IV. INDUSTRIAL PROGRAMME

Participants at the 4th annual PIMS GIMMC enjoyed dry days and summer sunshine in Victoria.

PIMS/MITACS Industrial Partners

- Advanis
- Amber Computer Systems
- APPEGA
- Ballard Power Systems Inc.
- Barrodale Computing
- Bayer Inc.
- BC Cancer Research Center
- BC Hydro
- BioTools
- The Boeing Company
- Canadian Cable Labs
- Canadian Marconi
- Charles Howards & Associates
- Chemex Labs
- Computer Modeling Group
- Corel Corporation
- Crystar Research Inc.
- Diagnostic Engineering Inc.
- Dynapro
- Eastman Kodak
- Enbridge
- FinancialCAD Corporation
- Firebird
- Galdos Systems
- Harley Street Software
- Hughes Aircraft
- Husky Oil
- IBM Canada Ltd
- IBM T. J. Watson Res. Center
- ICBC
- Imperial Oil
- In Silico
- Insightful
- ISE Research Ltd.
- Integrated Flight Systems
- Kinetek Pharmaceuticals Inc.
- Itres Research Ltd.
- Lockheed Martin Canada
- Lockheed Martin Tactical Defense Systems
- Math Resources Inc.
- MathSoft
- MacMillan Bloedel Ltd.
- McMillan-McGee
- MDSI
- Menex Technologies
- Merak
- Michelin
- NALCO Canada Inc.
- NORTEL Networks
- Novacor
- PanCanadian Petroleum Ltd.
- Petro Canada
- Progas
- Powerex
- Powertech Labs Inc.
- Precision Biochemicals
- Prestige Telecommunications
- Quatronix Media
- Raytheon
- RSI Technologies
- Searle
- Shaw Cable
- Siemens Research
- Simons International Copr.
- SmithKline BeeCham Pharma
- Sperry-Sun
- Soundlogic
- StemCell Technologies Inc.
- StemSoft Software Inc.
- Stentor
- Stern Stewart & Co.
- Sun Microsystems
- Syncrude
- Telecom. Research Labs
- Telus
- TransAlta
- Veritas DGC
- VisionSmart
- Vortek Industries Ltd.
- Waterloo Maple Inc.
- Worker's Compensation Board

Industrial Problem Solving Programme

The format of the **Industrial Problem Solving Workshops** is mainly based on the Oxford Study Group Model, in which problems of relevant and current interest to the participating companies are posed to the workshop participants by experts from industry. The participating graduate students and academics will spend five days working on the problems and the results will be published in the workshop's proceedings. The advantages for participating students and academics are:

- The challenge of applying one's skills to new and relevant problems directly applicable to industry.
- The opportunity for continued collaboration with the workshop's academic and industrial participants.
- Help PIMS and mathematics in general, by showing businesses and governments the tangible benefits of supporting the mathematical sciences.

4th PIMS Industrial Problem Solving Workshop (IPSW 4)

University of Alberta, May 29–June 2, 2000

Organizers:
J. Macki (U. Alberta)
B. Moodie (U. Alberta)
M. Paulhus (PIMS/UC)

Industrial Participants:
Stern Stewart & Company
McMillian-McGee
Imperial Oil
Vision Smart
Michelin

5rd PIMS Industrial Problem Solving Workshop (IPSW 5)

University of Washington, June 18–22, 2001

Organizers:
Randy LeVeque (U. Washington)
Chris Bose (U. Victoria)
Huaxiong Huang (York U.)
Marc Paulhus (U. Calgary)
Keith Promislow (SFU)
Ian Frigaard (UBC)

Industrial Participants:
Microsoft Research
Firebird Semiconductors
Communications Security Establishment
Alberta Energy Company
IBM
Algorithmics

PIMS Industrial Problem Solving Workshop (IPSW 4), University of Alberta, May 29 – June 2, 2000

Organizers: J. Macki (U. Alberta), B. Moodie (U. Alberta), M. Paulhus (PIMS/UC)

More than 70 participants spent a full week working intensely on five problems posed by industrial companies from across North America. The fourth annual Industrial Problem Solving Workshop was hosted by the Department of Mathematical Sciences at the University of Alberta in Edmonton, May 29-June 2, 2000. Among the participants were 40 graduate students who had spent a week at a training camp hosted by Simon Fraser University. The students were truly representative of Canadian Universities–there were students from Memorial University of Newfoundland, McGill and Concordia Universities in Quebec, McMaster, Guelph, York, Toronto, and Western Ontario in Ontario, Manitoba, University of Saskatchewan and University of Regina, Universities of Alberta and Calgary, and in B.C., UBC, Simon Fraser, and the University of Victoria. (throw in New York University as well). Participating faculty also spanned the country.

On the last day, we received a pleasant surprise from the Canadian Mathematical Society. With some help from one of its spies present at the workshop, the CMS had selected UBC's Kyle Biswanger to win the CMS Leadership Award for his contributions to the workshop.

International Experts:

Dr. J. DeWynne (Oxford University)
Dr. H. Huang (York University, Toronto)
Dr. J. King (Nottingham University)
Dr. D. Ross (Kodak University)

Workshop Problems:

Designing Incentive-Alignment Contracts in a Principal-Agent Setting in the Presence of Real Options. Stern Stewart & Co. is a global consulting firm that specializes in helping client companies in the measurement and creation of shareholder wealth through the application of tools based on modern financial theory. The company pioneered the development of its proprietary EVA (Economic Value Added) framework, which offers a consistent approach to setting goals and measuring performance, communicating with investors, evaluating strategies, allocating capital, valuing acquisitions, and determining incentive bonuses that make managers think like owners.

How can we reward managers of firms for making decisions which involve reduced returns now for greater returns in the long run, maybe even after they have left? This problem generated considerable debate and intense analysis among three different subgoups, and each subgroup presented a report. Their mentor was Professor Jeff DeWynne from Oxford University, and expert on financial modelling. In addition, U. of Calgary Professors Dan Calistrate, Gordon Sick and Tom Cottrell all played a major role in the work.

Wellbore Modeling — Boundary Value Problems in the Recovery of Petroleum Fluids from an Oil Reservoir. McMillian-McGee is a Calgary based engineering company. The company works according to its motto: "The Power Behind Energy".

How do we most efficiently apply induction heaters in oil well shafts to increase the flow? Owner Bruce McGee is a U of A Engineering graduate, so he participated enthusiastically during the week. Led by mentor Dr. David Ross of Eastman-Kodak in Rochester, New York, the group developed some important new ideas and made significant progress.

Complex System Modelling: Application to Imperial Oil's Cold Lake Oil Sands Facilities. Imperial Oil is Canada's largest producer of crude oil and a major producer of natural gas. It is also the largest refiner and marketer of petroleum products – sold primarily under the Esso brand – with a coast-to-coast supply network. As well, the company is a major supplier of petrochemicals. Imperial Oil shares (IMO) are listed on the Toronto stock exchange and are admitted to unlisted trading on the American Stock Exchange.

If you have a huge oilfield with, say, 3,000 wells, which wells should you choose for steam injection to enhance the production of the field? Applied mathematicians in group immediately did the right thing–"Let's start with two well...". At the end, substantial progress was reported. The group was ably led by mentor Huaxiong Huang of York University. Imperial Oil sent three representatives for the full week, and company representative Glynis Carling kept the group entertained with her marvelouw sense of humour.

The Tennis Ball Problem. VisionSmart is a group of engineering professionals specializing in solving difficult industrial scanning problems. The company strives to provide customers with cost-effective, highly customized solutions integrating high-speed digital signal processing with state-of-the-art machine vision technology.

Using two cameras to take digital images of a tennis ball as it begins its flight, how accurately can we predict

the future trajectory? This group was assisted by mentor Professor John King, head of the Theoretical Mechanics Group at Nottingham University. They ended up doing a lot of basic trig and geometry (what is the optima placing of two cameras?), some engineering (use a laser to sight the cameras), and a lot of physics –people were busy reading articles on the trajectory of a ball when it is spinning. President Dan Kenway and company representative Wolfgang Engler spent the full week assisting the team, and progress was excellent.

General Statistical Design of Experimental Problem for Harmonics. The Michelin Group of companies make tires for all types of vehicles: from bicycles to the space shuttle, including cars, trucks, motorcycles, earthmover equipment, buses, subway trains and aircraft. Every day they produce more than 830,000 tires over a broad product range, with the smallest under 200 grams (0.5 pounds) and the biggest over 5 tons.

How do you find the vibration characteristics of each of the many layers of a tire when you can only determine the composite vibrations after the tire is made? One trick is to build many tires with the various layers rotated by specific amounts. What is the least amount of tires we need to construct? Michelin Engineer Bill Mawbry came all the way from Michelin's research group in South Carolina to spend the week with the team. Would you believe prime numbers play a role? The team which worked on this one, ably led by mentor Professor Michael Lamoureux of U. Calgary, made significant progress in solving this problem. Bill said that he could see direct savings of up to $500,000 a year from their work.

PIMS Industrial Problem Solving Workshop (IPSW 5), University of Washington, June 18–22, 2001

Organizers: Randy LeVeque (U. Washington), Chris Bose (U. Victoria), Huaxiong Huang (York U.), Marc Paulhus (U. Calgary), Keith Promislow (SFU) and Ian Frigaard (UBC).

This year's **Industrial Problem Solving Workshop** (IPSW) was held at the University of Washington in Seattle. About 100 people registered for the event, including the 58 graduate students who had taken part in the graduate modelling camp the week before. Faculty from a number of universities around the world were also involved. Participants split up into six groups to attack the industrial problems brought to the workshop, spanning a broad range of applications and mathematical techniques. Most of the industrial participants were able to stay all week this year, and were actively involved in working with the groups. A brief description of the problems and some of the progress made is given below. More complete problem descriptions may be obtained from the website, **www.pims.math.ca/industrial/2001/ipsw** and proceedings papers are being written by each group.

Workshop Problems:

Disk Layout Problem: Representing local Seattle industry, **John DeTreville** brought a problem from **Microsoft** on optimizing the layout of files on a disk, given an expected order in which the files will be accessed. The group learned a great deal about the complex details involved in hard drive technologies. They also quickly established that the problem was equivalent to the intractable Travelling Salesman Problem. After building some one- and two-dimension disk models, they applied various heuristic techniques to try to find the optimal solution for some sample data that Microsoft provided. It was concluded that the heuristic methods appear to provide better solutions more quickly using the 2-D model than with the 1-D model, suggesting that the more realistic 2-D (or the even more realistic 3-D model not studied) should be used when disk performance is critical. Current hardware limitations make the 1-D model the industry standard.

Model For InSb Czochralski Growth: Many of the participants who specialize in continuous modelling were attracted to the problem presented by **Bill Mickelthwiate** of **Firebird Semicondutors**, arising from growing large single crystals of Indium Antimonide (InSb) from a melt. These crystals, about the size of a wine bottle, may develop imperfections due to thermal stresses as they cool. This problem contained something for everyone in continuum mechanics – fluid dynamics coupled with convective, diffusive, and radiative heat transfer, Stefan problems for the moving phase boundary, and temperature-dependent stress analysis within the solid phase. This group split into several subgroups to tackle various aspects of the problem by both analytical and numerical approaches. Some new insights were gained into the expected shape of the moving boundary and the relative importance of different heat-transfer mechanisms.

Network Search Theory: Allan Douglas from the **Communications Security Establishment** brought a problem relating to computer security on the large computer networks, such as the internet. Mobile software

objects that move around between computers are becoming more common and the problem concerns the ability of the "good guys" to track down malicious software of this form. This led to an extensive literature search on problems of graph searching and random walks. The group discovered a vast and richly developed literature that was directly applicable to the problem at hand. They then expanded on that literature and established some new results based on the particulars of the problem.

Decline Analysis: **Ron Forth** presented a problem from the **Alberta Energy Company** on decline analysis, attempting to extrapolate trends in production rate data from oil and gas wells to forecast future production. The current practice is for a petroleum engineer to perform the extrapolation using visual curve fitting biased heavily by personal experience. The data is typically very noisy and has the additional feature that physical parameters in operation during the period of data collection are randomly changing (changes to pumping schedules, shutdowns, production enhancement, etc) so no one model can be expected to fit the entire time series. The workshop group concentrated on three aspects of the problem. First, the partitioning of the time series into intervals over which one physical model may be applied. Moving average and wavelet techniques were investigated; both seemed sufficient to perform the partition, provided reasonable thresholding values were used. Second, a curve fitting over each subinterval was performed. This was fairly straightforward as physical considerations lead to a parametric family of model curves and a simple, weighted, least-squares fit within that family appears to suffice. Finally a weighting of the various extrapolations obtained in the previous step determines the final decline curve estimate. A heuristic weighting scheme was proposed and tested with reasonable results on a restricted data set. The possibility that this last step would lend itself to a neural-net approach was discussed.

Web Hosting Service Agreements: **Alan King** of **IBM** brought a problem on properly pricing web-hosting service agreements. A web-hosting service provider may have a large number of clients with different needs, and a finite amount of computer resources to distribute amongst those customers in order to satisfy certain Quality-of-Service (QoS) agreements. However, the web-hosting service can also dynamically reallocate its resources based on the observed needs of its clients at any given time. The team tackled this extremely complex problem and built a very realistic model taking into account a wide range of complexities such as requests of different size with different priorities, time-lag in the hardware re-distribution, as well as penalties for failing to meet the QoS agreements.

A Problem in Financial Mathematics: The final problem came from **Algorithmics**, a financial mathematics firm. **Alex Kreinin** presented a problem on measuring the credit risk of a given portfolio, based on the credit ratings of the obligors. Standard Monte-Carlo techniques do not work very well since the interesting events (default by the obligors) are very rare and hence require a large number of simulations. Algorithmics came to the workshop with a very well thought out model and everyone was pleasantly surprised that the group discovered an analytical solution based on using the Lindberg-Feller Theorem (basically the Central Limit Theorem in this context) to approximate the credit risk of all counterparties in a single (credit driver) scenario. This resulted in approximating the risk across scenarios by a mixture of Gaussians, the latter being one of the current methods for treating distributions with long tails. The group then proceeded to test this fast, approximate solution against much more time-consuming full Monte Carlo simulations for one time step. They found reasonable agreement and expect much better results for longer time horizons since the CLT is better suited when the number of independent random variables increases. This was viewed as a significant development in the important area of credit risk, and we look forward to seeing it developed further.

A Glimpse at 2002

MITACS Annual General meeting
UBC, May 23–25, 2002

6th Industrial Problem Solving Workshop
UBC, May 27–31, 2002

PIMS-MITACS Workshop on Facility Location Problems,
SFU, June 8–11, 2002

Workshop on Design and Analysis of Experiments,
Coast Plaza Suites Hotel,
Vancouver, July 14–18, 2002

Participants in IPSW 2001 outside the Miller Building at the University of Washington.

Industrial and Scientific Training Activities

Basic Components of Programme:

The PIMS Graduate Industrial Mathematics Modeling Camp: Graduate students from Canadian universities come to learn various aspects of high-level techniques for solving industrial mathematics problems. The camp prepares them for:

The PIMS Summer School in Industrial Fluid Dynamics: The participants attend a comprehensive series of graduate-level lectures and are also given hands-on experience performing and analyzing experiments in the Environmental and Industrial Fluid Dynamics Laboratory, as well as running numerical simulations using research-level codes.

The IAM-CSC-PIMS School in Industrial Math for Senior Undergraduates shows students how the mathematics they are learning can be useful. Faculty mentors lecture on various industrial problems to all the participants. Subsequently, the students have the option of choosing one or more problems to work on during the three-day workshop.

The PIMS/MITACS Undergraduate Industrial Case Study Workshop giving students in their senior year the opportunity to compete in a 3-day industrial case study competition.

The Industrial Workshops and Mini-courses with topics of interest to both industry and academia serve to disseminate newly developed mathematical tools that can be of use in industry. The workshops are more interactive than the mini-courses.

3rd PIMS Graduate Industrial Math Modeling Camp
SFU, May 23–27, 2000
Coordinator: Keith Promislow (SFU)

4nd PIMS Graduate Industrial Math Modeling Camp
University of Victoria, June 11–15, 2001
Coordinator: Chris Bose (U. Victoria)

2nd PIMS Summer School in Fluid Dynamics
University of Alberta, July 30 – August 11, 2000
Organizers: B. R. Sutherland (U. Alberta) and T. B. Moodie (U. Alberta)

3rd PIMS Fluid Dynamics Summer School
PIMS at the University of Alberta, May 27 – June 8, 2001
Organizers: B. R. Sutherland (U. Alberta) and T. B. Moodie (U. Alberta)

IAM-PIMS Senior Undergraduate Industrial Math Workshop
UBC, February 18–20, 2000
Organizers: Anthony Peirce (UBC) and Michael Ward (UBC)

IAM-CSC-PIMS Senior Undergraduate Math Modelling Workshop
PIMS-UBC & PIMS-SFU, February 17–18, 2001
Organizers: R. Russell (SFU) & B. Shizgal (IAM)

PIMS/MITACS Undergraduate Industrial Case Study Workshop
Centre for Operations Excellence at UBC, October 25–29, 2001
Organizers: M. Puterman (Commerce and Business Admin, UBC) and Stephen Jones (COE, UBC)

Statistical Genetics and Computational Molecular Biology Workshop
Univ. of Washington, December 16–18, 2001
Organizer: Elizabeth Thompson (UWashington)

Month of Industrial Math at PIMS: A wealth of opportunities for Canadian and US graduate students

The month of June 2001 witnessed a succession of scientific events in industrial mathematics at PIMS. More than 300 researchers, graduate students and senior undergraduates came from 25 Universities in Canada and the US to learn, research, interact, network and solve industrial problems at several interrelated events. The timetable was configured so that visiting students could participate in more than one of the worskhops.

The program started by the *PIMS-MITACS-Ballard Inc. Workshop on Computational Dynamic Fuel Cells* at Simon Fraser University held on June 4–8. This was organized in conjunction with the **PIMS Center for Scientific Computing**.

This was followed on June 9-10, by a PIMS-NSF-MITACS Workshop on *Inverse Problems and Imaging* at the PIMS facility at the University of British Columbia. This was organized in conjunction with the **PIMS Center for Inverse Imaging and Applications**.

Between June 11–15, the 4th PIMS Graduate Industrial Mathematics Modelling Camp was held at the University of Victoria. This year, 20 US graduate students were admitted to the program in addition to the customary 40 Canadian participants. As usual, it was followed by the 5th PIMS Industrial Problem Solving Workshop held this year at University of Washington in Seattle June 18–22.

John Chadam wrote to the organizers: "Just wanted to thank you all for your efforts in organizing three wonderful workshops. All three were intellectually stimulating and exceptionally well run. Hope I see you all soon in the east."

3rd PIMS Graduate Industrial Math Modeling Camp, Simon Fraser University, May 23–27, 2000

Organizers: K. Promislow (SFU), M. Kropinski (SFU) and S. Jungic (SFU)

Forty-one graduate students came from North America came to SFU to work five mentors from industry. Almost all the students came from 16 universities across Canada, however one came from as far away as New York University. The mentors were:

Rachel Kuske (University of Minnesota)
Colin Please (University of Southampton)
David Ross (Eastman Kodak)
Donald Schwendeman (Renssalar Polytechnic Institute)
Brett Stevens (IBM)

The problems examined over the course of the programme were:

- Catalytic Converter: A Simple Mathematical Solution to Understanding Operation
- Queue Compatible Gray Codes and Applications
- Optimal Design of a Micro-Electrical-Mechanical Systems Actuator
- Temperature Effects on a River or Estuary Due to the Construction of a Power Station
- Optimal Policies for Disk Controllers

4rd PIMS Graduate Industrial Math Modeling Camp, University of Victoria, June 11–15, 2001

Organizers: Chris Bose (Ui. Victoria), Randy LeVeque (University of Washington), Huaxiong Huang (York University), Mark Paulhus (University of Calgary), Keith Promislow (Simon Fraser University) and Ian Frigaard (University of British Columbia).

From June 11–15, the University of Victoria hosted the fourth annual **PIMS Graduate Industrial Math Modelling Camp** (GIMMC). The students followed up with a second week of industrial mathematics at the IPSW in Seattle, June 18–22. A record 58 students attended the Camp, led by 8 academic mentors on a selection

of industrial problems. This year's hardworking mentors were:

Sergei Bespamyatnikh (UBC)
John Chadam (Univ. of Pittsburgh)
Ian Frigaard (UBC)
Lisa Korf (U. Washington)
Hedley Morris (San Jose State)
Tim Myers (Univ. of Capetown)
Miro Powojowski (Algorithmics Corp.)
Moshe Rosenfeld (Univ. of Washington)

The problems examined over the course of the programme were:

- Problems in Portfolio Analysis
- Locating Watchtowers in Terrains (PDF)
- Modelling a metal spray forming process
- Web-hosting Service Agreements
- Defect analysis using Depth from Defocus methods
- Modeling Ice Accretion
- Risk Neutral Probability Measure
- Optimal Control of Streetlight Networks

John Chadam

As with previous camps, students from all regions of Canada were eligible to attend. This year the programme was expanded to include 60 invited participants, up from the usual cap of 40. Further, in recognition of our newest PIMS institution, University of Washington, a special effort was made to attract students from US universities. In all, we had more than 130 applicants to the Camp, and we accepted participants representing 25 North American Universities. Thirty-nine participants were from Canada and the remaining 19 were from the United States. Many favourable comments were collected from our mentors attesting to the excellent academic preparedness and to the enthusiasm of the students.

Increased exposure throughout North America given to this year's Camp will result in even more applications next year.

Graduate students doing numerical simulations.

2nd PIMS Summer School in Fluid Dynamics, University of Alberta, July 30 – August 11, 2000

Organizers: B. R. Sutherland (U. Alberta) and T. Bryant Moodie (U. Alberta)

Participants at the Second Annual PIMS Summer School in Fluid Mechanics will attend a comprehensive series of lectures and will be given hands-on experience performing and analyzing experiments in the Environmental and Industrial Fluid Dynamics Laboratory, as well as running numerical simulations using research-level codes. Topics will include fluid dynamics fundamentals, industrial and environmental flows, geophysical fluid dynamics, turbulence modelling and computational fluid dynamics. Subjects will be taught at the graduate level.

Invited Speakers:

Paul F. Linden (UC San Diego)
James C. McWilliams (UCLA)
Frans T. W. Nieuwstadt (Delft University of Technology)

Core Lecturers:

John C. Bowman, *Turbulence Modelling*
Andrew B. G. Bush, *Climate Modelling*
Peter Minev, *Computational Fluid Dynamics*
T. Bryant Moodie, *Wave Theory*
Bruce R. Sutherland, *Stratified Flows*
Gordon E. Swaters, *Physical Oceanography*

3rd PIMS Fluid Dynamics Summer School, PIMS at the University of Alberta May 27 – June 8, 2001

Organizers: B. R. Sutherland (U. Alberta) and T. Bryant Moodie (U. Alberta)

Eighteen graduate students from all over the world attended a comprehensive series of lectures, and were given hands-on experience performing and analyzing experiments in the Environmental and Industrial Fluid Dynamics Laboratory, as well as running numerical simulations using research-level codes. Topics included fluid dynamics fundamentals, industrial and environmental flows, geophysical fluid dynamics, turbulence modelling and computational fluid dynamics. Subjects were all taught at a graduate level.

This year's summer school was particularly rewarding for the students since it was held in conjunction with a PIMS Thematic Programme on Wave Phenomena and Fluid Dynamics. Special invited speakers were T. G. Shepherd (Univ. of Toronto) who spoke on *The Fluid Dynamics of the Middle Atmosphere* and H. J. S. Fernando (Arizona State) who spoke on *Turbulence and Mixing in Stably Stratified Fluid Layers.*

The Core Lecturers for the courses were **John C. Bowman** (Univ. of Alberta), *Turbulence Modelling*; **Andrew B. G. Bush** (Univ. of Alberta), *Climate Modelling*; **Peter Minev** (Univ. of Alberta), *Computational Fluid Dynamics*; **T. Bryant Moodie** (Univ. of Alberta), *Wave Theory*; **Bruce R. Sutherland** (Univ. of Alberta), *Stratified Flows* and **Gordon E. Swaters** (Univ. of Alberta), *Physical Oceanography.*

IAM-PIMS Senior Undergraduate Industrial Math Workshop, University of Brtish Columbia, February 18–20, 2000

Organizers: Anthony Peirce (UBC) and Michael Ward (UBC)

The workshop's goal was to show students how the mathematics they are learning can be useful. It ran for three days during which time faculty mentors firstly outlined each of the industrial problems (such as a tumor imaging problem) to all the participants. Each one of the students had the option of choosing one or more problems to work on during the three day workshop. Lectures on each of the problems were presented by the mentors in which the tools for the modeling and analysis of the problem were developed. The mentors then helped groups of approximately eight students to develop the models and answer the questions posed. The workshop culminated with a brief presentation by each of the groups working on the chosen problems. The mathematical tools used in the workshop were accessible to third and fourth year undergraduates in mathematics, applied mathematics, physics and applied science. The workshop also proved to be an excellent opportunity to meet students from across BC and Canada.

IAM-CSC-PIMS Senior Undergraduate Math Modelling Workshop, PIMS-UBC and PIMS-SFU February 17–18, 2001

Organizers: Bernie Schizgal (UBC) and Bob Russell (SFU)

The annual SFU-UBC-PIMS Senior Undergraduate Math Modelling Workshop was held on February 17 and 18, with Saturday's portion organized by UBC's **Institute for Applied Mathematics** and Sunday's by SFU's **Centre for Scientific Computing.** The students came from across Canada — Acadia, University of Western Ontario, University of Alberta, University of Calgary, University of British Columbia, Memorial University of Newfoundland, McGill University, University of Toronto, York University, and SFU.

On Saturday, the students were given the choice of working on one of three projects: *Nonlinear Heat Conduction in the Microwave Heating of Ceramics* with Michael Ward (Math, UBC), *An Analytical and Numerical Study of Solitary Waves (Solitons)* with Bernie Shizgal

(Chemistry, UBC and Director of the Institute for Applied Mathematics) or *Modelling the Flight Path of a Softball* with Douw Steyn (Earth and Ocean Science, UBC).

On Sunday, the students were given the choice of participating in one of two projects: *Liquid Mobility in Fuel Cells* run by Keith Promislow (Math, SFU) with help from Ron Haynes (Math Ph. D. student at SFU) or *Visualizing A Snowstorm* run by Dave Muraki (Math, SFU) and Torsten Moeller (Computing Science, SFU).

Both days of the workshop were highly successful, with the mentors being rewarded by an enthusiastic and lively response from the students. For more information, see **pims.math.ca/industrial/2001/suimw**.

Participants in the IAM-CSC-PIMS Senior Undergraduate Math Modelling Workshop.

PIMS/MITACS Undergraduate Industrial Case Study Workshop, Centre for Operations Excellence at UBC, October 25–29, 2001

Organizers: Martin Puterman and Stephen Jones (UBC)

Selected students in the summer preceding their senior year are invited by PIMS and MITACS to compete in a 3-day industrial case study competition. Fifteen students from across North America, in undergraduate programmes such as Engineering, Mathematics, Statistics, Computer Science and Economics, will be chosen for this intensive three-day industrial case study competition. Business problems will be selected to require mathematical analyses, complemented with problem formulation, problem solving, and presentation skills.

This workshop is designed to:

- Introduce students to current research initiatives and industrial problems in the operations research sector.
- Provide a unique opportunity for students to work in teams to solve challenging problems with mathematical and business content.
- Allow industry executives the opportunity to become acquainted with students and evaluate them for potential future employment.
- Inform students of the exciting opportunities for graduate studies in applied math and operations research.

For more information and registration please see **http://pims.math.ca/industrial/2001/uicsw**.

Statistical Genetics and Computational Molecular Biology, University of Washington, December 16–18, 2001

The programmes in **Statistical Genetics** and **Computational Molecular Biology** at the University of Washington will host a Workshop in Statistical Genetics and Computational Molecular Biology. The workshop is aimed at students from the mathematical, computational, and statistical sciences who may be considering graduate study and research in these areas of mathematical and computational biology. The intended participants are primarily undergraduate seniors or first-year graduate students at Colleges and Universities of the Pacific Northwest Region or Western Canada. PIMS will provide support for graduate students from the PIMS universities.

Topics will be in computational molecular biology, genomics, statistical genetics, and bioinformatics. Lectures will be given by: **David Baker** (Biochemistry, Univ. of Washington) *Protein Structure Prediction*; **Joe Felsenstein** (Genetics, Univ. of Washington); **Jinko Graham** (Statistics and Actuarial Science,

SFU) *Testing and Estimation of Recombination Breakpoints in a Set of Aligned Sequences*; **Phil Green** (Molecular Biotechnology, Univ. of Washington) *Analyzing Genome Sequences*; **Kathleen Kerr** (Biostatistics, Univ. of Washington) *Gene Expression Microarrays: Classical Statistics and Modern Genomics*; **Leonid Kruglyak** (FHCRC); **John Mittler** (Microbiology, Univ. of Washington); **Stephanie Monks** (Biostatistics, Univ. of Washington); **Jim Mullins** (Microbiology, Univ. of Washington) *Genomics is Solving Problems in Infectious Diseases*; **Maynard Olson** (Univ. of Washington Genome Center) *Resequencing Segments of the Human Genome: Experimental and Statistical Considerations*; **Steve Self** (or other representative from the Bioinformatics Group of the FHCRC); **Elizabeth Thompson** (Statistics, Univ. of Washington) *Inferring Gene Locations from Genetic Data on Pedigrees*; **Martin Tompa** (Computer Science and Engineering, Univ. of Washington) *An Exact Algorithm to Identify Motifs in Orthologous Sequences from Multiple Species*; and **Ellen Wijsman** (Division of Medical Genetics, School of Medicine, U.Washington).

A Glimpse at 2002

3rd IAM-CSC-PIMS Senior Undergraduate Math Modelling Workshop,
UBC and SFU,
February 16-17, 2002

1st School of mathematical biology for senior undergraduates,
University of Alberta,
May 11–19, 2002

5th Graduate Industrial Math. Modeling Camp
SFU, May 18–23, 2002

Summer school in Applications of Computational Geometry,
SFU, June 3–7, 2002

4th School of environmental and industrial fluid dynamics,
University of Alberta,
July 28–August 9, 2002

Industrial Collaborative Projects

The Industrial Collaborative Program supports innovative research in the mathematical sciences which is driven by industrial applications and which will lead to new, creative mathematical and statistical results to be available to industry and for wide dissemination. A critical component in these collaborative projects is the active involvement of both academic researchers to guide the scientific research, and industrial partners to focus the project on industrially relevant problems. The PIMS contribution is directed towards the support of highly qualified personnel (graduate students, postdoctoral fellows and research assistants) in the mathematical sciences working directly on the activity.

Industrial Postdoctoral Fellowship Programme

Central to the PIMS strategy is the identification of industrial projects that can be tackled by young mathematical scientists.

Jointly supervised by PIMS scientists working in concert with their industrial counterparts, PIMS postdoctoral fellows split their time between the university and the company, exchanging intellectual ideas between these two domains. The PDFs are expected to participate in the PIMS industrial workshops and conferences. They act as the conduit for dissemination of knowledge between the industrial partner and the university research group.

PIMS Industrial Postdoctoral Fellows for 2000/2001

The following projects have been supported in 2000/2001.

1. **Hongwei Long**
   Industrial Partner: Lockheed Martin
   Sponsors: Mike Kouritzin (U. Alberta)
   Project: Markov Chain Methods of Filtering
2. **Sun Wei**
   Industrial Partner: Lockheed Martin, Vision Smart and APR
   Sponsors: Mike Kouritzin (U. Alberta)
   Project: Filtering for Diffusions in Random Environments
3. **Joseph Mmbaga**
   Industrial Partner: Paprican
   Sponsors: Bob Hayes (Chemical Engineering, U. Alberta)
   Project: Computer Modelling of Forward Roll Coating
4. **Simon MacNair**
   Industrial Partner: Powerex
   Sponsors: U. Haussmann (UBC)
5. **Alexandra Chavez-Ross**
   Industrial Partner: In Silico
   Sponsors: L. Keshet (UBC)
6. **Matias Salibian-Barrera**
   Industrial Partner: Mathsoft
   Sponsors: Ruben Zamar (Statistics, SFU?)
   Project: Data mining
7. **Sviatoslav Pelipenko**
   Industrial Partner: Schlumberger
   Sponsors: Ian Frigaard (Math, UBC)
8. **Janez Ales**
   Industrial Partner: Maple
   Sponsors: M. Monagan (SFU)
9. **Brett Stevens**
   Industrial Partner: IBM
   Sponsors: L. Goddyn (SFU)

MITACS: A Network of Centers of Excellence in the Mathematical Sciences

Founders of MITACS: Nassif Ghoussoub, Don Dawson, Steve Halperin. Missing is Luc Vinet (seen below).

Mathematics of Information Technology and Complex Systems (MITACS) is one of the three new Networks of Centers of Excellence (NCE) created in 1998. The MITACS NCE is a joint venture of the three Canadian mathematical sciences institutes: the Centre de Recherches Mathématiques, the Fields Institute in Mathematical Sciences and the Pacific Institute for the Mathematical Sciences. MITACS harnesses mathematical power for the benefit of the Canadian economy. The network brings together more than 150 researchers at 22 Canadian universities with more than 70 Canadian industrial, medical, and financial organizations. The network comprises 23 projects addressing problems in five sectors of the Canadian economy, including two new projects funded in 2000.

Luc Vinet

The creation of the MITACS network provides an exceptional opportunity for the mathematical sciences community to develop a large scale systematic programme for research, HQP training and the development of partnerships with key business, industrial and health care sectors across the country.

Arvind Gupta,
MITACS
Programme Leader

MITACS Projects at PIMS

There are 21 ongoing MITACS projects across the country in five themes. Here are the current 11 projects coordinated by PIMS:

Pseudodifferential Operator Theory in Seismic Imaging

Leaders: Dr. M. Lamoureux (Math), Dr. G. Margrave (Geophysics), University of Calgary

Members: R. Aggarwala (Math, U. Calgary), W. Allegretto (Math, U. Alberta), J. Bancroft (Geophysics, U. Calgary), L. Bentley (Geophysics, U. Calgary), P. Binding (Math, U. Calgary), A. Calvert (Earth Sciences, SFU), R. Ferguson (Chevron), S. Gray (Veritas D.G.C.), C. Laflamme (Math, U. Calgary), P. Lancaster (Math, U. Calgary), L. Lines (Geophysics, U. Calgary) , E. Nyland (Physics, U. Alberta), M. Slawinski (Mechanical Eng, U. Calgary), M. Sacchi (Physics, U. Alberta), J. Sniatycki (Math, U. Calgary), D. R. Westbrook (Math, U. Calgary)

Industrial Affiliates: Consortium for Research in Elastic Wave Exploration Seismology, including AEC, BP-Amoco, Chevron, Pan Canadian, Petro-Canada, Talisman, Veritas D.G.C., Imperial Oil, Shell and others.

Mathematical Modeling in Pharmaceutical Development

Leader: Dr. J.A. Tuszynski, Physics, U. Alberta

Members: Dr. G. de Vries (Math, U. Alberta), Dr. G. A Dumont (Elec. & Computer Engg., UBC), Dr. M. Klobukowski (Chemistry, U. Alberta), Dr. B. MacLeod (Anaesthesia, Pharmacology & Therapeutics, UBC), Dr. J. Muldowney (Math, U. Alberta), Dr. K. Rubenson (CHET, Education, UBC), Dr. J. Samuel (Pharmacy & Pharmaceutical Sc., U. Alberta), Dr. Y. Tam (Pharmacy & Pharmaceutical Sc., U. Alberta), Dr. D. Wiens (Stats Centre, U. Alberta), Dr. D. Bevan, Dr. D. Quastel, Dr. C. Ries, Dr. M. Sutter, Dr.M. Walker, Dr. J. Wright

Industrial Affiliates: Drs. Y.K. Tam and D. Ridgway (Kinetana), Dr. R.R. Koganty (Biomira, Inc.), Mr. Willaim Gough (Universal Dynamics Technologies), Dr. M. Huzmezant (M.I.H. Consulting Group), Dr. W. de Brouwer (Starlab, Belgium)

Other Affliates: Canadian-European Research Initiative on Nanostructure (Belgium), Drs. P.L. Christiansen and E. Mosekilde (Inst. of Math. Modeling, Danish Technical University), Dr. Y. Engelborghs (Biomolecular Dynamics, K. U. Leuven), Dr. M. Kimmel (Stats, Rice University) Jim Laukes (Psychology, U. Arizona), Dr. E. Unger (Molecular Biotechnology, Jena, Germany),

Modeling, Trading and Risk in the Market

Leader: U. Haussmann (Math, UBC)

Members: L. Bates (Management, U. Calgary) M. Barlow (Math, UBC) M. Buchko (Trader, Powerex Corporation) D. Druce (Research Scientist, BC Hydro) D. Glassco (Chairman & CEO, Financial CAD Corporation) C. Gui (Math, UBC) A. Lari-Lavassani (Math, U. Calgary) J. Liu (Math, UBC) N. Ghoussoub (Math, UBC) M. Margolis (Head Trader, Powerex Corporation) A. Peirce (Math, UBC) E. Perkins (Math, UBC) G. Sick (Finance, U. Calgary) J. Walsh (Math, UBC) O. Walsh (Director of Financial Engineering, Fiancial CAD Corporation)

Industrial Affiliates: Financial CAD, Powerex Corporation, BC Hydro, Transalta

Biomedical Models of Cellular and Physiological Systems in Health and Disease

Leader: L. Keshet (Math, UBC)

Members: Dr. G. de Vries (Math, UA), Dr. D. Finegood (Kinesiology, SFU), Dr. R. Miura (Math, UBC), Dr. J. Piret (Biotech Lab, Chemical Eng, Bioresource Eng, UBC), Dr. E.Puil (Pharmacology, UBC) Dr. D. Schwarz (Research Director, Dept of Surgery, UBC), Dr. C. Shaw (Opthalmology, UBC), Dr. Y. Xian Li (Math, UBC) Dr. M. Mackey (Math, McGill)

Industrial Affiliates: Bayer Inc., InSilico Biosciences, Kinetek Pharmaceuticals, Precision Biochemicals, StemCell Technologies, SmithKline Beecham, BC Cancer Research Center.

Symbolic Analysis

Leader: P. Borwein (Math & Stats, SFU)

Members: F. Bergeron (Math, Université de Québec à Montréal), J. Borwein (Math & Stats, SFU), R. Corless (Math, UWO), S. Devitt (Waterloo Maple Inc), D. Jeffrey (Math, UWO), L. Jorgenson (Math & Stats, SFU), M. Lamoureux (Math & Stats, U. Calgary), M. Monagan (Math & Stats, SFU), J. Stafford (Math, UWO), S. Watt (Math, UWO)

Industrial Affiliates: Math Resources, Sun Microsystems, Waterloo Maple

Mathematical Methods for Modeling, Verification and Testing in Information Technology

Leader: B. Kapron (CS, U. Victoria)

Members: M. Cheng (CS, U. Victoria), J. Delgrande (CS, SFU), M. Greenstreet (CS, UBC), A. Hu (CS, UBC), P. Panangaden (CS, McGill)

Industrial Affiliates: Nortel Networks

Prediction in Interacting Systems

Leader: M. Kouritzin (Math, U. Alberta)

Members: D. Blount (Math, Arizona State University), J. Bowman (Math, U. Alberta), D. Dawson (Director, Fields), R. Eliott (Math, U. Alberta), S. Feng (Math, McMaster), K. Fleischmann (Math, U. Alberta), E. Gombay (Math, U. Alberta), A. Heunis (Engineering, Waterloo), A. Jouan (Research and Development, Lockheed Martin-Montial), B. Kapron (CS, U. Victoria), B. Leininger (Lockheed Martin Tactical Defence Systems at Eagan), R. Mahler (Lockheed Martin Tactical Defence Systems at Eagan), C. Poling (Lockheed Martin Tactical Defence Systems at Eagan), N. Prasad (Math, U. Alberta), B. Remillard (Université du Québec à Trois Rivihres), B. Schmuland (Math, U. Alberta), E. Shahbazian (Lockheed Martin-Montréal), S. Shen (Math, U. Alberta), Y. Shu Wong (Math, U. Alberta),

Industrial Affiliates: Advantis, Lockheed Martin Canada, Lockheed Martin Tactical Defence, VisionSmart

Facility Location Optimization

Leader: B. Bhattacharya (School of Computer Sciences, Simon Fraser University)

Members: P. Bose (CS, Carleton U.), J. M. Keil (CS, U. Saskatchewan), D. Kirkpatrick (CS, UBC), T. Shermer (CS, SFU), J. Snoeyink (CS, UBC), G. Toussaint (CS, McGill U.)

Industrial Affiliates: Soundlogic, Quatronix.

The Mathematics of Resource Allocation and Scheduling

Leader: P. Hell (CS and Math & Stats, SFU),

Members: B. Alspach (Math & Stats, SFU), J. M. Bourjolly (Concordia), W. Cunningham (C & O, U. Waterloo), L. Goddyn (Math & Stats, SFU), A. Gupta (CS, SFU), L. Hafer (CS, SFU), R. Krishnamurti (CS, SFU), W. Pulleyblank (Director, Math. Sciences, T.J.Watson Labs, IBM), M. Queyranne (Manag. Sci, UBC)

Industrial Affiliates: Amber Systems, HA Simons, IBM, Prestige Telecommunications

Probabilistic Mathematical Models for Complex Industrial Systems

Leader: M. Puterman (Commerce, UBC)

Members: D. Atkins (Commerce, UBC), J. Bookbinder (Waterloo), C. Boutilier (CS, UBC), H. Chen (Commerce, UBC), M. Gendreau (Université de Montréal), B. Lamond (Université Laval), J. McGill (Queen's U.), D. Lawson (Commerce, UBC),

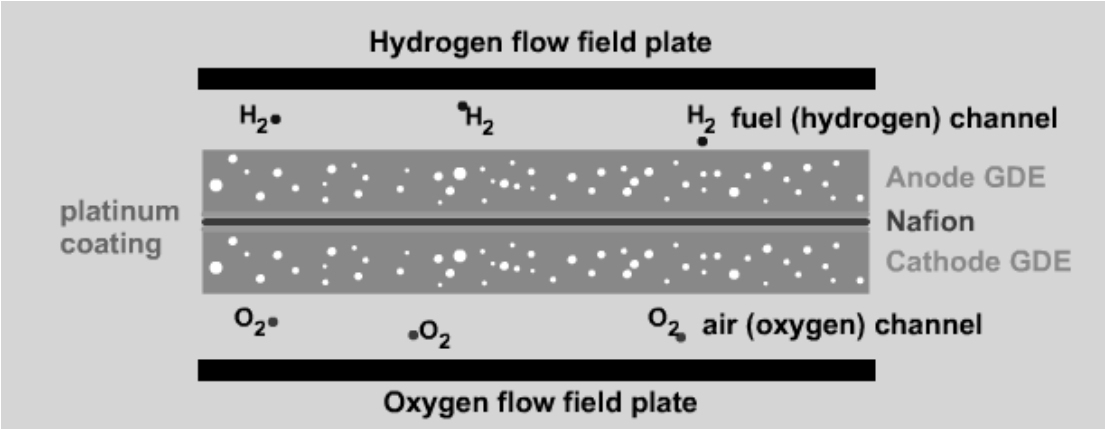
Industrial Affiliates: BC Tel, Canadian Airlines, Workers Compensation Board of BC

Mathematical Modeling and Scientific Computation

Leader: B. Wetton (Math, UBC),

Members: R. Choksi (Math & Stats, SFU), H. Huang (Math, York U.), M. C. Kropinski (Math & Stats, SFU), A. Peirce (Math, UBC), K. Promislow (Math & Stats, SFU), B. Russell (Math & Stats, SFU), B. Seymour (Math, UBC), M. Ward (Math, UBC), R. Westbrook (Math & Stats, U. Calgary)

Industrial Affiliates: Ballard Powersystems, Powertech Labs, Vortek Industries



MITACS-Ballard Power Systems Collaboration: Condensation and water management are crucial issues in fuel cells. Sufficient water must be present to keep the membrane (typically Nafion) wet. Too much water will block pores and prevent gases diffusing to the catalyst sites. Condensation modeling in porous media is complicated by the capillary pressure, the pressure difference between gas and liquid phases. The widely used models of capillary pressure for wetting media are not valid in the teflonated carbon fibre paper of the GDE. In addition, the modeling and computation of the movement of boundaries between wet and dry zones inside the GDL present a considerable scientific challenge.

PIMS affiliated MITACS Postdoctoral Fellows (2000/2001)

1. Ales Janez, Simon Fraser University
2. Bespamyatnikh Sergei, University of British Columbia
3. Bradean Radu, Simon Fraser University
4. Cao Jun Simon Fraser University
5. Chavez-Ross Alexandra, University of British Columbia
6. Cheb-Terrab Edgardo, Simon Fraser University
7. Derbez Eric, UQATR
8. Desharnais Josee, University of Victoria
9. Enns-Ruttan Jennifer, University of British Columbia
10. Ferguson Ron, Simon Fraser University
11. Glenn David, University of Michigan
12. Gibson Peter, University of Calgary
13. Gusev Y., University of British Columbia
14. Klassen Matt, Simon Fraser University
15. Kononov Alexander, Simon Fraser University
16. Lewis Gregory, University of British Columbia
17. Lewis Mark, Georgia Institute of Technology
18. Li Ruisheng, University of Alberta
19. Long Hongwei, University of Alberta
20. Lyder David, University of Alberta
21. MacNair S., University of British Columbia
22. Novruzi Arian, University of British Columbia
23. Pen Y., University of Calgary
24. Ram Gaur Daya, Simon Fraser University
25. Sadeghi A., University of Calgary
26. Sinha Sanjoy, University of Alberta
27. Solomon Andrew, Simon Fraser University
28. Spiros Athan, University of British Columbia
29. Stacho Ladislav, Simon Fraser University
30. Stamicar R., University of British Columbia
31. Stevens Brett, Simon Fraser University
32. Sun Wei, University of Alberta
33. Ware Tony, University of Calgary
34. Wenpin Jiao, University of Victoria
35. Wehner Stephan, Simon
36. Xia Y., University of Calgary
37. Yan L., University of British Columbia
38. Yao Zhengsheng, University of Calgary
39. Zhang Xue-Wu, University of British Columbia