Teacher-student relationships

PhD student **Robin Averill** is exploring effective teacher-student relationships in Year 10 mathematics classrooms and their connection with mathematics learning. The project explores three ways in which teachers care for students: as individuals; for their mathematics learning; and as culturally located people.

Averill is aiming to discover key features of these aspects of caring, and the students' perceptions of their importance for their mathematics achievement. Participating in the study are six teachers and their classes, from three schools, made up of predominantly Maori, Pasifika and New Zealand European students.

It is thought that understanding how caring relationships are established and maintained is important to help improve students' access to mathematics learning during secondary school and in their future study. *Anna Meyer*

Minimum-energy distortions

When a material is physically changed from one form into another, such as by heating or stressing, it is expected that it will deform in such a way that a minimum of energy is spent.

Recently, important connections have been established between finding minimum-energy deformations, and problems in a branch of mathematics known as the calculus of variations.

The results of research in this area indicate that in certain cases, no minimum-energy deformation can be obtained, even though visually and intuitively it would be expected that this would be possible.

PhD student **Maarten Jordens** aims to show that minimum-energy deformations do not exist outside certain ranges, and that when they do, they are of a certain form. *Anna Meyer*

How the heart functions

PhD student **Vicky Wang** is studying how the left ventricle of the heart adapts its structure and function during cardiac disease. In diabetes or myocardial infarction, the heart cells adapt to physiological, geometric and loading changes in the heart muscle. This leads to thickening or thinning of the ventricular wall, and enhancement or degradation in regional muscle function.

Wang's project involves formulating mathematical models of left ventricle geometry and function, using clinical MRI data.

The new methodology and results from the project will provide an improved understanding of the underlying structural basis of ventricular mechanics in both normal and pathological conditions, and will reduce the number of human studies required to investigate cardiac disease and treatment in the future. *Anna Meyer*

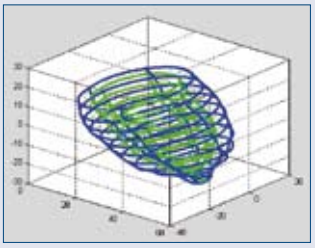
Modelling childbirth

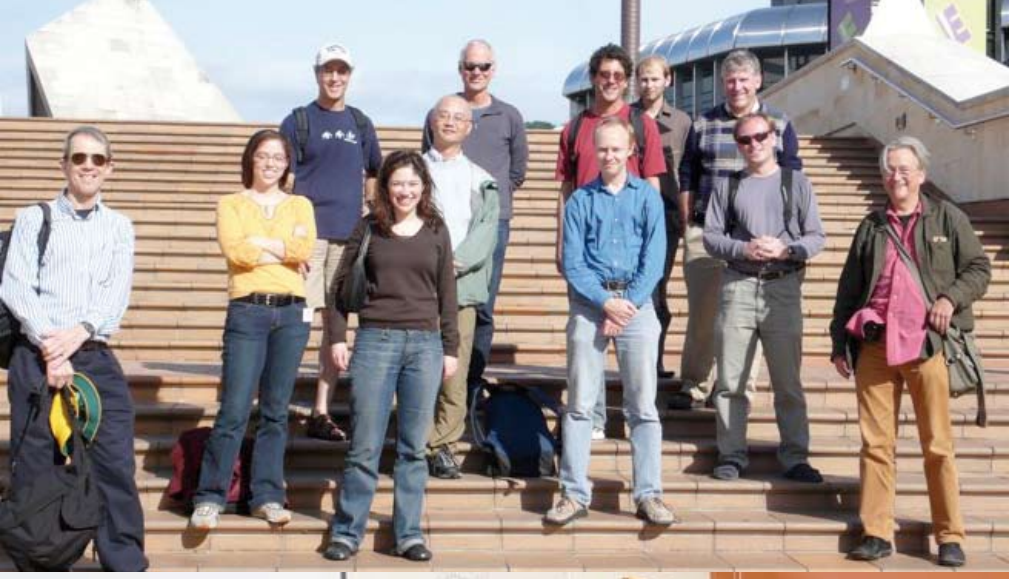
Research has suggested that female athletes involved in high-intensity sports for sustained periods have a higher probability of experiencing a prolonged second stage of labour during childbirth compared to non-athletes.

The mechanisms underpinning this complication are unclear, but may depend on the size or tone of the pelvic floor muscles. PhD student **Shannon Li** is studying the relationship between the size and tone of the pelvic floor muscles and the level of difficulty during childbirth. This involves generating anatomically realistic models of the pelvic floor for a female athlete and a non-athlete, as well as the fetal skull. So far, an initial modelling framework has been constructed to simulate the motion of the fetal head during delivery. *Anna Meyer*

Is mathematics an act of creation or an act of discovery? Many mathematicians fluctuate between feeling they are being creative and a sense they are discovering absolute scientific truths.
Marcus de Sautoy, Music of the Primes.

Wang's model of deformation of the heart





Top: Dillon Mayhew and James Oxley convened the special session on Matroids, Graphs and Complexity; members at the City to Sea Bridge. Centre: Special session on Group Theory, Actions and Computation speakers, convened by Russell Blyth and Marston Conder. Below: Vaughan Jones, Rod Downey, Ruth Charney (AMS Vice-President) and Gaven Martin (NZMS President) enjoy the opening ceremony.

AMERICAN AND NEW ZEALAND MATHS SOCIETIES MEET

Almost 300 international and New Zealand participants enjoyed over 200 high quality presentations at the first Joint Meeting of the American and New Zealand Mathematical Societies, held in Wellington in December.

Plenary lectures were given by four speakers from the US and four from New Zealand – with all of the latter being principal investigators of the NZIMA (Marston Conder, Rod Downey, Gaven Martin and Matt Visser). In addition, 20 keynote lectures and 205 other talks were presented in 15 special sessions. A notable feature was the unexpected degree of connection between the talks, especially around the themes of computation and computability.

Special sessions covered a wide range of pure and applied mathematics as well as the history and philosophy of mathematics and mathematics education. These sessions enabled communities of researchers to interact, and start or continue collaborations. Significant progress was made on many problems and projects as a result of collaborations organised at the meeting.

Peter Humphries and Ratneesh Suri jointly won the Aitken Prize for best talk by a student; the inaugural New Zealand Mathematical Society (NZMS) Early Career Award went jointly to Noam Greenberg and Catherine McCartin; and the annual NZMS Research Award to Ernie Kalnins.

The meeting was supported by grants from the AMS and the NZMS; the NZIMA provided travel support worth a total of $6,000 to 14 graduate students as well as sponsoring one of the plenary speakers, Bruce Kleiner of Yale University.

Planing the crew

Oliver Weide is the latest in a procession of University of Auckland operations research students whose research has been implemented at Air New Zealand.

The airline first collaborated with Professor David Ryan, Weide's PhD supervisor and an NZIMA board member, in 1984. This led to the airline being the first to operate a computerised crew schedule.

Weide's research focused on integrating the airline's aircraft and crew schedules. Crew tours of duty and rosters were still worked out after aircraft routes are fixed, which limited the options.

"Flight schedules are cheaper if there are short turnarounds between flights. But when crew have to swap planes with tight turnarounds, a short delay in one flight can cause a chain of delays in many other flights. We developed a robustness measure for each connection in the previous Air New Zealand summer schedule, which penalised crew changing aircraft; the shorter the ground time, the higher the penalty.

"We integrated aircraft routing and crew tours of duty by going back and forth between the two problems iteratively. Each iteration increased the penalties for crew changing planes, making the solutions more robust, and resulting in much cheaper and more robust schedules."

The Optima Corporation has implemented the measure for Air New Zealand.

Jenny Rankine

NOTABLE MATHS PROBLEMS

TWIN PRIME CONJECTURE

There are infinitely many primes p such that p + 2 is also prime.

Simply: That the number of prime numbers that differ by two, such as 101 and 103, is infinite.

Discipline: Number theory.

Originator: Euclid, around 300BC.

Incentive: Being the first to solve a 2,300-year-old problem.

Partial proofs: In 1915, Norwegian mathematician Viggo Brun showed that the sum of reciprocals of the twin primes was convergent. This famous result was the first use of the Brun sieve and helped initiate the development of modern sieve theory, a set of techniques designed to estimate the size of sifted sets of integers.

From 1940, Paul Erdős showed that there is a constant $c < 1$ and infinitely many primes p such that $(p' - p) < (c \ln p)$ where p' denotes the next prime after p. This result was successively improved by Helmut Maier, Daniel Goldston and Cem Yildirim.

In 1966, Chinese mathematician Chen Jingrun used sieve theory to show that there are infinitely many primes p such that p + 2 is either a prime or the product of two primes, now known as Chen primes. Terence Tao and Ben Green built on this to show that there are infinitely many three-term arithmetic progressions of Chen primes.

Mathematicians believe the twin prime conjecture to be true, based on numerical evidence and the probabilistic distribution of primes.

Unusual aspect: Because it is easily understood by non-mathematicians, the twin prime conjecture is a popular target for pseudo-mathematicians who attempt to prove or disprove it, sometimes using only high-school mathematics.

NZIMA connection: Marcus du Sautoy, visiting Maclaurin Fellow in 2007, for whom the distribution of prime numbers is a major interest.

Awards and honours

ROD DOWNEY, one of the NZIMA principals and our first Maclaurin Fellow, has been elected a Fellow of the Association for Computing Machinery (FACM), for his contributions to computability and complexity theory, and he has also been awarded a James Cook Research Fellowship for 2008-2010.

ERNIE KALNINS, a key member of our new programme on Conformal Geometry, won the New Zealand Mathematical Society's Research Award for 2007, for his work on symmetries of PDEs, separable co-ordinates and superintegrable systems.

JOHN KERNOHAN, a member of the NZIMA Governing Board, won the 2007 Thomson Medal of the Royal Society of New Zealand, for outstanding and inspirational leadership in the management of science.

THE OPTIMA CORPORATION, a spin-off company created by NZIMA principal David Ryan and his colleagues, won one of four Technology Commendations from the Foundation for Research, Science and Technology in 2007, for the development of software systems for optimal use of resources by Andrew Mason and his team.

DAVID RYAN, a member of our Executive Committee and co-director of our programme on transportation modelling, has been elected to a Fellowship of the Institute for Operations Research and the Management Sciences (INFORMS).

MIKE SAUNDERS (Stanford), a member of our International Scientific Advisory Board, was elected an Honorary Fellow of the Royal Society of New Zealand in November 2007.

MATHEMATICAL EVENTS

16 - 20 June, Dunedin
Conference on Permutation Patterns, www.cs.otago.ac.nz/staffpriv/mike/PP2008/

7 - 8 July, Hamilton
New Zealand Statistical Association Conference 2008, http://nzsa.rsnz.org/NZSA2008/index.htm

14 - 18 July, Auckland
GLADE 2008 conference on numerical methods for differential equations and related problems, www.auckland-ode-2008.org/

21 - 25 July, Auckland
GLADE 2008 workshop on numerical methods for differential equations and related problems, www.auckland-ode-2008.org/

4 - 8 August, Massey, Albany
Research workshop on Parabolic Geometry and PDE, www.math.auckland.ac.nz/wiki/Research_Workshop_on_Parabolic_Geometry

8 - 12 December, Christchurch
7th Australia-New Zealand Mathematics Convention, www.math.canterbury.ac.nz/ANZMC2008/

15 - 19 December, Auckland
4th International Conference on Combinatorial Mathematics and Combinatorial Computing, http://www.cs.auckland.ac.nz/research/groups/theory/4ICC/index.html

Because it is so useful, people think that mathematics only exists for its use, but actually that is not true. The development of maths is one of the rich streams of intellectual history. *Geoff Whittle, Wellington*