE grant was the suggestion by graduate students themselves that they would like to work more closely together across departments. We developed the

idea of having groups of VIGRE students working together on committees targeting various areas. We have refined this idea over several years, and it has continued to be quite effective in not only initiating and carrying out ideas, but also in building collaborations across departments and in informing our students of different cultures in the mathematical sciences.

During 2005-2006, eight committees were active: Professional Development Forums (organizing professional development forums), VIGRE Distinguished Lecturer (inviting and organizing visits by outstanding researchers with a view to their interactions with our graduate students), Web Site (updating and maintaining the site), Undergraduate Projects (encouraging and publicizing the availability of VIGRE funding for undergraduate projects, both in the three departments and also other locations around campus), ACMS and Math Targeting (helping the ACMS Director develop a new brochure to recruit students into the ACMS major and advertising the math sciences programs more generally), Undergraduate Seminar (explained earlier), PIMS-VIGRE (determine which VIGRE proposals to fund for summer schools and PIMS-VIGRE projects), and the Problem of the Week (compose problems, post on web, check solutions, maintain statistics, and declare winners!). Some highlights of particular committees are explained more in what follows.

VIGRE Distinguished Lecturer. An idea developed during our first VIGRE grant was to let a group of VIGRE graduate fellows invite, organize, and run a visit by a distinguished researcher of particular interest to them. This provides our students with scientific contacts, prepares them in the nuts and bolts of organizing events, including budgets and support details, and gives them a chance to practice important leadership skills. Barry Mazur was our first VIGRE Distinguished Lecturer in 2004-05 and the visit was extremely successful.

In May 2006, Steven Strogatz of Cornell was hosted by the VIGRE fellows. He gave a joint Applied Mathematics and Mathematics colloquium entitled *Weird Phase Transition in a Randomly Grown Network*. He met with the graduate students in all three departments and talked with them about how to be successful researchers. This was very well received. The next night he gave a public lecture to a packed house based on his book *Sync*. The title of the talk was *Sync: The Emerging Science of Spontaneous Order*. This event was also great for putting mathematics in the spotlight within the University.

In the coming year, Hendrik Lenstra will be the VIGRE distinguished lecturer. This is currently advertised on our VIGRE web site. The students also have Margaret Wright and Ron Graham lined up for the future.

Problem of the Week. A new VIGRE Committee, started in Fall 2006, was organized by Bernard DeConinck (faculty, Applied Mathematics). DeConinck and a group of VIGRE fellows from all three departments posed weekly a mathematical

problem to the whole University of Washington community and beyond via the web-site <http://www.ms.washington.edu/challenge>. Problems are meant to be understandable to almost everyone on campus with their solution not requiring more than the ingenious use of calculus or lower level mathematics. The goal is to increase the visibility of the mathematical sciences on campus, and to attract students to major in math that might otherwise have not considered the option. DeConinck used this vehicle successfully at Colorado State. Already, the average page loads/day is 102, with 54 unique visitors each day. The number of average correct solutions for each problem is 15.6 (with mostly undergraduates and some graduate students and faculty). Peak days (when a new problem appears) have seen as many as 300 visitors to the web site. The winner each week is drawn from the set of correct solution with preference given to undergraduates. Winners get a five dollar gift certificate from Mix Ice Cream (our sponsor). In the long run, the Challenge of the Week would be an area-wide activity, through interactions with other local institutions. We would also like to advertise more broadly through local newspapers - say right beside the cross-word puzzle! Such an activity is an easily sustainable cross-departmental endeavor.

PIMS-VIGRE Sponsored Postdoc Professional Development Day. Loyce Adams, VIGRE PI, Alejandro Adem (PIMS Deputy Director), Tom Archibald (Chair, Math Dept, Simon Fraser University), Brian Marcus (Head, Math Dept UBC), and Brian Wetton (Math Dept, UBC) organized a day for the professional development of postdoctoral fellows in the Pacific Northwest. This meeting was held in Vancouver, Canada in October 2006. A description of the day's activities and slides of all the presentations can be found at

http://www.pims.math.ca/TheNews/Events/PIMS_Postdoc_Day.

Our VIGRE postdoc Helga Schaffrin Huntley as well as non-VIGRE postdocs participated in this professional development forum.

PIMS-VIGRE Sponsored Graduate Student Summer Schools. One new feature of our proposal was to use VIGRE funds, in cooperation with PIMS (the Pacific Institute of Mathematical Sciences) to run summer schools and workshops where University of Washington students could participate. In 2004-2005, PIMS-VIGRE sponsored two such workshops detailed in the 2004-2005 annual report. In 2005-2006, PIMS-VIGRE again sponsored two summer workshops for graduate students that were ramp-up workshops for a bigger meeting.

The first workshop, held in August 2006, was organized by Krzysztof Burdzy and Zhen-Qiang Chen of the Mathematics Department and was entitled *International Conference of Stochastic Analysis and Its Applications*. The conference had 60 participants which included 23 advanced graduate students or recent Ph.Ds. The goals were to survey changes in the field and to expose young researchers to the field's recent developments. Three tutorials were given by Masatoshi Fukushima, Davar Khoshnevisan, and Michael Roeckner. The research lectures and the tutorials can be

found at <http://www.math.washington.edu/~zchen/Conference/abstracts.html> and <http://www.math.washington.edu/~zchen/Conference/tutoriallabs.shtml>, respectively. Fukushima visited the University of Washington during July and August as a PIMS distinguished professor. He gave two tutorials and one research lecture at the conference. He also interacted with graduate students, in particular Ryan Card on the subject of diffusion processes in a domain that have diffusive motion on the boundary.

The second workshop, held September 2006, was organized by J. Nathan Kutz and Bernard Deconinck of the Applied Mathematics Department and was entitled *Stability and Instability of Nonlinear Waves*. This workshop's goals were to give an overview of current state-of-the-art methods for examining stability, present some widely applicable new techniques, and prepare students for the SIAM Conference on Nonlinear Waves and Coherent Structures that took place in Seattle immediately following the workshop. The workshop was aimed at graduate students and beginning researchers. It had 97 participants with 7 lecturers. The lecturers were Mariana Haragus (Dept. Mathematics, Universite de Franche-Comte), Todd Kapitula (Dept Mathematics and Statistics, University of New Mexico), Nathan Kutz and Bernard Deconinck (Dept. Applied Mathematics, University of Washington), Jens Rademacher (Dept. of Modeling, Analysis, and Simulation, Centrum voor Wiskunde en Informatica), Jeff Humphreys (Dept. Mathematics, Brigham Young University), and Harvey Segur (Dept. Applied Mathematics, University of Colorado, Boulder). The lecture notes can be found at <http://www.amath.washington.edu/~stability>. These notes will be made into a book that can be used by graduate students that want to study this area. The book will be edited by Kutz and Deconinck and will be available by summer 2007.

Postdoc Recruitment. We learned of VIGRE funding too late to appoint post-docs for 2004-2005. During 2005-2006, Aravind Asok became a VIGRE postdoc in Mathematics and Helga Schaffrin Huntley in Applied Mathematics.

Impacts. VIGRE continues to have large positive impacts on all three departments. Our undergraduate programs continue to attract students of very high quality with numbers dramatically higher than the pre-VIGRE years. The annual report for 2004-05 reports gives these numbers for past years. During 2005-06, we saw a slight dip, but overall the numbers continue to be much higher than in pre-VIGRE years.

As noted in the 2004-05 annual report, our undergraduates have been winning and placing highly in the Mathematical Contest in Modeling and the Mathematics Department has been recognized for Instructional Excellence. In the 2006 Mathematical Contest in Modeling, all four of our teams again won recognition — either meritorious or honorable mention.

The numbers of students and the awards they are winning is of note, but just as important to note is the way the culture of the three departments is changing:

- The culture has changed to broaden the education of the graduate students by involving them in cross-disciplinary committees and vertically integrated research.
- The culture has changed to include conference travel for graduate students.
- The culture has changed to include professional development as a goal for graduate students. Our students plan distinguished lecturer visits, plan and implement workshops for undergraduates, organize research seminars, and give talks at prestigious conferences. They also participate in the life of the department taking responsibilities that were once reserved for faculty which prepares them for life beyond graduate school. They participate in a community outside the university through special topics workshops in the Pacific Northwest, including ones jointly organized by PIMS, the Pacific Institute of Mathematical Sciences.
- The culture has changed to include service projects by VIGRE Fellows. Often these projects are aimed at undergraduate recruitment in the mathematical sciences, but often include outreach to the K-12 community.
- The culture has changed to include faculty that reach out to the K-12 community. One example of a sustainable effort driven by the Mathematics Department and the NSF GK-12 Program in Mathematics (Adams, PI; Warfield, Co-PI) is to run Math Fairs in local elementary schools. Warfield and Toro are developing a template that can involve any faculty member that wants to participate.
- The culture has changed to include the education of undergraduates and graduate students in summer school workshops (boot-camps) to prepare them to interact with the research community at major research meetings.

Assessment. Our on-going internal assessment is handled by our VIGRE Executive Committee, comprised of the five co-PIs (including the three current department chairs), the PIMS Site Director (Uhlmann), the ACMS Director (Stuetzle), and the three graduate program coordinators (Duchamp from Mathematics, Hoff from Statistics, and O'Malley from Applied Mathematics).

In order to get an independent assessment of how well our VIGRE program is meeting its goals, in April, 2006, we invited a team of three external scientists familiar with VIGRE at their own institutions to visit the UW campus for a day. These were Bill Symes from Rice University (the only other VIGRE site involving three departments), Deb Nolan of the University of California, Berkeley, Statistics Department, and Robert Greene of the Mathematics Department at UCLA. They met with groups of undergraduates, graduate students, postdocs, and faculty for frank discussions of how things are going. Their report to us was generally very positive. They did have some concrete and constructive suggestions for improvement, which we are in the process of implementing.

Dissemination. In April 2006, our VIGRE program sponsored the Seattle VIGRE Workshop. This was a Saturday meeting on the University of Washington campus to bring together representatives from many VIGRE sites and the NSF to discuss what has been learned from VIGRE nationally including its successes, its shortcomings, its nuggets, and its future. Seventeen universities were represented and Tom Russell, NSF, and Peter March (new DMS director) attended. Talks were limited to three (Peter May, Chicago), Bill Symes (Rice), and Tom Russell (NSF). The majority of the time was spent in discussion with concrete ideas and suggestions for the funding of graduate education in the future. Our postdocs and graduate students attended and participated in the discussions.