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NEWSLETTER

OF THE

NEW ZEALAND MATHEMATICAL SOCIETY

Contents

PUBLISHER'S NOTICE

This newsletter is the official organ of the New Zealand Mathematical Society Inc. This issue was edited by Miguel A Moyers González and Phillip L Wilson. Editorial enquiries and items for submission to this journal should be submitted as plain text or LaTeX files with "NZMS newsletter" in the title of the email to phillip.wilson@canterbury.ac.nz. LaTeX templates are available upon request from the editors.

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The newsletter is available at: nzmathsoc.org.nz/?newsletter

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EDITORIAL

After a cold and somewhat wet winter in Ōtautahi spring starts to creep in and longer days are upon us. With a springtime cheer we deliver our second to last issue of the Newsletter. Do not forget that the New Zealand Mathematical Society Colloquium will be held at the University of Otago from 4–6 December 2018, see page 28 for information about registration and abstract submission deadlines.

Miguel Moyers and Phil Wilson

Photo by Meriç Dağlı on Unsplash.com.

PRESIDENT'S COLUMN

Mathematicians throughout New Zealand regularly engage in public outreach activities, including public lectures, presentations in schools, activities at open days, and the spectacular Maths Craft (mathscraftnz.org) events of the last few years.

These activities are important. They provide opportunities to convey some of the fun of mathematics to the wider public, showcase ways in which mathematics is useful in tackling challenges that face our communities and our planet, and highlight the importance of basic research in mathematics for many breakthroughs in technology. In a nutshell, outreach activities are our chance to show the public that mathematics is relevant and important, as well as creative and fascinating, and could be regarded as a core responsibility for our community. Of course, we are often overwhelmed by teaching, research, grant writing, attending conferences, pastoral care of students, and a vast range of administrative tasks associated with strategic and operational priorities of our employers; it is no wonder, then, that outreach activities often take a back seat.

The next meeting of the Council of the NZMS (in early September) will have a focus on outreach. The Council will be assessing what activities currently occur across NZ and what else we might add to the mix, with the aim of sharing good ideas and discussing the role of the NZMS in supporting outreach. You are all invited to contribute ideas for the discussion. I would welcome hearing about the activities you have been involved in and their relative merits, as well as ideas for the future; feel free to email me with any comments. If you have strong feelings or great ideas about the direction the NZMS should be taking with outreach, consider joining us for the Council meeting to share your ideas; again, just email me to let me know you are interested.

A new international outreach opportunity is currently being developed by the IMU, which is lobbying for March 14th ("Pi Day") to be designated International Day of Mathematics by UNESCO. The IMU envisages that countries around the world will organise activities for that day, in schools and with the public, centred on a common theme. The overall aim is to highlight the importance of mathematics and mathematics education as a tool for development towards the achievement of the Sustainable Development Goals of the 2030 Agenda of the United Nations. It is hoped that the proposal will be adopted by UNESCO in time for the first International Day of Mathematics to be held in 2020, and more information should be available later this year. The NZMS has given its support to the proposal and it is not too soon to start thinking of the kinds of activities we could have in NZ.

The website for the 2018 NZMS Colloquium is now up and running: nzmathsoc.org.nz/colloquium2018. I encourage you to attend the Colloquium, which will be held December 4–6 in Dunedin. In addition to having a fine slate of plenary speakers, the Colloquium will once again feature an Education Day, which provides an opportunity for interaction between mathematicians in the tertiary and secondary education sectors. I hope to see you in Dunedin.

Vivien Kirk

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EDUCATION

Do you think New Zealand has its Education system right? Are there changes you would like to see? What about the Maths education of a general New Zealander? The Government has launched a review of NCEA (National Certificate of Educational Achievement) and wants to hear your opinions.

The NZMS Education group has developed the following foundational goal for our approach to the review:

> All students should experience mathematics and statistics teaching and learning that leads to the development of problem solving, reasoning, conceptual understanding and fluency. This should be underpinned by confidence and competence in the skills of mathematics and statistics, including using data and transferring skills to other contexts. Teachers and schools need to be given the systematic support and tools to enable this.

The NZMS Education Group uses an online collaboration tool, Loomio, where you can engage with us as we develop our ideas around maths education in NZ. Please join us for ongoing, asynchronous discussions: loomio.org/join/group/1YMTrBpaMET6uDPrpo3szjhC/.

The government wants to hear from all stakeholders — NZ citizens, parents, teachers, university staff, etc. Both the quantity and quality of voices matter. *Your voice matters.* Please take the time to engage with the review: conversation.education.govt.nz/conversations/ncea-have-your-say.

Rachel Passmore, secretary of the NZMS Education group, Professional Teaching Fellow in Foundation Mathematics at the University of Auckland, and Past President of the Auckland Mathematical Association, gives more information about the government review and how you can engage with it below.

NCEA Review — Have your say!

The Minister for Education, Hon. Chris Hipkins, has launched an extensive review of NCEA, with the areas of over-assessment of students and teacher workload identified as the most important issues to address.

Earlier this year the Minister commissioned an Advisory Group of "innovative thinkers" to begin the review and to put together some issues for further discussion. Their output was "six big ideas" that they regarded as potential opportunities for NCEA.

A national "conversation" about NCEA was formally launched by Chris Hipkins in May 2018 at two Education summits held in Auckland and Christchurch. A team of professional facilitators were engaged to conduct public meetings and focus group sessions around the country. A substantial information pack was distributed to every secondary school and other stake holders around the country. A website, conversation.education.govt.nz/, was established which contains a vast array of information about aspects of NCEA, plus surveys to complete, and different online conversations for people to join.

This consultation process continues until **16th September 2018** when the public consultation phase will close. So there is still time for you to have your say!

Six Big Ideas

These are:

1. **Reducing the number of credits at Level 1 from 80 to 40 credits.**

   Twenty credits to come from numeracy and literacy, and 20 credits to come from a project. It is not clear whether the numeracy/literacy split is to be 10 credits from each or even if the numeracy credits have to be obtained from Mathematics Achievement Standards. Some schools are abandoning Level 1 assessment completely in order to reduce the assessment burden on students and teachers.

   Reducing the number of numeracy credits at Level 1 to some proportion of 20 is concerning, particularly as it is not clear that these credits will necessarily be from Mathematics. Any student who is limited to 10 credits or less at Level 1 has seriously diminished their options for the future.

   Teachers tend to be divided on the project component with some thinking it a great idea and others seeing it as the beginning of a dilution of their subject. Significant professional development will be required for all teachers to manage projects well.

2. **Strengthen literacy and numeracy.**

   Literacy and numeracy requirements should be established at a level that allows a student to be successful in life. No mention is made of allowing a student to be successful in their tertiary study, but it would be good to hear mathematicians' views on what they feel students should know before they arrive at University.

3. **Ensure NCEA Levels 2 and 3 support good connections beyond schooling.**

   The focus of this is the transition from school to the workplace which is the path taken by the majority of school leavers (only 9% of the adult population participated in tertiary education in 2017, with only 3.3% of those participating in Bachelor level courses).

4. **Make it easier for teachers to refocus on learning.**

   Strengthen teaching practice, while reducing workload and stress.

5. **Record of Achievement should be clearer.**

   Families, employers and tertiary providers need a more informed understanding of a student's strengths and weaknesses. As an ex-secondary school Mathematics teacher, I can interpret a record of achievement but I know many of my colleagues at University are unable to see the significance of which Achievement Standards have been studied and which have not; nor can they interpret the differences in ability reflected in the grades Achieved, Merit and Excellence. *I firmly believe that any student wishing to pursue tertiary study should regard an Achieved grade as insufficient.*

6. **Fairer assessment conditions.**

   Currently a student that sits one external exam receives the same time allocation as a student that sits three external exams. Internal assessment conditions have also come under close scrutiny. Some have called for internal assessments to be externally marked so that a consistent standard is adhered to and teacher workload reduced.

In addition, there has been discussion of changing the **University Entrance** qualification or indeed abandoning it all together. University Entrance is rather a misnomer in that it does not guarantee entry to any University programme. Many programmes and courses have already all but abandoned University entrance, specifying their own entry requirements, which usually exceed the level specified by University Entrance.

The 2012 National Government's Better Service target of 85% of students attaining Level 2 NCEA by 2017 resulted in schools adopting some strategic manoeuvres. Any Achievement Standard that was perceived as "difficult" was to be avoided in preference of "easier" Achievement Standards worth a similar number of credits, regardless of whether the content of that Achievement Standard was central to the wider understanding of the discipline. As a consequence, students may attain University Entrance and arrive at tertiary institutions with significant gaps in their knowledge.

I think abandoning the University Entrance qualification would allow tertiary institutions to be more prescriptive about the preparation students require for their programmes, which in turn should result in higher pass rates and improved student retention. A blanket University Entrance qualification has meant that students feel "entitled" to study whatever they like at University whether or not they are adequately prepared. Under-prepared students can and should still be accepted but require guidance about appropriate preparation courses first.

So how can you have your say?

Ministry of Education website
conversation.education.govt.nz/

NZMS Education Group Loomio
loomio.org/join/group/1YMTrBpaMET6uDPrpo3szjhC/

Or email me, I'd love some feedback on any aspect of NCEA: r.passmore@auckland.ac.nz.

Rachel Passmore
August 2018

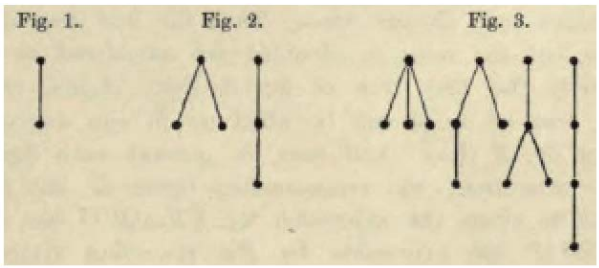
Rachel Passmore received one of two awards for Early Career Research Excellence at the International Conference on the Teaching of Statistics, Kyoto, 8–13 July, 2018.

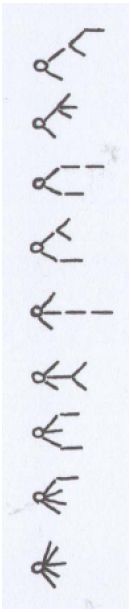
Sione Ma'u

MATHEMATICAL MINIATURE

MM45: Drawing Trees

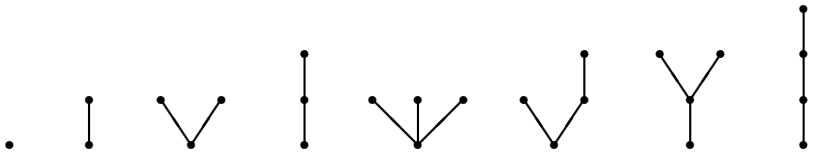
Arthur Cayley was both a lawyer and a mathematician until he was elected as the first Sadleirian Professor of Pure Mathematics at Cambridge University. He could then give up his lucrative legal career and become a full-time mathematician. Amongst his many achievements was the introduction of the word "tree" into mathematics [1]. Some drawings from his famous paper are given below



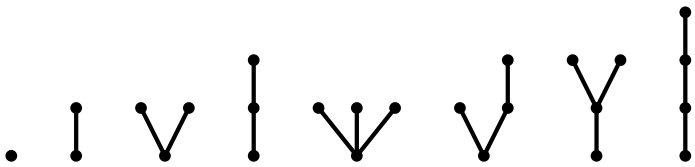


One hundred years later, Merson [2] also used trees in studying differential equations. Some of his diagrams are shown on the right.

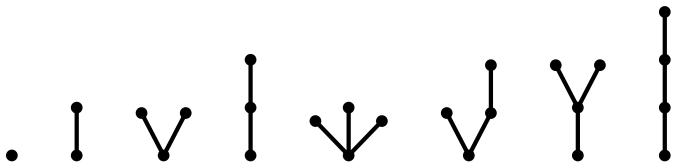
In the TEX/LaTeX age, we don't need to draw diagrams, like trees, by hand. To start with, we have the very simple picture environment, and trees can be drawn very conveniently with this tool.



The picture environment is very restrictive and has been superseded by pstricks. However, this is not as portable as we might want; it can't even be used in this Newsletter. Better to use tikz.



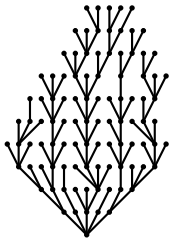
In my own attempts to put trees into things I write, I have become a little dissatisfied with pictures like this. I think I might prefer all edges to be represented by lines of the same length. Here is how this looks



Which looks better – edges of fixed height or edges of fixed length? I would welcome opinions on this question. Here is a further example tree, reproduced from MM43:

I repeat a challenge. Can you guess what is interesting, at least to me, about this particular tree? A very slight hint might come from the poem "Abou Ben Adhem" by Leigh Hunt.

Sometimes it is useful to draw a haphazard tree with very high order, to illustrate some generic property. Here is an example:



It is possible to code a picture like this into lines such as

00000 00655 44000
00000 06545 45400
00000 65454 54540
00065 46540 50654
00565 46546 54540
05435 46546 57650
65465 46546 54654
07665 57654 55430
00076 66544 43000
00000 76543 00000
00000 00100 00000

In this code, 5 denotes a vertical line downwards from a point on one of the lines, 6 denotes a line terminating one step to the right, and 4 one step to the left, and so on. It is relatively easy to draw a complicated tree with this mechanism.

J.C. Butcher
butcher@math.auckland.ac.nz

References

1. Cayley, A.: On the theory of the analytical forms called trees. Phil. Mag. **13**, 172–176 (1857)
2. Merson, R.H.: An operational method for the study of integration processes. Proc. Symp. Data Processing, Weapons Research Establishment, Salisbury, S. Australia, (1957)

MATHEMATICAL MISEPONYMY

The Jordan Curve Theorem

The Jordan Curve Theorem (JCT), named for Camille Jordan (1838–1922), states:

> Any simple closed curve in the plane divides the plane into two pieces, an inside and an outside, each having the curve as its boundary.

Some explanation is needed. By a **curve** is meant the continuous image of the interval $[0,1]$ of real numbers between 0 and 1 (including the end points); there is no assumption of smoothness. By saying that it is **closed** we mean that the images of 0 and 1 are the same and **simple** means that 0 and 1 are the only two points which map to the same place. If we take the interval $[0,1]$ and identify the end points before even mapping onto the plane we end up with a circle which topologically might as well be $\mathbb{S}^1 = \{(x,y) \in \mathbb{R}^2 \,/\, x^2+y^2 = 1\}$, $\mathbb{R}^2$ being the plane of the JCT. This leads to another formulation of the JCT:

> If $e : \mathbb{S}^1 \to \mathbb{R}^2$ is an embedding then $\mathbb{R}^2 \setminus e(\mathbb{S}^1)$ consists of two components each having $e(\mathbb{S}^1)$ as its boundary.

There is a discussion of the JCT in [4] with some delightful examples of simple closed curves

Now it is nearly impossible to decide who first formulated the JCT. To quote from [5],

> This is the mathematical formulation of a fact that shepherds have relied on since time immemorial!

Maybe Larry Siebenmann went a bit far in going back to time immemorial, but surely at least 10,000 years ago. In his article [6] Siebenmann notes that Jordan first presented the JCT in 1887 at [3, pp 587–594]. In between these two came Bernard Bolzano (1781–1848) and, if not providing a modern formulation of the JCT he surely comes close to it[1]. At [2, p 281] there is reference to an unpublished manuscript *Anti-Euklid* of Bolzano that, according to Johnson, was "only recently discovered ... stemming from the late 1830's or early 1840's."[2] At [2, p 285] the author gives the following translation of a statement in *Anti-Euklid*:

> If a closed line lies in a plane and if by means of a connected line one joins a point of the plane which is enclosed within the closed line with a point of the plane which is not enclosed within it, then the connected line must cut the closed line.

While the language here might not be as precise as in the statements above it seems pretty clear that Bolzano's lines need not be straight so are curves as discussed above, and probably should not cross themselves. Bolzano runs a line from one component to the other so is really looking at path connectedness instead of connectedness but in a locally path connected space (as $\mathbb{R}^2 \setminus e(\mathbb{S}^1)$ above is) the two concepts are the same. The only complaint I have is that Bolzano does not seem to say that $\mathbb{R}^2 \setminus e(\mathbb{S}^1)$ consists of two components though surely even that is at least implicit in his statement. Since $1848 < 1887$ it seems that Bolzano should get as much credit for the statement of the JCT as does Jordan.

Though Bolzano calls his statement Lehrsatz it seems that he did not present a proof (was the margin too small?) so we need to skip to Jordan for this. As Siebenmann notes at [6, Section 3], whether Jordan presented a complete proof of the JCT or not has triggered lots of debate, with a strong school of thought claiming that he did not. However others claim that his proof is sound, see in particular [1]. In fact these days it is quite easy to present a complete proof at a fairly elementary level. I presented a complete proof in a 50 minute talk to a group of mostly undergraduates years ago, assuming that they knew little more than some basic topological notions such as continuity, compactness and connectedness in the plane. Email me if you would like a copy of my write-up of this.

David Gauld

[1] I am grateful to Alexandre Gabard of Geneva for pointing this out to me.

[2] Appointed a professor at the University of Prague at the age of 24, Bolzano's popularity as a lecturer didn't save him from dismissal 14 years later for his anti-war views. After that his mathematical studies were mostly conducted in exile under tight publishing restrictions.

References

[1] Thomas C Hales, *Jordan's proof of the Jordan Curve Theorem*, Studies in Logic, Grammar and Rhetoric **10 (23)** (2007), 45–60.

[2] Dale M Johnson, *Prelude to dimension theory: the geometrical investigations of Bernard Bolzano*, Archive for History of Exact Sciences **17** (1977), 262–295.

[3] Camille Jordan, *Cours d'analyse de l'École Polytechnique, Tome III, Calcul Intégrale*, Gauthier-Villiars, Paris, 1887.

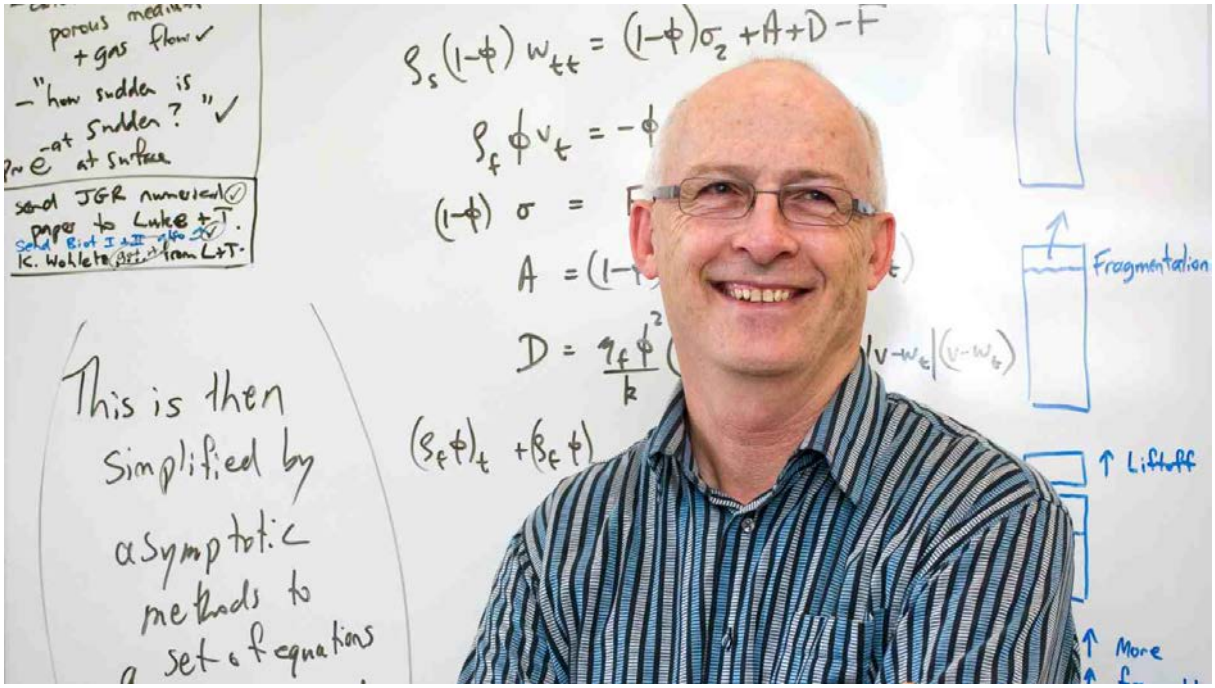
[4] Fiona Ross and William T Ross, *The Jordan Curve Theorem is nontrivial*, in *The best writing in mathematics 2013*, Mircea Pitici (ed), Princeton University Press, 2014.

[5] Laurent Siebenmann, *Letter to Andrew Ranicki*, 19/11/2005. Found at http://www.maths.ed.ac.uk/~v1ranick/jordan/readme.pdf

[6] Laurence Siebenmann, *The Osgood-Schoenflies theorem revisited*, Russian Mathematical Surveys 60(4):645 (2007). Found at https://www.researchgate.net/publication/230994655_The_Osgood-Schoenflies_theorem_revisited

PROFILE

Mark McGuinness



Professor Mark McGuinness exemplifies New Zealand's fine tradition of mathematical modelling and industrial mathematics. As Chair of the Australia and New Zealand Industrial and Applied Mathematics division (ANZIAM), as a Director of Mathematics-in-Industry NZ (MINZ), and as a long-standing Councillor and sometime Treasurer of this Society, Mark has worked tirelessly for the betterment of industrial and applied mathematics and for the sheer pleasure of doing it. Wherever there is a mathematics-in-industry study group, it is more than likely that Mark will have had a hand in its activities.

Mark graduated with a Fist Class Honours degree in Physics from the University of Canterbury in 1975 and, three years later, completed his PhD thesis there, titled "Infinite sets of polynomial conserved densities for nonlinear evolution equations", under the supervision of Professor Walt L. Jones. This led to Mark's first, of over 100, refereed articles, published in the Journal of Mathematical Physics in 1978. Soon after, he took up a three-year post-doctoral research fellowship at the Department of Mathematical Physics at University College Dublin, where he worked with newly appointed lecturer John Gibbon, later Professor of Applied Mathematics at Imperial College, and Trinity College post-doc Andrew Fowler, now a Professor at both Oxford and Limerick. These collaborations sparked his interest in the Lorenz equations, chaos and fractals. It also began a lifelong association with Ireland and with Fowler. From Dublin, Mark took up an instructorship in applied mathematics at Caltech, before returning to New Zealand in 1983 and a position as research scientist in the Applied Mathematics Division of the DSIR, then located on the 7th floor of the Rankine Brown Building at Victoria University of Wellington, and along the corridor from the Department of Mathematics.

In the eight years Mark spent at AMD, his research turned towards modelling with important applications, especially a sequence of papers on geothermal energy with colleagues including Steve White, Roger Young, Graham Weir, Alec McNabb and Warwick Kissling. Alongside his growing body of research, Mark retained a passion for teaching and when, in 1991, a vacancy arose along the corridor, Mark applied and was appointed to a senior lectureship in the Mathematics Department at Victoria University. He has been with us ever since, promoted regularly first to Reader and up that scale, and then to Professor in 2014. During the 90s, new opportunities arose and Mark quickly became engaged in the mathematics-in-industry study groups. The Australia-New Zealand versions had begun in the 1980s and were supported by Oxford applied mathematicians, such as Hilary and John Ockendon, who maintained strong links to this part of the world. Mark's first such meeting was in 1996 and he attended annually for the next 12 years as a moderator. For three of those years, Graeme Wake was instrumental in having them hosted in New Zealand. These events were a highlight of Mark's academic year and he quickly developed

a skill for bringing the best out of his research teams. The industry problems led to a series of fascinating modelling problems: cooking crispier cereals, brewing better beer, grain flow in silos, submarine batteries, high-speed weighing and sustainable water management, among others. For several years, Mark was involved with KAIST in South Korea, helping them develop strength in industrial modelling. He has also been a regular at study groups in Limerick and Oxford. Now MINZ is established here in its own right, Mark co-directed its first incarnation in Wellington in 2016.

An underlying mathematical theme in Mark's research has been the complex dynamics arising from interacting processes. These may be reaction-diffusion processes, delay-differential systems, different time scales operating, or heat and chemical diffusion. The art of modelling involves knowing what to include and what to leave out. It also requires facility with a wide range of approaches that may include asymptotic methods, numerical methods, qualitative dynamics, bifurcation and chaos. Mark has demonstrated an ability to focus on the essentials. As a result, he has been able to contribute significantly to modelling such diverse processes as sea-ice formation, volcanic ejecta, cardiorespiratory systems, and groundwater contamination. As Mark said, when delivering his inaugural professorial lecture in 2016, "curiosity continues to drive my research today — it's really rewarding brainstorming and then solving a problem". This often involves working with scientists in different fields — geophysicists, physiologists, vulcanologists — and converting their knowledge and instincts into mathematics. Mark's early work with Fowler and Gibbon on the Lorenz equation continues to be highly cited. It also underpins one of Mark's current major projects, co-authorship with Fowler of their book "Chaos — An Introduction for Applied Mathematicians". The finishing touches were made on a recent return to Limerick and the book is expected to be published later this year.

In recent years, Mark has made the most of opportunities to promote the pleasure and value of mathematics more widely. As well as giving plenary lectures at research conferences, he has given radio interviews in Ireland and New Zealand, and lectured and talked about his work with University of the Third Age, Zonta and the Rotary Club. Mark has supervised many excellent Master's and PhD students including Irene Pestov, Young Hong, Jonathan Crook and Sione Paea, and continues to do so with Emma Greenbank. Those of us lucky enough to work with Mark appreciate his willingness to take on the less popular roles such as programme director or Faculty representative on various committees. Students always enjoy his light touch in teaching and musical interludes in his lectures. As Mark puts it, he has been on "a 40-year academic journey of discovery" and it still has some way to go.

Peter Donelan

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

Event

The Department of Mathematical Sciences and the Mathematical Science Research Group (MSRG) hosted the 2018 Mathematics-in-Industry NZ Workshop (MINZ 2018) from 25 to 29 June. The workshop went very well on all six projects sponsored by Fisher & Paykel, International Cable Protection Committee, Methanex, Sanford, Transpower, and Fonterra. These industry partners were very happy with the progress made by the working teams.

Dr Hyuck Chung was on RNZ talking about the MINZ 2018 Workshop, and the webpage link of the talk is at radionz.co.nz/national/programmes/afternoons/audio/2018650964/using-maths-to-solve-big-problems.

Several postgraduate students from AUT also actively participated in this event. In particular, Aaron Jiang, one of Master of Analytics student, participated in the workshop as a student moderator for the Transpower's challenge. At the workshop, Aaron was offered an internship at Genesis, and was also short-listed for a job at Trustpower.

News

The WZ building — the new home of our School of Engineering, Computer and Mathematical Sciences at the AUT City Campus — is now open. After two-and-half years of construction, the $120 million building opened in time for Semester 2. At 18,000 m^2 over 12 floors, with student focused social learning spaces on every level, it's a building that has been designed and built with the end user in mind. The building represents a new way of teaching and learning for AUT. No longer is theory just taught in a traditional classroom. The building itself is a teaching tool, with glazed plant rooms so students can see the theory they are learning operationalised, exposed ceilings, services and structural connections and the building management system viewable on screens and able to be used for teaching and manipulation by students. It represents the evolving curriculum and the knowledge that learning can happen anywhere.

Travel and Conference Participation

Dr Hyuck Chung is taking a research leave for Semester 2 in 2018. He is visiting Associate Professor Nicole Kessissoglou at the University of New South Wales to work on an ongoing project of acoustical waves and their interaction with elastic structures.

Professor Jiling Cao attended the 2nd International Conference of Mathematical Sciences (ICMS 2018), 31 July — 6 August 2018, Istanbul, Turkey. At the conference, he delivered a plenary talk on his recent work in Mathematical Economics and also organized the session of Analytic Topology and Applications. After the conference, Jiling visited the Department of Mathematics at Hacettepe University to undertake some joint research work with Professor Alev Kanibir.

Dr Xinfeng Ruan attended the 2018 Derivative Markets Conference held at AUT from 9 to 10 August 2018. At the conference, he delivered a talk on his recent work of "Cross Section of Option Returns and Volatility of Volatility".

Professor Jeffrey Hunter organized a Special Invited Session on "Applied Probability" at Linstat 2018: "The International Conference on Trends and Perspectives in Linear Statistical Inference" held on 20–24 August 2018 at Bedlewo, Poland, the Mathematical Research and Conference Center of the Polish Academy of Sciences. Speakers included Beatrice Meini (Pisa, Italy), Dario Bini (Pisa, Italy), Iddo Ben-Ari (U. Connecticut, USA), Jungong Xue (Fundan University, China), Konstantin Avrachenkov (INRIA Sophia, France) and Quanlin Li (Yanshan University, China). In addition, Jeff contributed a talk on extending his research on Kemeny's constant to "Kemenys function for Markov chains and Markov renewal processes".

Visitor

Professor Jin E. Zhang (Department of Accountancy and Finance, University of Otago) visited the Department of Mathematical Sciences in May. Professor Zhang is going ot work with Professor Jiling Cao, Dr Wenjun Zhang and Dr Xinfeng Ruan on using mathematical models to study CBOE volatility and skew indexes.

Seminars

Associate Professor Hao Chang, School of Science, Tianjin Polytechnic University, "DC pension plan with stochastic interest rate and mean-reverting returns under HARA preference".

Professor Jin E. Zhang, Department of Accountancy & Finance, University of Otago, "The CBOE SKEW".

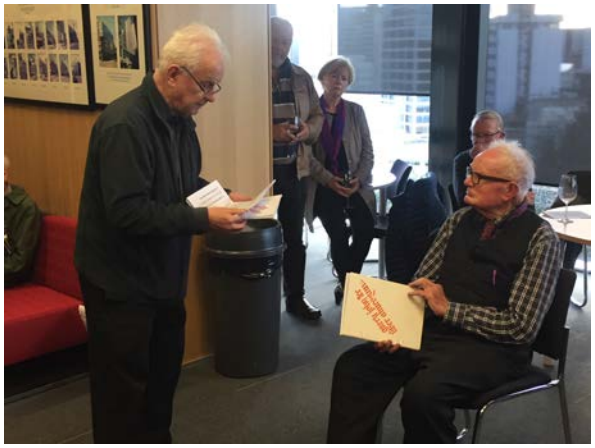
Wenjun Zhang

From left to right: International Cable Protection working group. Keynote speech from Professor Troy Farrell, Head of the Mathematical Sciences School at Queensland University of Technology.

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

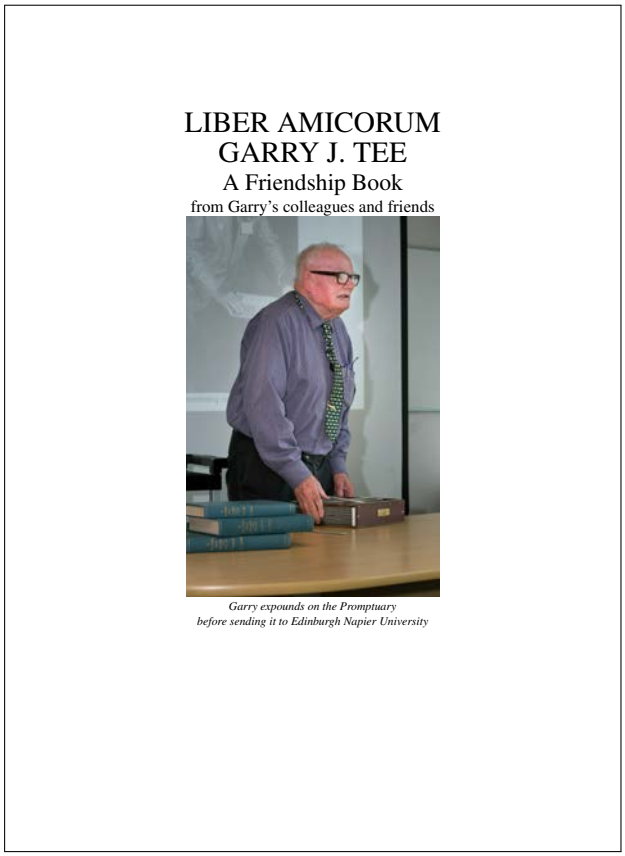
In staffing news, Tanya Evans and Thorsten Scheiner have been appointed to Lectureships in Mathematics Education in July. Nicolette Rattenbury and Jonny Stephenson took up Professional Teaching Fellow (PTF) positions in the department in August. Charlotte Hoffman started as our new Group Services Coordinator (replacing Amanda Zieltjes (née Gordon) who took up a permanent role as Employer Liaison Manager for the ICT Grad School) and Deana Lado is our Group Services Administrator.



The presentation of the Liber Amicorum to Garry.

The venerable (and long-serving NZMS Newsletter correspondent) Garry Tee has decided to retire from his position as Honorary Academic in the Department of Mathematics. Garry joined the Department of Mathematics in 1968, was a founding member of the Department of Computer Science from 1980 to 1990, and then returned to the Department of Mathematics. Garry has still been coming to campus almost every weekday. Of Garry's retirement function, John Butcher writes:

"*To mark his final retirement and say farewell, the two departments celebrated Garry's career of service and achievement in a social function on Friday 24 August, attended by many members of the University, as well as a large number of former colleagues, former students and other family and friends.*



The title page of the Liber Amicorum.

"*During the evening, Garry was presented with a Liber Amicorum, or Friendship Book. This contained entries from more than 30 people Garry has worked with, collaborated with, or simply befriended, from*

all over the world. Many of the contributors wrote about Garry's interests, and research contributions, in the history of mathematics, and the lives of mathematicians, in New Zealand and elsewhere. Many colleagues, and former colleagues, wrote about collaborations, some of which had arisen just from casual conversations about shared interests. The breadth of Garry's individual work and his work with other people, has been nothing short of spectacular."

Garry Tee surrounded by many of the contributors and other guests.

The following staff are enjoying research and study leave this Semester: Steven Galbraith, Igor Klep, Sione Ma'u, Warren Moors, Shayne Waldron, and Caroline Yoon.

The department ran a very successful Auckland Maths Olympiad on Saturday May 12 with over 160 students participating. This was coordinated by Phil Kane and Deana Lado, while Igor Klep and Arkadii Slinko contributed questions.

On Tuesday 5th June our annual Student Research Conference was held, organised by Shixiao Wang and Arkadii Slinko. The four overall winners were Ielyaas Cloete, Scarlett Shi, Daniel Snell and Lukas Zobernig.

Members of the Department have been invited to submit five 2nd round Marsden proposals, namely Gabriel Verret (fast-start); Sina Greenwood; Bernd Krauskopf; Vivien Kirk and James Sneyd; Jari Kaipio and Tom ter Elst.

The ANZAMP 2018 annual congress was held at The Spencer on Byron Hotel, Takapuna, 30 January until February 1 2018. ANZAMP is the Australian and New Zealand Association of Mathematical Physics. The event attracted more than 80 participants and was supported by the University of Auckland, ANZAMP, and a number of sponsors. The local organisers were Rod Gover, Bernd Krauskopf, Anna Barry, Andrew Keane, and Pedram Hekmati.

Kalnins Fest 2018 "Harnessing hidden symmetry — geometry and superintegrable systems" was held on the 2nd of February at the The Spencer on Byron Hotel Takapuna. It was a one day symposium celebrating the career and work of Ernie Kalnins. It was organised by Rod Gover and Jonathan Kress and supported by University of Auckland, University of Waikato and UNSW.

The conference "Conformal and Symplectic Geoemetry" was held at the University of Auckland on February 5–9, 2018. This event attracted around 35 international participants and was organised by Rod Gover, Pedram Hekmati, and Andreas Cap. It was supported by the Marsden Fund and the University of Auckland.

A focus group workshop "geometry and analysis" was held Feb 9–16 at the conference centre of Andre Nies `cs.auckland.ac.nz/~nies/` in Whiritoa. This attracted eight international participants, was partly supported by the Marsden Fund and organised by Rod Gover.

Our PhD students Austin Ibarra, Nathan Pages and Elias Siguenza, won poster prizes at the Society for Mathematical Biology annual meeting, in Sydney.

At the end of June, Tanya Evans visited the Mathematics Education Centre at Loughborough University (UK) establishing future research collaborations with Barbara Jaworski and Matthew Inglis. Both Barbara and Matthew are coming to New Zealand to visit Tanya in the beginning of next year. Tanya also attended the Psychology of Mathematics Education (PME42) conference in Sweden and gave a presentation titled "Puzzle-based learning in university mathematics: students' perspectives" (co-authored with Sergiy Klymchuk and Mike Thomas).

Steven Galbraith was an invited speaker at the Algorithmic Number Theory Symposium in Madison, Wisconsin in July. He also hosted research collaborators Leo Ducas (CWI, Amsterdam), Christian Collberg (Arizona) and Luca de Feo (Versaille, Paris).

Rod Gover gave a series of invited lectures at The Australian Mathematical Sciences Institute (AMSI) Winter School in Brisbane (hosted by the University of Queensland) in July. Rod was also an invited speaker at the Banff International Research Station for Mathematical Innovation and Discovery (BIRS) workshop on "Asymptotically Hyperbolic Manifolds" in May, and gave a colloquium talk at Monash University in April.

Sione Ma'u will be spending part of his sabbatical at University of Verona (Italy) and Indiana University (Bloomington IN, USA) between October and April.

Warren Moors has been in Sofia for six weeks, then a week in Borovets for the 14th International Workshop on Well-posedness of Optimization Problems and Related Topics, where he was one the invited speakers. While in Sofia he is mainly working on one of the three books that he is currently co-authoring.

Eamonn O'Brien is serving on the PBRF panel and is also a co-chair (with André Nies and Katrin Tent) of the Trimester Program "Logic and Algorithms in Group Theory" at the Hausdorff Research Institute for Mathematics in Bonn, Germany.

Rachel Passmore received one of two awards for Early Career Research Excellence at the International Conference on the Teaching of Statistics, just held in Kyoto. ICOTS is the largest Statistics Education conference and is held every four years on behalf of the International Association for Statistical Education. Rachel's award was for her paper on time series and their place in the secondary school curriculum. The other award went to Pip Arnold, also from New Zealand. Maxine Pfannkuch supervised both their research projects, and also received an award for editing a prominent Statistics Education Journal.

Claire Postlethwaite's PhD student Rebecca Turner passed her oral and will graduate in September. Her thesis title was "Mathematical modelling of animal navigation".

Jeroen Schillewaert hosted Professor Hendrik Van Maldeghem (Ghent University) between March and April, funded on a Hood Fellowship. He gave lectures in July in Bielefeld, Berlin and Munster.

Arkadii Slinko participated in the following recent conferences: the 14th Meeting of the Society for Social Choice and Welfare, Seoul National University, Korea, June 14–17; AAMAS-18 (International Conference on Autonomous Agents and Multiagent Systems), Stockholm, Sweden, July 10–15; IJCAI-18 (International Joint Conferences on Artificial Intelligence), Stockholm, July 13–19.

Thorsten Scheiner attended the International Congress of Mathematicians in Rio, Brazil in August. He gave a research presentation entitled "Contextualizing, complementizing, and complexifying in mathematical cognition", together with Dr Marcia M. F. Pinto, with whom he has been collaborating since 2013. A brief report of this presentation has been published on the ICM 2018 website: tinyurl.com/y7csmu9v.

Abstracts of Recent PhD Theses

Rebecca Turner, PhD Applied Mathematics. Supervisor: Claire Postlethwaite. Title: *Mathematical modelling of animal navigation*.

Animals navigate all over the world at many different scales. Among their navigation abilities is an intriguing skill which allows them to navigate in the absence of familiar landmarks or outward journey information. This skill is hypothesised to be an ability to use a map and compass. Animals are known to use a variety of compasses, such as the sun and the magnetic field vector, however, the map mechanism is still poorly understood.

This thesis focuses on grid map hypotheses and how they might be experimentally tested. The hypotheses propose that the animal uses two predictably varying environmental fields as coordinates. The animal is assumed to know the field values at their target and current location, but may either hold information on the coordinate field gradients based on the fields about the target or about the current location. The hypotheses also differ in how they incorporate field gradient magnitudes and directions. Certain combinations of assumptions give different navigation models, which we term: Correct Bicoordinate (Target or Release based), Approximate Bicoordinate, and Directional Navigation.

Differences in model predictions can be exploited to test the model assumptions. In particular, this thesis presents methods for model comparison to: initial bearings such as might be obtained when an animal is released after displacement, bearings from virtual displacement experiments, and animal trajectories recorded by tracking devices. The methods are trialled using homing pigeons as a model species utilising historical data. We test the additional hypothesis that features of the geomagnetic field are used as coordinates. No evidence is found to support the hypothesis that pigeons are using the magnetic field as part of a bicoordinate map over distances of a few hundred kilometres. We suggest that using the magnetic field as a coordinate would be more efficient over greater distances where it would be robust to variation. As tracking devices improve, more data are being collected from long distance travellers. This in combination with the grid map navigation models will enable testing of the navigation hypothesis of the use of the magnetic field, or alternative environmental fields, as a map coordinate in multiple species.

Iresha Gayani Ratnayake, PhD Maths Education. Supervisor: Mike Thomas. Title: *Teaching Algebra with Digital Technology: Factors Influencing Secondary Mathematics Teachers' Task Development and Implementation*

Research suggests using digital technology (DT) has the potential to support students' mathematical understanding and that rich tasks enhance the effectiveness of using such technology in the classroom. Tasks, carefully designed by educators, inevitably need adapting during teacher implementation. Thus, this research considered it important to support teachers in designing rich DT tasks themselves for their students. To do this, the benefits of collaborative work in small teacher communities in the same school or educational zone were investigated. This study sought to identify what teacher factors influence secondary mathematics teachers in designing and implementing DT tasks, and how. Design-based research methodology was adopted within a sociocultural constructivist paradigm to identify these teacher factors. Further, a professional development (PD) programme was designed and conducted to investigate its supportive benefits for teachers. Four groups of three teachers collaboratively designed a preliminary task before participating in the PD researcher

intervention. Then, the groups modified and implemented their tasks and then participated in an interview.

Data was collected using a questionnaire comprising open and closed questions and Likert-style attitude scales, semi-structured interviews, task development video- and audio-recordings, and observations. Both tasks were analysed using the Task Richness Framework developed for the research. The observations and data recordings were translated into English and transcribed before being coded. The theories of MKT, instrumental genesis (IG), resources, orientations and goals, group dynamics, and the FOCUS framework were used to develop codes for the qualitative data.

The findings suggest that the task richness after the PD intervention had significantly increased for all groups. Further, the PD programme's supportive nature improved teacher attitudes towards using technology in teaching and encouraged confidence in developing tasks. Teachers having higher IG, positive attitudes and confidence are more likely design quality tasks. Among the four groups, members of groups homogeneous in age and experience showed more willingness to share ideas, with greater flexibility in approaching DT. The evidence suggested higher success of PD programmes with communities of inquiry where age and experience are homogenous. The study showed that conducting similar DT PD programmes may be effective in supporting teacher producing better tasks.

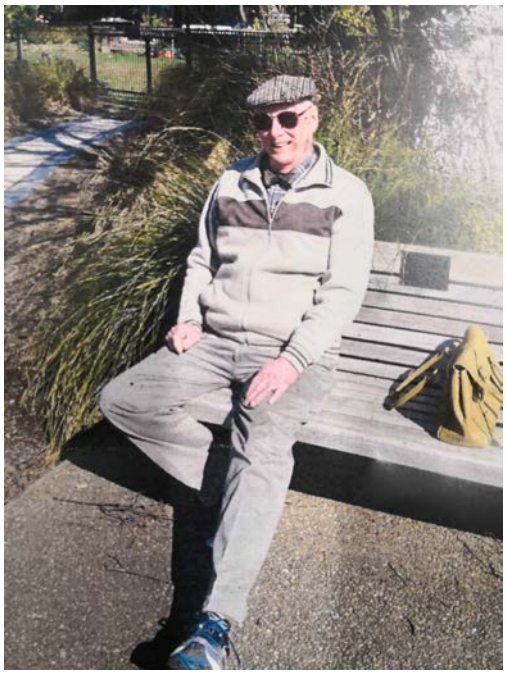
Steven Galbraith

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

The passing of Ted Zulauf

In late June we celebrated the death of Teddy (Opa) Zulauf, the second head of mathematics at Waikato. A brief note on his background: after a number of years as professor at the University of Sierra Leone he had been appointed reader. At the end of 1969 Desmond Sawyer returned to Otago and Ted took over as head and professor of mathematics. He prepared the department for the courses which would be need in the Waikato School of Science which started in 1970, establishing three strands — pure mathematics, statistic and OR, and applied mathematics. He retired early, soon after the establishment of rotating chairs, and had a long and happy retirement. Although Ted and his dear wife Trudy, who passed away a few years ago, had no children, they became very close to one of their helpers, Gay-Lyn. She gave a beautiful tribute to Ted at the celebration including a poem which is included here with the permission of Gay-Lyn dos Santos.



Professor Achim Zulauf, 24 June 1926 to 20 June 2018.

In Honour of Opa

When Opa was 90, you'd never have known it. He was sharp as a tack, his mind sure showed it.

He was quick and was funny, generous too, I learnt so much I never knew.

A wealth of knowledge, shared with any, Yet he was still learning, pursuits were many.

A Professor of Mathematics, he loved numbers. He never stopped till he slumbered.

He owned an iPad and was never without a book. A rarity but was true, you needed only take a look.

A champ at Sudoku, link and crossword puzzles, There he found the meaning of axolotls.

He introduced words, Chesed, b'seder and ballagan; Musicians like Andre Rieu, made me a fan.

Weekly visits, cups of tea, apple cake and beesting; A man strictly routine, everything was ping!

Accordions, jigsaws, microscope, gifts galore; M&Ms each week, what could children have wanted more.

We celebrated festivals from his Jewish background; Which brought tasty treats all the year round.

Then his garden was filled with blooms each season, He loved flowers, that was the reason.

He was driving, and healthy, yet that was no shock, His pacemaker ran like a Swiss made clock.

He was shopping, dining, living alone, he sure was a coper. Kind thoughts and gestures, A TRUE OPA!

I have included this poem because it shows a very human side of Ted, something not always on show in the rough and tumble of university life. He made a huge contribution to mathematics at Waikato in its early years, sacrificing his considerable research potential to build the department.

Retirement of Keith Allan

Keith came to us from the Waikato Foundation Studies program. Before that he had been a senior science and mathematics teacher at Fairfield college. He worked for the department on contract from 2006 onwards, and started his continuing Senior Tutor position in 2013. As well as teaching some of our important first year bridging papers, he continued with his interest in Fibonacci number research. He will be sorely missed.

With the retirement of Keith, Paul Brown is being employed until the end of the year to cover Keith's teaching. Paul has recently submitted his PhD thesis on "Computational Bayesian Inference using Low Discrepancy Sequences". A continuing Senior Tutor replacement for Keith is arriving in August, namely Raziyeh Zarre. She's coming to Waikato from Lincoln University.

Arriving and going

Woei Chet Lim spent the first half of the year on study leave. He visited Sweden and Poland. In particular, he visited his co-author Claes Uggla at University of Karlstad, in Karlstad, Sweden for one month. Florian Beyer from Otago was also on his study leave at KTH, Stockholm at the time, so a one-day mini-conference dubbed the "Sweden-New Zealand Joint Workshop in Relativity" was held at KTH. Two speakers from each country gave a talk, with Florian and Woei Chet representing NZ, and Claes Uggla and Michael Bradley representing Sweden.

While in Poland, he attended and gave a talk at the week-long workshop "singularities of general relativity and their quantum fate" at the Banach Mathematical Center in Warsaw. He also visited Wlodzimierz Piechocki, one of the organizers of the workshop, at the National Centre for Nuclear Research, Warsaw.

Tim Stokes has returned from his extensive travels, having achieved what he intended and made many new contacts. Kevin Broughan made a webinar for Cambridge University Press (see his web pages) while in New York in July, and attended ICM 2018 (with two other Kiwi mathematicians) in Rio in August giving a presentation entitled "Old and new equivalents of the Riemann hypothesis".

Mathematics competitions training

This year in the B semester, Ian Hawthorn and Woei Chet Lim are running a one-hour weekly training program for participants of the Simon Marais mathematics competition. Students practise on past problems from the competition and also from the Putnam mathematics competition.

Kevin Broughan

MASSEY UNIVERSITY

INSTITUTE OF FUNDAMENTAL SCIENCES

It has been a quiet few months in the mathematics group at Massey Manawatū. Of note, David Simpson was an invited lecturer at the International Centre for Theoretical Sciences (ICTS) just outside Bengaluru, India, in June 2018 (see photo overleaf). ICTS is an interdisciplinary centre for theoretical research and regularly holds workshops and research programs. David gave a series of lectures on piecewise-smooth differential equations as part of a summer school on the Dynamics of Complex Systems to an audience mostly comprised of Indian PhD students.

Richard Brown

INSTITUTE OF NATURAL AND MATHEMATICAL SCIENCES

Annalisa Conversano is now a lecturer.

Gaven Martin was a plenary speaker at the Rickman memorial conference in June in Helsinki. He also participated in the "Art and Mathematics" conference run by the University of Helsinki and Aalto's Art School, as well as an attendee at the Geometric Measure Theory conference there.

PhD alumnus Ali Ashher Zaidi (supervisors Graeme Wake and Bruce van-Brunt) visited the Albany campus in June and gave a lecture "Functional differential equations arising in a cell growth model". Dr Zaidi is an associate professor at Lahore University of Management Sciences, Pakistan.

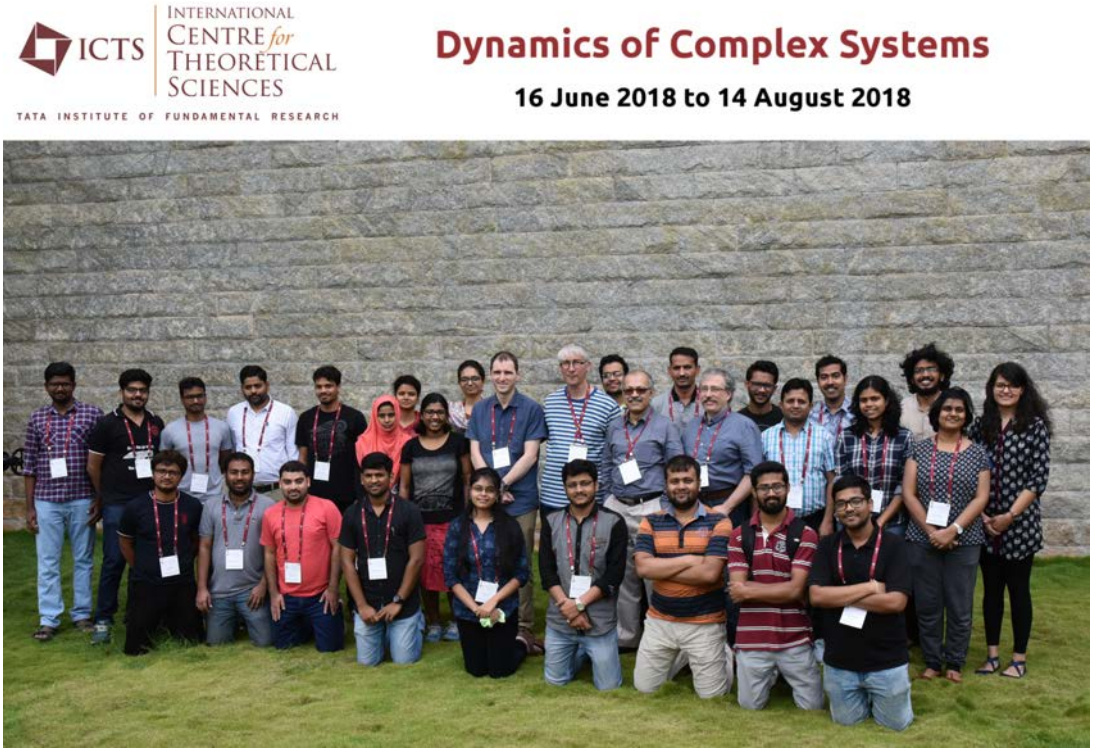
The fourth national workshop in the MINZ (Mathematics-in-Industry for New Zealand) series was held at AUT during June 25–29. Over 100 people participated. Moderator leaders from Albany were Alona Ben-Tal, Christian Blasche (student), Barry McDonald, Winston Sweatman and Graeme Wake.

Shaun Cooper

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

We are delighted to have been joined recently by five new staff members. Dr Martino Lupini has joined the



David Simpson (Massey IFS) at the summer school on the Dynamics of Complex Systems at ICTS.

School as a lecturer in mathematics. Martino has been Harry Bateman Research Instructor at the California Institute of Technology until joining us in July. His first degree was from the University of Parma, Italy, followed by a Master's from the University of Pisa and his PhD, under the supervision of Professor Ilijas Farah, at York University, Toronto was on "Operator algebras and abstract classification". Martino's research has significant overlap with that of Astrid an Huef, Lisa Clark and Iain Raeburn (operator algebras) as well as Noam Greenberg and Adam Day (model theory), so will consolidate a strong school of research here. Martino has already visited Auckland to continue a collaboration with Igor Klep.

Dr Dan Turetsky has been appointed a senior lecturer in mathematics. Dan is no stranger to SMS as he was a postdoctoral fellow working with Noam Greenberg and Rod Downey in 2010 and, more recently, had a 2-year lectureship while Geoff Whittle was on his James Cook Fellowship. Dan works in mathematical logic, particularly aspects of computability theory. Dan (re)started with SMS in July, returning from a position at Notre Dame University. Dan's presence will ensure that Victoria retains one of the strongest groups of experts in logic and computability anywhere in the world.

Dr Matthew Harrison-Trainor also joined us in June as a postdoctoral fellow in mathematics, funded by Rod Downey's Marsden grant, "The Mathematics of Computation". Matthew has a Ph.D. in Logic and the Methodology of Science from the University of California, Berkeley (2017) and a BMath from University of Waterloo, where he has been a postdoctoral fellow until now. Matthew's research is principally in computable structure theory. Dr Nirosha Priyadarshani has joined Stephen Marsland, also as a postdoctoral fellow, in data science, as part of the AviaNZ birdsong project with Isabel Castro at Massey University, where Nirosha was awarded her PhD last year.

Finally, Dr Binh Phu Nguyen has been appointed as a senior lecturer in data science, starting in July. Binh received his PhD from the National University of Singapore for his thesis "Visualization of large medical volume data". Subsequently he has been employed as a research fellow at the centre for Computational Biology at the Duke University/NUS Medical School in Singapore. He has worked on a wide range of projects in health informatics and image analysis. The School has been leading development of the university's new multi-disciplinary major in Data Science that will be offered from 2019 as part of the BSc, BCom and BA degrees. The programme received CUAP approval in June.

In the flow and ebb of staff, there have inevitably been some departures. Marking the end of an era, Professor Rob Goldblatt retired at the end of June. Rob has been a member of the Victoria University of Wellington community for 51 years, beginning as an undergraduate student in 1967. In 1971, Rob took up his first appointment at Victoria as a Junior Lecturer in the Department of Mathematics and received his PhD on modal logic in

1974. After taking up a lectureship, Rob was rapidly promoted and in 1981 was awarded a Personal Chair, recognizing his outstanding research achievement. In 1983, the university conferred on him the degree Doctor of Science for his substantial body of published research and in 1985, he was appointed Professor of Pure Mathematics, an 'established' chair. Rob's research interests are mainly in mathematical logic, using tools from algebra and topology to study symbolic languages that are used to express mathematical discourse and systematize deductive reasoning. Retirement notwithstanding, Rob's research and wider contributions will continue. For example, he gave a talk in early July at the annual meeting of the Australasian Association of Logic, at VUW, which was held in honour of Rob and Max Cresswell, long-time colleague and professor of philosophy, and he is an invited plenary speaker at the Advances in Modal Logic conference in Bern in August.

In addition to some 85 published research articles in mathematical logic and general algebra, Rob has published seven books, a mixture of research monographs and textbooks, sometimes in the same volume. These have been the fruit of his interest in the communication of mathematical ideas and in expository writing as a creative activity. Two of his books, *Logics of Time and Computation* and *Topoi: The Categorial Analysis of Logic*, have become international best-sellers, relative to the market for mathematics books! "Topoi", originally published by North-Holland, has had several reincarnations, and as a revised edition, in a Russian translation, available for free download from Project Euclid, and reprinted in the Dover Books on Mathematics series.

Service to the NZMS included 10 years on the Council, including a term as President, eight years as the NZ representative to the International Mathematical Union, and membership of the management committee of the NZ Journal of Mathematics since 1991. Rob's contributions have been recognized by a number of awards and fellowships, including the RSNZ Jones Medal for lifetime achievement in the mathematical sciences (2012), Honorary Life Member of NZMS (2004), Fellow of the NZMS (1996), New Zealand Mathematical Society Research Award (1991), Fellow of the Royal Society of New Zealand (1990), and Research Medal of the New Zealand Association of Scientists (1985). Rob has held a number of senior roles in the mathematical logic community, such as Member of Executive Committee and Council of the Association for Symbolic Logic, including editor of its Journal of Symbolic Logic for six years, with a term as Coordinating Editor.

Rob's service to the university has (until June) spanned that of all of his colleagues in the School. Many of us have been strongly influenced by his intellectual leadership. It has been Rob's vision for pure mathematics at Victoria that has driven its reputation, not just as a leading centre in New Zealand, but one that has international recognition, especially in his field of logic and computation. It was an appropriate recognition that the university's Academic Board, at its May meeting, approved his award of Emeritus Professor status. Characteristically, at his request, Rob's retirement was simply marked by a School morning tea.

Two post-doctoral fellows are also moving on. Nick Brettell, who has been working with Geoff Whittle for the last couple of years, has started his new position as a postdoctoral researcher in the Department of Mathematics and Computer Science, working with Rudi Pendavingh at Eindhoven University of Technology, in the Netherlands. Monique Ladds, whose research has been supported by the Sustainable Seas NSC, joins the Department of Conservation as a marine technical adviser. Both have made excellent contributions to the research and teaching environments in the school.

In further proof that mathematics is a lifelong passion, Emeritus Professor John Harper's paper, "Effect of a negatively surface-active solute on a bubble rising in a liquid", is in press at Quarterly Journal of Mechanics and Applied Mathematics, and he will give talks on the research at Nottingham University and the Schlumberger Gould Research Center, Cambridge UK in September. Dimitrios Mitsotakis recently returned from Taipei, where he attended the 12th AIMS Conference on Dynamical Systems, Differential Equations and Applications, presenting new research on asymptotic models for pulsatile flow in viscoelastic vessels, in collaboration with students Qian Li and Elijah Peach. He was able to continue work with collaborators Jerry Bona and Hongqiu Chen as well as initiating new collaborations with Colette Guillope and Juan-Ming Yua. Dimitrios reports, "I was astonished with the Taiwanese hospitality and kindness. People were very well educated, super kind, and very generous. They treated us often with dinners and lunches and one invited us to her home. We also had the chance to experience the impact of a typhoon which passed close to Taipei. Our flight to Hong Kong was cancelled but the APX people rearranged our trip and we managed to return back home safely and with only one day of delay."

Stephen Marsland has three new PhD students. Michal Salter-Duke is working on the mathematical structure of networks. He has been in NZ for about 18 months, having finished his Master in Bioinformatics at Melbourne University and Auckland University. Before that he spent 10 years as a high school maths teacher. Lingyan Han is starting her PhD on Generative Models for Medreal Signal Analysis. Julius Juodakis is the newest arrival, funded for his PhD by Stephen's marsden grant.

Mark McGuinness is back from two months in Europe, where he visited colleague Andrew Fowler in Kil-

kee, Ireland, to work on their book "Chaos — An Introduction for Applied Mathematicians". It is expected to be published later this year. He helped lead a four-day Student Modelling Workshop at the University of Limerick and gave a talk at Oxford University, entitled "Great Balls of Fire — Steaming Surtseyan Bombs". Mark attended the 137th European Study Group held in Ålesund, Norway, where he worked with a group that was modelling segregation during the formation of Søderberg electrodes. In Ålesund, he reports, the sun did not set until 11:30pm giving plenty of time for a three-hour evening walk up and down the hill, with plenty of photo opportunities. Mark gave two talks at the 20th European Conference on Mathematics for Industry held in Budapest in June, one on continuously measuring moisture levels in bauxite using microwaves. To top the trip off, Mark returned to the thriving metropolis of Auckland for the fourth Mathematics in Industry NZ (MINZ) study group, held at AUT, where problems included mussel farming, submarine cable faults data, research on the mouth feel of dairy products, modelling washing machines, and how the national electricity grid can adapt to the increasing uptake of domestic solar power panels and storage batteries.

Matt Visser and PhD student Jessica Santiago have been awarded First Prize in the 2018 essay contest sponsored by the Gravity Research Foundation, for their essay (available at static1.squarespace.com/static/5852e579be659442a01f27b8/t/5af9c04faa4a993b554df0e9/1526317136980/Santiago_Visser_2018.pdf) entitled, "Gravity's Universality: The Physics Underlying Tolman Temperature Gradients". The essay addresses the subtle way in which general relativity modifies the notion of thermality, allowing and indeed requiring non-zero locally measured temperature gradients in thermal equilibrium. The contest has been running yearly since 1949 and previous winners include luminaries such as 't Hooft (2015), Padmanabhan (2008), Wald (1992), Penrose (1975), and Hawking (1971).

Rod Downey has been in Heidelberg, fulfilling Humboldt Fellowship commitments including giving a Kolloquium Lecture at the University of Darmstadt. He has also delivered the Association for Symbolic Logic's Annual Gödel Lecture at the European Logic Meeting in Udine, Italy. Peter Smith was awarded a Benjamin Meaker Visiting Professorship by the Institute for Advanced Studies at the University of Bristol. He has been working on the project "Stochastic processes and mobility models for drones" in the School of Mathematics with Professor Carl Dettmann. In September, Pete is also visiting the University of Bologna in Cesena, Italy as an Institute of Advanced Studies Visiting Fellow.

The School hosted the 4th NZ Number Theory Workshop, with B D Kim organising and, in July, the workshop "Parameterized Complexity for Practical Computin", organised by Catherine McCartin (Massey University) together with former colleagues Mike Fellows and Fran Rosamond. The annual Maths Challenge, sponsored by the School and the Wellington Mathematics Association had another successful run in April, with some 80 school students participating. The School also joined with Vic Careers to put on our third successful evening exposition on careers in the mathematical sciences, attended by over 80 current students and with a fine panel of alumni representing a range of careers and employers.

Visitors and seminars

Professor Valerie Isham (University College, London), Forder Lecturer: "A life in Stochastic Modelling" and "Stochastic Epidemic Models: approximations, structured populations and networks"; Professor Jeremy Taylor, Shayle Searle Visiting Fellow (University of Michigan) "Updating established prediction models with new biomarkers"; Karen Seidel (Potsdam University), "Theoretical perspectives on probabilistic reasoning from labeled data". Professor Philip Stamp (University of British Columbia) has been visiting Matt Visser; Dr Jaehyun Ahn visited Byoung Du Kim at the end of July; alumna Dr Elizabeth Burslem (Northwestern University) visited the school for the first half of 2018 and undertook some contract teaching for two 100-level courses. It was great to have Lizzie back in Wellington for a while.

Peter Donelan

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Congratulations to *Rachael Tappenden* and Tim Candy who got married in April. Following their wedding Rachael took unpaid leave to join Tim in Germany for the remainder of the year.

Congratulations to *Blair Robertson* and his wife Emma on the birth in April of their second child Sadie Lee.

Welcome to *Leigh Davidson* who joined our admin team in mid April. Leigh is from the Department of Civil and Natural Resources Engineering at UC, where she was the postgraduate administrator. Leigh already worked in the then Department of Mathematics and Statistics in 2002.

In July the School welcomed *Giulio Dalla Riva* as continuing staff member in data science. Giulio, who is from Italy, got his PhD in 2016 from this School under the supervision of Mike Steel, Daniel Stouffer

Leigh Davidson.

and Charles Semple. He then went on a Postdoctoral Teaching Fellowship in the Master of Data Science programme at the University of British Columbia, Vancouver, Canada, run by the Department of Statistics and the Department of Computer Science. Giulio's research interests are in complex networks and their time evolution, phylogenetics, and the interaction between ecological and evolutionary processes.

Jeanette McLeod and *Phil Wilson* held the Christchurch Maths Craft Day 2018 on July 1 at the Arts Centre in partnership with UC Arts and the Teece Museum of Classical Antiquities. This festival aims to bring the joy of maths to the general public by celebrating the links between mathematics and craft. A full report on the event, co-sponsored by the NZMS, appears on page 25.

Following his research month at the University of Stockholm earlier in the year, Emeritus Professor Douglas Bridges is based, from May through August, in Bonn, Germany, where he is one of the organisers of a research trimester on Types, Sets, and Constructions, at the Hausdorff Institute. He and his wife Vivien managed three weeks of vacation in Provence and Switzerland, including three glorious days walking in the amazing mountain scenery around Zermatt.

In July the School welcomed three Erskine Fellows, Chris Bose, Stefano De Marchi and Octavio Manero. Chris is from the University of Victoria, Canada. His research interests are broadly in the area of dynamical systems, with an emphasis on the application of modern probability theory and functional analysis to the study of long term or asymptotic properties of complicated time-evolving systems. The field is sometimes called ergodic theory. During his eight-weeks-long visit Chris is teaching into one of our main 200-level applied mathematics courses, MATH202 Differential Equations. This is his third visit to Canterbury, although the first one as an Erskine fellow. Chris is hosted by *Rua Murray*.

Stefano is from the Department of Mathematics "Tullio Levi-Civita" at the University Padova, Italy. He is also affiliated with the Padova Neuroscience Center. Stefano's research interests are broadly in numerical analysis with special interest in approximation of multivariate functions with polynomial and radial basis functions (theory, algorithms and applications) and mathematical imaging in medicine and neurosciences. During his seven-weeks-long visit Stefano is teaching into MATH365 Applications of Complex Variables. Stefano is hosted by *Rick Beatson*.

Octavio is from the Institute of Materials Research at the National Autonomous University of Mexico (UNAM), Mexico. Octavio's research interests are broadly in the area of theoretical Rheology and Non-Newtonian Fluid Mechanics. During his five-weeks-long visit Octavio is teaching into EMTH118 Engineering Mathematics 1A. Octavio is hosted by *Miguel Moyers*.

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

We bid farewell to *Petru Cioica-Licht*. Together with his wife and daughter, he moved to Germany, where he is taking up a position in the stochastic analysis group at the University of Duisburg-Essen. Petru first joined the department as a postdoc in 2016, then he became a lecturer one year later. Petru is an expert in stochastic partial differential equations. In particular, he is interested in regularity, L_p theory and numerical methods for these equations. We wish you and your family all the best!

The latest issue of the International Electronic Journal of Algebra (volume 24, 2018, available at ieja.net) is dedicated to *John Clark*, our dear colleague and friend for many years, who died last year. The issue starts with a tribute by Patrick F. Smith (University of Glasgow), concluding "We are all grateful that this present collection of research articles gives us another opportunity to express our respect and affection for John. He will live long in our memories."

New Zealand's premier public science event, the Dunedin-based, biannual New Zealand International Science Festival, attracted thousands of visitors in July. The 10-day festival featured more than 220 events and 20 special guests from New Zealand and overseas. A highlight was the University of Otago Science Expo, which showed all sorts of interactive displays from Otago Departments. The Maths & Stats department, in particular, addressed questions such as: What would the world look like if you travelled close to the speed

of light? What pattern can be seen in the magnitudes of earthquakes? Can we predict if an epidemic will start or stop?

The Department is hosting an international conference on General Relativity: the Birthday Colloquium in honour of *Jörg Frauendiener* on the occasion of his 60th birthday earlier this year. Renowned speakers from New Zealand and overseas are gathering to celebrate Jörg's anniversary and his internationally recognised contributions to Einstein's theory of gravitation.

We observe worrying numeracy problems among the students at this university, which clearly shows issues in mathematics education at NZ schools. Research indicates that this even affects students who would otherwise be the best students, and just a little help can completely change the performance of those students. Hence our department has approached the Division of Sciences and suggested university-wide offerings of numeracy courses. Unfortunately, it turned out that the University administration is currently not interested in dealing with any numeracy problems. Therefore, we risk observing more and more students whose maths performance in the standard numeracy test puts them at a level below school year 9. If you have encountered similar problems at other universities, please feel free to contact us to share your findings.

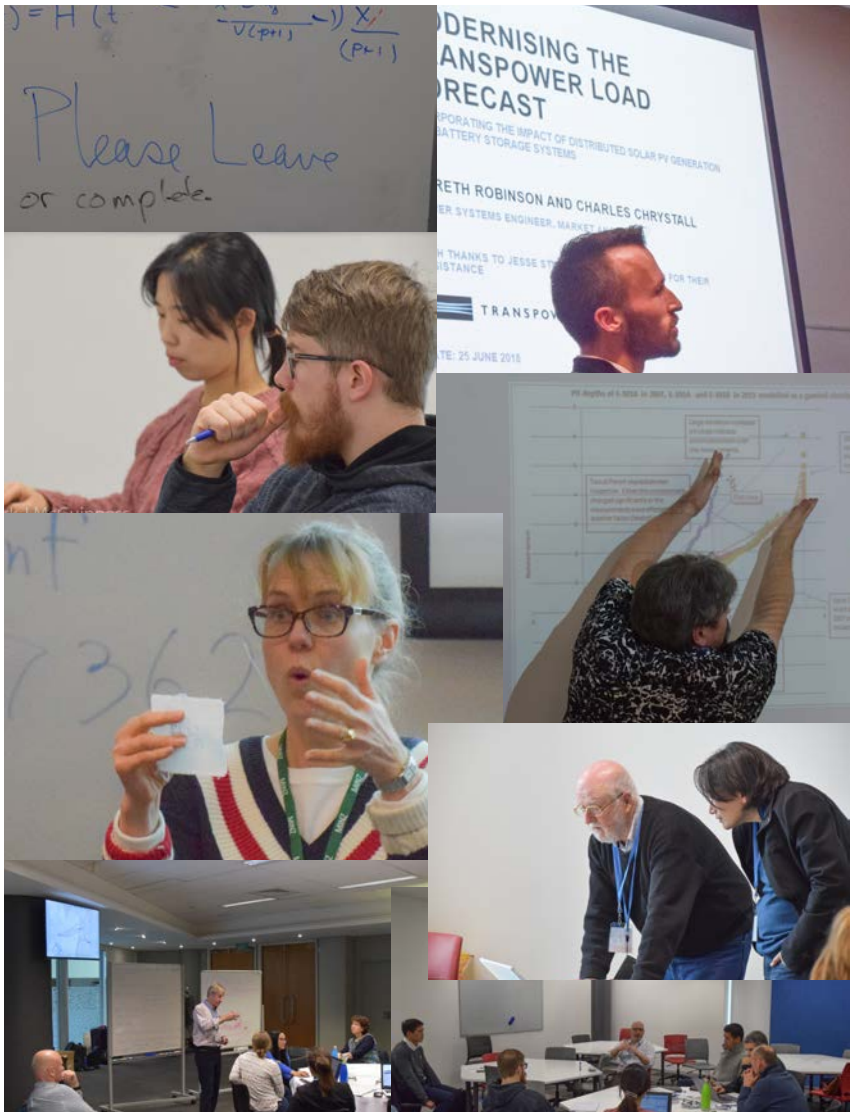
Jörg Hennig

REPORTS ON EVENTS

MINZ 2018 Report

The 2018 Mathematics in Industry New Zealand (MINZ) study group was held at the Auckland University of Technology from 25-29 June, and Directors Hyuck Chung and Professor Jiling Cao were delighted with the week, saying it was an unqualified success with stimulating discussions and great progress made on every front.

Over eighty mathematics academics, students, teachers and scientists descended upon AUT to tackle six problems from industry and to hear the keynote address delivered by Professor Troy Farrell, Head of Mathematical Sciences at Queensland University of Technology in Australia. Challenges to be solved came from Fonterra, Transpower, Methanex, the International Cable Protection Committee, Sanford, and Fisher and Paykel. During the week the meeting broke into separate groups which engaged in free-form brainstorming of each of the challenges, subjecting the industry representatives to intensive interrogation as ideas were raised and assessed in an effort to solve the challenges on offer.



MINZ 2018 Study Group Snaps

Data analytical techniques were used to explore the database for repair of faults in the network of trans-oceanic optical fibre cables that connect the modern world; the mouth-feel of dairy products was considered in the scientific context; corrosion in heat exchangers was analysed with sophisticated statistical models tailored to the application; the logistics of mussel farming were investigated with a view to improving the processes and helping

decision-making; the delicate matter of washing clothes without overly distressing them was delved into; and the implications of increasingly popular new technology in solar power generation with local storage at the household level for the national New Zealand power grid were investigated.

On the final day, each group presented its results to the entire MINZ gathering and to the industry representatives, who responded to each presentation with a short comment on what they thought of the process. All representatives thanked their groups for the progress made during the week, and many commented on the benefit they had already derived from a fresh approach to their challenge. Methanex have followed up the study week with the establishment of two summer intern positions in applied mathematics.

MINZ study groups, initiated by Professor Graeme Wake at Massey in Auckland in 2015, have been held annually thanks to logistic and administrative support from KiwiNet, and operate as a special activity of the ANZIAM New Zealand Branch. ANZIAM itself is a Division of the Australian Mathematical Society, and enjoys a close relationship with the New Zealand Mathematical Society. These study groups are an excellent example of outreach between universities, research groups, business and industry in New Zealand, and the interactions between academics and industry at study groups often lead to further collaborative interactions and innovations.

Mark McGuinness, Convenor of the MINZ Reference Group, and Victoria University of Wellington

Christchurch Maths Craft Day 2018

Maths Craft New Zealand's second Christchurch festival was held on Sunday 1st July in The Great Hall and in The Teece Museum of Classical Antiquities in The Arts Centre. Over 1,100 visitors explored maths through crafts at our free day-long event, which featured eight craft creation stations in The Great Hall and one in The Teece Museum, along with public lectures given by mathematicians, crafters, and classicists. Our hands-on craft stations were staffed by a trained team of volunteers drawn from University of Canterbury students and staff, from local school teachers, and from a growing pool of experienced volunteers from other Maths Craft New Zealand events. These volunteers guided our visitors through the maths and the craft at the craft stations: Möbius strips, mathematical colouring and drawing, knitted knots, Menger cubes, origami, flexagons, crocheted hyperbolic planes, meanders, and string art.

A busy day of maths and craft.

We were especially excited to introduce a new mathematical craft at this event in conjunction with The Teece Museum. This new craft activity allowed visitors to explore the mathematics of meanders in ancient art. These beautiful repeating patterns can be found on pottery and mosaics from the ancient world, and our maths craft activity lead people through the hidden but beautiful mathematical symmetries and algorithmic thinking behind the creation of meanders. We ran this craft activity in The Teece Museum, so that visitors could explore the mathematics of meanders while surrounded by beautiful examples from The Logie Collection housed in the Teece. This is the second year in a row that we have run the Christchurch festival in conjunction with the Teece, and the museum reported that almost 400 visitors came through their doors that day, many of whom were first-time visitors, compared to a typical winter Sunday of 50 people.

Learning knot theory with French kniting.

Our first visitors to the Maths Craft Day arrived as soon as our doors opened at 10am, continued steadily throughout the day, and were still arriving as we were preparing to close at 5pm. We were pleased with the number of visitors, which we felt suited the beautiful Great Hall setting perfectly. Rather than a hectic and crowded room, we had instead a bustling but relaxed atmosphere in which our visitors could easily get to the craft stations and have the attention of our enthusiastic volunteers. This meant that visitors had plenty of time to explore the crafts at the station, and to enjoy the many maths craft objects on display at the stations and in display cabinets. Like last year, we also had several crafting tables on the raised stage at one end of the Hall, at which visitors could sit and work together on their chosen craft. But this year, people also chose to sit on the floor in the middle of the Hall. It was a moving and inspiring sight to see a floor full of people working in family groups to understand beautiful mathematical concepts while working with their hands to make beautiful craft objects. People stayed for hours, and we even spotted a few enthusiastic visitors who stayed all day. As is always the case at our events, we were gratified to see people of all ages, genders, ethnicities, and backgrounds working together in an atmosphere of serious fun. Our friendly and keen volunteers were always on hand to help, both at the stations and at the craft tables, where they circulated with advice, encouragement, and materials.

Three free public lectures were held in the Recital Room of UC Arts, next to The Teece Museum and just across the quad from The Great Hall. The lectures were given by two New Zealanders and an Australian, and were attended by dozens of visitors of all ages. The first talk was given by Ms Elizabeth Chesney, a University of Canterbury student and retired school teacher from Christchurch, who talked about knitting mathematical knots and the mathematical theory behind them. We were delighted that our second public lecture was given by mathematician Prof Graham Farr of Monash University, Australia. Graham spoke to a large audience about the mathematics of Bill Tutte, a leading codebreaker at Bletchley Park during the Second World War, who later made many important contributions to mathematics. Graham's talk on "Making Links and Breaking Codes" introduced some serious but accessible mathematics, including examples which have been made into craft objects. Our final speaker was Dr Patrick O'Sullivan, Head of Classics at the University of Canterbury, who gave a fascinating talk on the art and culture of the ancient world, and its connections with mathematics.

The Derrick Breach Collection.

Maths Craft New Zealand and the School of Mathematics & Statistics at the University of Canterbury are now the proud custodians of the Derrick Breach Collection of Polyhedra. At the Christchurch Maths Craft Day we were privileged to be able to share a number of objects from the collection with the Maths Craft audience for the first time. Incorporating more than 300 models painstakingly crafted from paper by mathematician Derrick Breach, the collection is widely acknowledged as being without parallel in the Southern Hemisphere. Derrick made the collection during his tenure at the University of Canterbury in the period from the early 1970s through to the mid-1990s. Following his death in 1996, a dedicated gallery and teaching space was established to showcase these extraordinary objects to individuals, school tour groups, and university students alike. Regrettably this popular outreach activity was ended by the 2011 Canterbury earthquakes. Planning is underway to once again enable the community to step into the Breach and be filled with wonder at one man's labour of love to mathematics and craft, and this first public outing of the polyhedra in many years was an important first step. The dedicated Derrick Breach Collection display cabinet was surrounded by fascinated visitors all day long.

The second Christchurch Maths Craft Day was a big success, with over 1,100 enthusiastic people of all ages and backgrounds spending the day exploring maths through craft. It was wonderful to have another successful event in our home town of Christchurch, in the stunning setting of The Great Hall, to build on our relationship with The Teece Museum and UC Arts, and to forge news connections to mathematicians in Australia. We thank all of the sponsors of the 2018 Christchurch Maths Craft Day, and in particular the NZMS for their generous support, and look forward to our future events with excitement.

Phil Wilson & Jeanette McLeod, Maths Craft NZ and University of Canterbury

GENERAL NOTICES

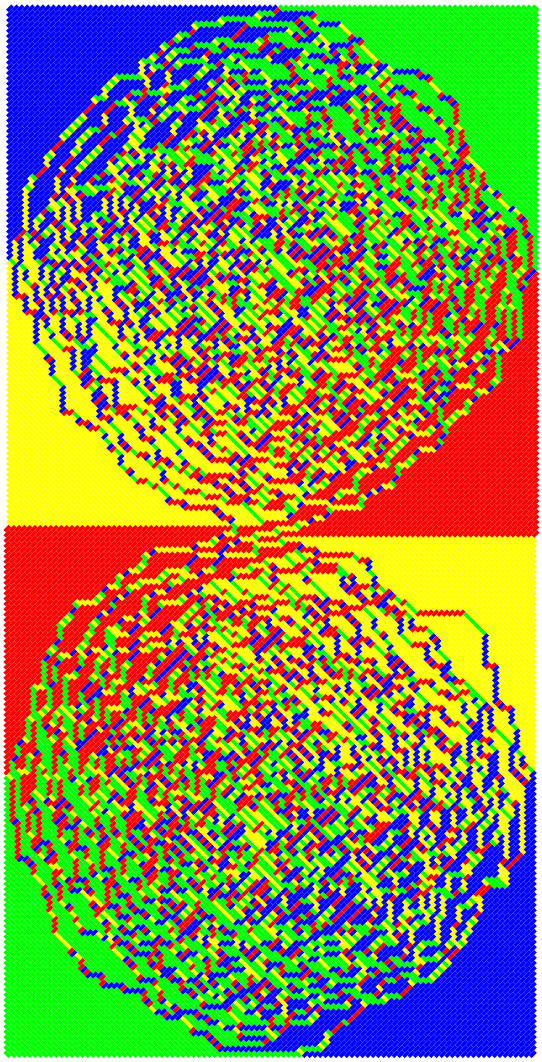
Modern Analysis and Geometry 2019: A conference to celebrate Gaven Martin's 60th birthday

A two-day conference will be held at Massey University's Albany campus on Thursday and Friday January 24–25, 2019. More information, including registration details, are at the conference webpage ctcp.massey.ac.nz/index.php?group=&page=conference&menu=Conference.

Shaun Cooper

2019 NZMRI SUMMER SCHOOL

New Zealand Mathematics Research Institute (Inc.)



Sunil Chhita: *Prob. Theory Relat. Fields* 162, 275 (2015)
Uniformly random domino tiling of a Double Aztec Diamond with the overlap parameter set to 2.

The Unreasonable Effectiveness of Random Matrix Theory: Achievements and Challenges since Hurwitz, Wishart and Wigner

Waikanae, New Zealand/Aotearoa

LECTURERS:
- Peter Forrester
- Alice Guionnet
- Iain Johnstone
- Jon Keating
- Craig Tracy

VENUE:
El Rancho, Waikanae

The theory of random matrices lies at the crossroads of many sub-disciplines within mathematics - probability theory, mathematical statistics, representation theory, approximation theory, integrable systems theory - and has profound implications for an ever-widening horizon of diverse applications.

Participants will be taken on a pedagogical journey by the lecturers towards problems of contemporary importance.

REGISTRATION:
http://www.massey.ac.nz/nzmri2019

CONTACT:
Nicholas Witte (Massey University)
N.S.Witte@massey.ac.nz
Tel: 64 6 951 7655
Stephen Marsland (Victoria University of Wellington)
stephen.marsland@vuw.ac.nz

JAN. 6 - 11

NZMS NOTICES

New Zealand Mathematical Society Colloquium 4–6 December 2018: University of Otago

The website for the 2018 NZMS Colloquium is now up and the registration is open. Please keep checking nzmathsoc.org.nz/colloquium2018 for the most up-to-date information on the speakers, programme, accommodation, etc. The deadline for abstract submissions will be 2 November 2018. We do not guarantee that every abstract will be accepted, but we hope to be able to accept most of them.

The deadline for conference registrations will be 19 November 2018. After that date there will be a late fee.

The plenary speakers are:

- Lesley Ward — School of Information Technology and Mathematical Sciences, University of South Australia;
- Edgar Knobloch — ANZIAM Speaker, Department of Physics, UC Berkeley;
- Geertrui Van der Voorde — Butcher-Kalman lecturer, University of Canterbury, New Zealand;
- Alona Ben-Tal — Institute of Natural and Mathematical Sciences, Massey University.
- Igor Kontorovich, NZMS Speaker, The University of Auckland.

As usual, there will be prizes for the best student talks and the best student posters. Students are strongly encouraged to attend the conference and to present a talk or poster.

Both the NZMS and the ANZIAM AGMs will take place during the Colloquium.

Florian Beyer & Boris Baeumer (on behalf of the local organisation committee)

Notice of Annual General Meeting

The Society's AGM will be held at 5pm, December 4th 2018 during the New Zealand Mathematics Colloquium at the University of Otago. Please send any potential agenda items to the NZMS Secretary by November 20, 2018 (rua.murray@canterbury.ac.nz).

Call for nominations for NZMS Council positions

Nominations are called for one or more Councillor positions on the New Zealand Mathematical Society Council. The term of office of a Council member is three years. Council members may hold office for two (but no more than two) consecutive terms. Members could consider the current makeup of the Council and nominate candidates who would increase the diversity of the Council (e.g. career stages, areas of mathematics, geographic locations, genders, types of institutes) in order for us to best represent the NZ mathematics community. Existing Council members, and their terms, can be found on the website: nzmathsoc.org.nz/?membership.

Nominations are also called for the position of Incoming Vice-President. The term of this position is one year, with the Incoming Vice-President then becoming President for a term of two years. Ordinary members (including existing Councillors) may be nominated for the position of Incoming Vice-President. If an existing Councillor is elected their vacant Council position will be filled by nominations for the vacant Council position(s).

Nominations should be put forward by two proposers. The nominee and the two proposers should be current Ordinary members (including Student members) or Honorary members of the New Zealand Mathematical Society. The nominations, including the nominee's consent, should be forwarded by 6 November 2018 to the NZMS Secretary, preferably by email to rua.murray@canterbury.ac.nz. If nominations are sent by email, the two proposers and the nominee should each send separate email messages to the NZMS Secretary.

Applications for Financial Assistance (deadline November 15, 2018)

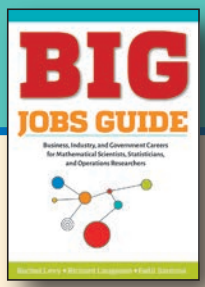
The NZ Mathematical Society has quarterly deadlines for financial assistance applications. Applications must be made well in advance (at least one month before the funded activity, but the earlier the better) and retrospective applications will not be considered. The deadlines for applications for 2018 are: 15 February, 15 May, 15 August, and 15 November. You will hear back from the Council within a month of the deadline. The types of grants are as follows.

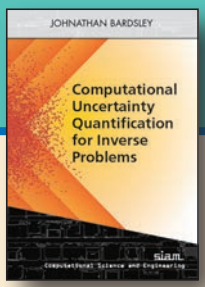
NZMS Student Travel Grants (for travel commencing after December 15). The NZMS invites applications from students for financial support for the presentation of research at conferences, attending workshops, and developing new collaborations. Typical grants for travel within NZ and Australia are in the range $200-$600. For travel further overseas, larger grants may be considered. To be eligible, a student must be based at an institution in New Zealand and be active within the New Zealand mathematical community. NZMS Student Travel Grants can contribute to costs including: flights, conference registration, accommodation, and travel-related costs associated with family responsibilities. NZMS Student Travel Grants are generously supported by an annual grant from the Margaret and John Kalman Charitable Trust .

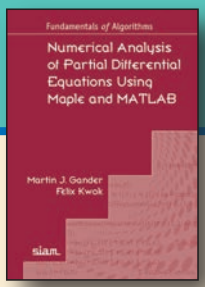
NZMS Financial Assistance. The NZMS invites applications for financial assistance with the costs of mathematical research-related activity. Any research-related activity will be considered. For example: hosting mathematical visitors; organising conferences, workshops, or outreach activities; and conference attendance, including costs associated with family responsibilities.

Further information and application details can be found on the NZMS website: nzmathsoc.org.nz/?assistance.

NEW AND NOTABLE TITLES FROM SIAM







BIG Jobs Guide: *Business, Industry, and Government Careers for Mathematical Scientists, Statisticians, and Operations Researchers*

Rachel Levy, Richard Laugesen, and Fadil Santosa

Jobs using mathematics, statistics, and operations research are projected to grow by almost 30% over the next decade. *BIG Jobs Guide* helps job seekers at every stage of their careers in these fields explore opportunities in business, industry, and government (BIG) by providing insight on what skills to offer employers, how to write a high-impact resumé, where to find a rewarding internship, and more.

2018 / xii + 141 pages / Softcover / 978-1-611975-28-4
List $25.00 / SIAM Member $17.50 / Student $15.00 / OT158

Computational Uncertainty Quantification for Inverse Problems

Johnathan M. Bardsley

This book is an introduction to both computational inverse problems and uncertainty quantification (UQ) for inverse problems. The book also presents more advanced material on Bayesian methods and UQ, including Markov chain Monte Carlo sampling methods for UQ in inverse problems. Each chapter contains MATLAB code that implements the algorithms and generates the figures, as well as a large number of accessible exercises.

2018 / viii + 135 pages / Softcover / 978-1-611975-37-6 / List $59.00 / SIAM Member $41.30 / CS19

Numerical Analysis of Partial Differential Equations Using Maple and MATLAB

Martin J. Gander and Felix Kwok

This book provides an elementary yet comprehensive introduction to the numerical solution of partial differential equations. Used to model important phenomena, these equations have applications in engineering and the life sciences, and most can only be solved approximately using computers.

2018 / x + 153 pages / Softcover / 978-1-611975-30-7 / List $64.00 / SIAM Member $44.80 / FA12

Core-Chasing Algorithms for the Eigenvalue Problem

Jared L. Aurentz, Thomas Mach, Leonardo Robol, Raf Vandebril, and David S. Watkins

This book presents a new view of John Francis's implicitly shifted QR algorithm. The new version chases core transformations (not bulges), allowing the development of fast algorithms for eigenvalue problems with a variety of special structures.

2018 / x + 149 pages / Softcover / 978-1-611975-33-8 / List $64.00 / SIAM Member $44.80 / FA13

Structure-Preserving Doubling Algorithms for Nonlinear Matrix Equations

Tsung-Ming Huang, Ren-Cang Li, and Wen-Wei Lin

This is the first book to provide a unified treatment of structure-preserving doubling algorithms, which have been recently studied and proven effective for notoriously challenging problems. The authors present recent developments and results for the theory of doubling algorithms for nonlinear matrix equations associated with regular matrix pencils, and highlight the use of these algorithms in achieving robust solutions for notoriously challenging problems that other methods cannot.

2018 / Approx. xii + 144 pages / Softcover / 978-1-611975-35-2
Visit bookstore.siam.org/fa14 for pricing / FA14

Mathematical Models and Their Analysis

Frederic Y. M. Wan

Much can be learned about real-life phenomena through modeling and mathematical analysis, even before numerical simulations are used to accurately portray the specific configuration of a situation. Scientific computing also becomes more effective and efficient if it is preceded by some preliminary analysis. Wan uses models of historical importance to demonstrate these advantages of mathematical modeling in an easily understandable way.

2018 / xx + 402 pages / Softcover / 978-1-611975-26-0
List $74.00 / SIAM Member $51.80 / CL79

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