NEWSLETTER

OF THE

N E W   Z E A L A N D   M A T H E M A T I C A L   S O C I E T Y

Contents

PUBLISHER'S NOTICE

This newsletter is the official organ of the New Zealand Mathematical Society Inc. This issue was edited by Fabien Montiel and Melissa Tacy. 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 nzmsnews@maths.otago.ac.nz. LaTeX templates are available upon request from the editors.

The official address of the Society is:

The New Zealand Mathematical Society,
c/- The Royal Society of New Zealand,
P.O. Box 598, Wellington, New Zealand.

However, correspondence should normally be sent to the Secretary:

Dimitrios Mitsotakis
School of Mathematics and Statistics
Victoria University of Wellington
PO Box 600
Wellington 6140
New Zealand
dimitrios.mitsotakis@vuw.ac.nz

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Wenjun Zhang	AUT (SCMS)

Web Sites

NZMS homepage: nzmathsoc.org.nz (Webmaster: D.J.W.Simpson@massey.ac.nz)

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

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EDITORIAL

Congratulations everyone on surviving 2021, it's been another tough year. When we put out the last newsletter editions the country had just been put back into Level 4 lockdown due to the emergence of cases of the delta strain of COVID. We all hoped the outbreak would be swiftly contained as 2020's outbreaks were. Unfortunately that wasn't the case, particularly in Auckland. At the time of writing we are just emerging into the new traffic light system and learning to navigate its requirements. Can we dare to be hopeful for 2022? That will likely depend on how much of the Greek alphabet everyone (not just our students) will get to learn! Either way, the NZMS has great plans for the future of the Society, as highlighted in the President's column.

The lockdowns and restrictions unfortunately meant that the NZMS Colloquium due to be held at University of Canterbury had to be postponed to 2022. Instead a mini-colloquium was held online. We heard from last year's ECR prize winners, Geertrui Van de Voorde and Gabriel Verret, conducted the AGM and learnt of this year's prize winners (details in the Presidents column). Congratulations to all!

This edition is our final one as editors. But we are happy to announce that the new editorial team has been finalised, Marie Graff (University of Auckland) and Chris Stevens (University of Canterbury). We wish them well in this new role.

Fabien Montiel and Melissa Tacy

PRESIDENT'S COLUMN

I teach a 100-level mathematical modelling course. For years I've covered classical epidemiological models, usually spiced up with zombies and clips from the Contagion movie. I thought that this semester was the time I'd really get to demonstrate how relevant maths is. We'd explore the very same models that were being discussed on the news. But no. The students are just as fatigued by COVID and SIR and lockdown and zoom as we are.

For Academics, this has been a year of online lectures, online tutorials, online exams, online conferences, online seminars and, for me, an almost completely online tenure as president of the NZMS. So I was really very disappointed to miss out on an in-person Colloquium this year. The micro-colloquium worked fine, but it is no substitute, just like online teaching is no substitute for classrooms, despite the wishful thinking of our university administrators.

Even so, the NZMS has still had a very active and successful year.

There has been a lot of work around the high-profile Royal Society panel on mathematics education, chaired by Gaven Martin. Several NZMS members were on the panel, others were involved preparing reviews and providing support. The report shows that there need to be significant changes in mathematics education in this country, and more support for mathematics teachers. The NZMS must play a key role in following up this report and helping bring about the real change needed.

The NZMS education group has also been extremely active in the current revision of NCEA level mathematics, writing submissions, helping modernise the curriculum, and making sense of what decolonisation means for mathematics.

There has been ongoing work improving links between the NZMS and others in the mathematical community (and beyond). We have signed a reciprocal agreement with AMSI[1] an organisation with an impressive track record of championing mathematics and statistics and building links. They have promised concrete support in a range of areas. We've started talks with AMSI, the NZSA[2] and ANZIAM[3] aimed at creating internship opportunities for NZ mathematics and statistics students.

Those involved in student advising will be aware of the MathsAdds initiative[4], a fabulous online career resource for mathematics students and academics. For the first time, this Australian publication will include NZ students and positions.

We are working on the website. The NZMS website has been an invaluable tool for communicating with members, supporting students and advocating for mathematics. There will be complete redesign of the site, building on the years of expert, and much valued, work by John Shanks.

The trial run for the NZMS online seminar was successful. The intention was to provide a framework to broadcast quality talks from different universities. We will also invite speakers directly. We will be in contact with local seminar organisers early in the new year and draw up a schedule for the semester.

The society is working hard to reduce representation bias with respect to gender, diversity and identity. Aspects of this work should become embedded in our bylaws and constitution. I also think that our constitution should reflect the fact that the society is part of Aotearoa New Zealand and acknowledge out obligations under the Treaty. Expect consultation and discussion documents on these changes in the new year.

Finally, I have a large number of people to thank on behalf of myself and the NZMS.

Thanks to the Prize Committee, accreditation committee, Gillian Thornley prize committee and the Nomination Committee. These people, who remain anonymous, do critical work keeping our selection process fair and effective. Thanks to those in the education committee, particular the former convenor Cami Sawyer and the new co-convenors Julia Crawford and Sione Ma'u. Thanks also to those involved in the Royal Society report, both those on the panel and those reviewing. Thank you John Shanks and David Simpson for maintaining the NZMS website, and to Fabien Montiel and Melissa Tacy for editing the newsletter. Thanks again to John Shanks for his work as membership secretary.

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[1] Australian Mathematical Sciences Institute https://amsi.org.au/

[2] New Zealand Statistical Association

[3] Australia and New Zealand Industrial Applied Mathematics

[4] https://careers.amsi.org.au/

A big thank you to the NZMS council. My abrupt jump to the position of president entailed a pretty steep learning curve, and the council have patiently tolerated my lack of experience with NZMS protocols.

Finally I'm especially indebted to Graham Donovan as vice president and Phil Wilson as secretary. Both of Graham and Phil agreed to take these positions as a temporary stop-gap. I've really appreciated their support, hard work, and sage advice.

David Bryant

New fellows of the NZMS

- Liz Ackerley (Canterbury)

- Igor Kontorovich (Auckland)

- Michael Plank (Canterbury)

- Claire Postlethwaite (Auckland)

- Cami Sawyer (Ministry of Education)

- Chris Tuffley (Massey)

Prizes of the NZMS

Gillian Thornley Award for outstanding contribution to the cause or profession of mathematics

This annual award was established in 2020 to recognize outstanding contributions to the cause or profession of mathematics in New Zealand. The award will be made to a person or group that has made an outstanding contribution to mathematics within NZ.

The Gillian Thornley Award for 2021 goes to Dr Ross Atkins (Verizon Connect), for outstanding service in supporting mathematics in Aotearoa NZ through his work with the NZ Mathematical Olympiad Committee. Ross has volunteered with the NZMOC since 2017. In that time, he has introduced innovations in the training programme, initiated a NZ Mathematical Olympiad competition, and provided strong leadership as team leader or deputy team leader for four International Mathematical Olympiads.

Kalman prize for best paper

The Kalman Prize for Best Paper was instituted in 2016 to recognise excellence in research carried out by New Zealand mathematicians. The Prize will normally be awarded annually for an outstanding and innovative piece of research in the mathematical sciences published by a member or members of the NZMS. The Prize is for a single publication of original research, which may be an article, monograph or book, having appeared within the last 5 calendar years: 2016-2020. The value of the Prize is \$5000. The Prize is generously funded by the Margaret and John Kalman Charitable Trust, and recognises the significant contributions to mathematics in New Zealand made by Professor John Kalman.

This year's Kalman prize is awarded to Professor Eamonn O'Brien, as co-author of the paper *Surjective word maps and Burnside's $p^a q^b$ theorem*.

Robert M. Guralnick, Martin W. Liebeck, **E.A. O'Brien**, Aner Shalev and Pham Huu Tiep. "Surjective word maps and Burnside's $p^a q^b$ theorem", Inventiones Mathematicae 213(2) 589-695, 2018.

The nomination for this paper describes it as one of the two or three most significant research achievements a New Zealand based mathematician has ever been involved with.

NZMS Early Career Research Award

This award was instituted in 2006 to foster mathematical research in New Zealand and to recognise excellent research carried out by early-career New Zealand mathematicians. Candidates will be judged on their best three published research outputs and a brief CV. Research outputs could include publications in books, journals, other peer-reviewed venues, or other types of high quality mathematical research.

The 2021 NZMS early career award goes to Martino Lupini from Victoria University in Wellington. Dr Lupini pursues research in disparate areas of mathematics including functional analysis, dynamical systems, algebraic topology, combinatorics, and mathematical logic. He has made unique contributions to many fields by making connections between them.

NZMS Research Award

This annual Award was instituted in 1990 to foster mathematical research in New Zealand and to recognise excellence in research carried out by mathematicians in New Zealand. This Award is based on mathematical research published in the last five calendar years (2016-2020).

The 2021 NZMS award goes to Clemency Montelle at the University of Canterbury. Professor Montelle pursues outstanding research in the field of the history of mathematics, employing the rare combination of fluency in ancient languages and an extensive background in mathematics to uncover hitherto unknown profound and diverse mathematical achievements of our predecessors.

EDUCATION

Comment on the Royal Society Report

The Royal Society Te Apārangi Advisory Report on Mathematics Education has been released. There has been a lot of media interest in the Advisory Panel's work after the latest PISA[5] and TIMSS[6] studies (in 2018 and 2019 respectively) revealed the continuing decline in the level of attainment of mathematics in NZ schools.

The Panel's report emphasises that the problem is not so much with the curriculum as it is with the whole system of delivery. The fact is that if most students were achieving at the appropriate curriculum level for their age, they would be well positioned to master essential numeracy skills for the modern world as well as succeed in their further studies in mathematics and statistics.

While 81% of Year 4 students are at the expected level for their year, 55% of Year 8 students are *below* the expected level. The most drastic slippage occurs in low decile schools and among Māori and Pacific learners. The system perpetuates and exacerbates inequity.

Of the 14 recommendations in the report, only one recommendation deals specifically with curriculum content (introduce some concepts earlier, e.g. fractions). The others mainly target the education system, to provide adequate resources, guidance and renumeration for teachers, and to improve the quality of learning for students.

The New Zealand Institute for Economic Research (NZIER) has produced a couple of notes (NZIER Insights 98-2021, 99-2021) commenting on the Panel's report. In the second note they claim that the problem is not simply a lack of funding. NZ compares favourably with other OECD countries when it comes to government spending on education and staff-to-student ratios. A key thing that is missing is specialist mathematics expertise at primary and intermediate level.

Changing the current system as recommended in the report will require substantial government investment and commitment. Even if all the recommendations were implemented, it would take a decade to see results.

From the Education Group, I am pleased to see the involvement of mathematicians; members of the NZMS made up a third of the panel. Whatever government is in power, we need to keep pushing for policies that maintain a high standard of mathematics education.

We should also support ongoing initiatives that would address (even on a small scale) some of the recommendations. For example, mathematics enrichment and enhancement programmes for teachers and/or students (such as the Pacific Academy at the University of Auckland's South Campus) do make a difference. We can also learn from the success of such programmes overseas. It would be good to develop local examples that demonstrate in practice the truth of the claim in the Royal Society's report:

Given the right circumstances, everyone can learn mathematics and statistics, and a significant proportion can excel.

Links to further information

1. The Royal Society report:
   https://issuu.com/royalsocietynz/docs/pangarau-mathematics-and-tauanga-statistics-in-aot

2. NZIER Insights:
   https://nzier.org.nz/publication/declining-maths-scores-is-a-problem-for-the-new-zealand-economy

3. NZ Herald article:
   https://www.nzherald.co.nz/nz/school-maths-education-royal-society-report-calls-for-sweeping-changes/AHSDIC2EDB3WCATPMLR2R72PHU/

4. Radio NZ Nine to Noon segment:
   https://www.rnz.co.nz/national/programmes/ninetonoon/audio/2018821655/no-maths-economy-suffers

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[5]Programme for International Student Assessment
[6]Trends in International Mathematics and Science Study

NCEA update

The NCEA Review of Mathematics and Statistics was mentioned in the August newsletter. The position of the NZMS Education group was to keep Mathematics and Statistics as one subject at Level 2 and only split it into two subjects at Level 3. The concern with splitting it at level 2 was that allowing specialisation this early (e.g. taking statistics without mathematics) would result in students ending up with an inadequate mathematical background for many pathways.

However, the Ministry of Education decided to split Mathematics and Statistics into separate subjects at Level 2. This move was supported by the New Zealand Association of Mathematics Teachers (NZAMT) and the Statistics Education Group. Two subjects have twice as many achievement standards as one subject, which could be an advantage for students who concentrate on this Learning Area. (Each subject has 4 standards.) Although a split was not our ideal outcome, we argued strongly that schools should be given clear advice about what courses and standards are needed for particular pathways, to minimise student choices that lead to dead ends.

The Ministry of Education also floated the idea of a new subject in the Mathematics and Statistics Learning Area at NCEA Level 3 (tentatively called "applied maths"). We proposed a subject that combines data science, modelling and operations research, and uses a range of concepts in both mathematics and statistics. The Statistics Education Group supported collaborating with us on developing such a subject. In the end the Ministry dropped it from the final list of Level 2 and 3 subjects which was released in October. This is most likely due to a lack of funding.

Final subject list:
https://ncea-live-3-storagestack-53q-assetstorages3bucket-2o21xte0r81u.s3.amazonaws.com/s3fs-public/2021-09/TheNewCurriculumNCEAsubjectsLevel2&3.pdf

Sione Maʻu

THE WOEFUL STATE OF MATHEMATICS EDUCATION IN AOTEAROA NEW ZEALAND SCHOOLS

A generation of New Zealanders has been failed

The widespread and significant decline in student performance at schools in Aotearoa New Zealand, evidenced by both national achievement levels and international benchmarks, prompted an independent review by a Royal Society Te Apārangi Expert Advisory Panel, solicited by the Ministry of Education. The review panel consisted of mathematicians, statisticians, economists and mathematics education researchers, and their report can be found at https://www.royalsociety.org.nz/what-we-do/our-expert-advice/all-expert-advice-papers/pangarau-mathematics-and-tauanga-statistics-in-aotearoa-new-zealand/. The aim was to draw from all the evidence available from both large-scale international indicators, such as PISA and TIMSS, OECD data, and the Government's own indicators such as the long-term study "Growing up in NZ" and annual performance results such as the National Monitoring Study of Student Achievement. The Panel identified a decades-long, ongoing decline in student mathematical achievement against virtually all benchmarks and distressing trends showing increasing inequity in mathematical achievement.

"Looking at the data we get from the Ministry of Education, New Zealand's poor performance on international benchmarks in mathematical skills and those sorts of things, and I would honestly say a generation of New Zealanders has been failed," one of us said in a recent media release. The report has finally provided a fact base to support a sense many of us had for some time – the students coming to university know less and less year on year. This issue, coupled with the impact of Covid-19, will inevitably translate into additional challenges for many of us teaching at the tertiary level as we try to maintain learning outcomes standards.


PISA benchmarks from 2003
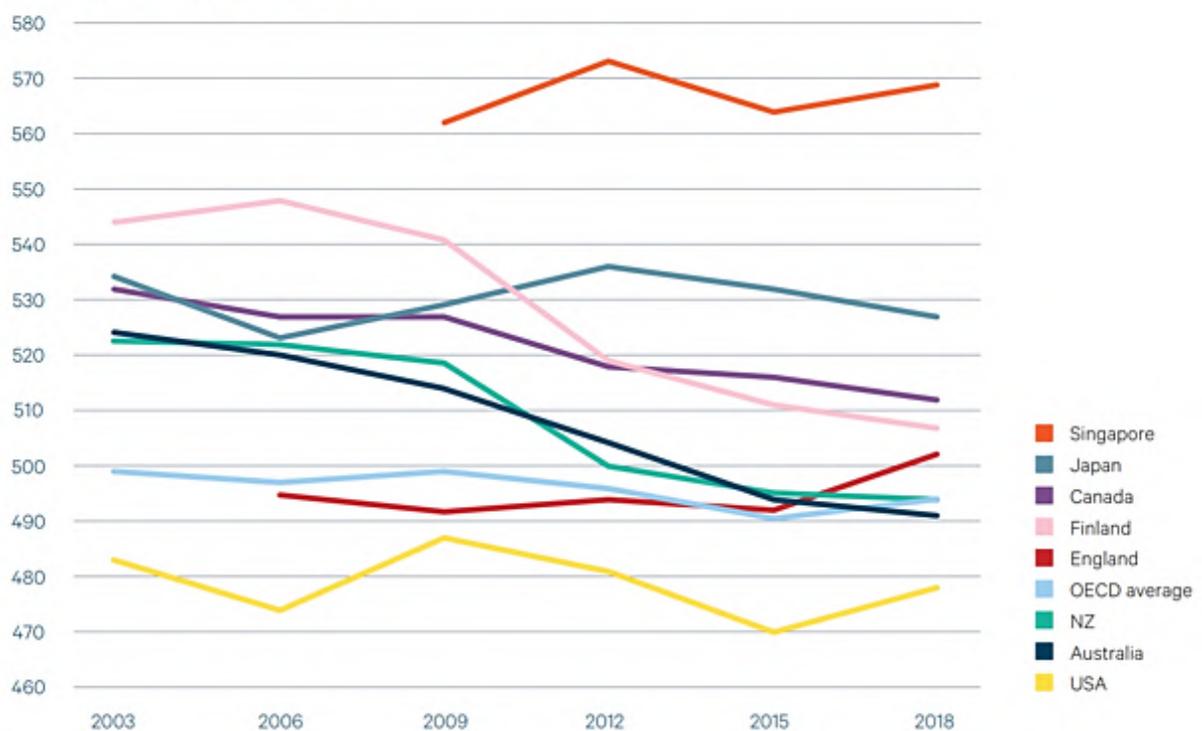
The Panel attempted to tease out the key relationships and dependencies between the current mathematics curriculum and student learning experience. While there are a number of isolated examples of exemplary practice in some schools, they were able to identify the many unfortunate changes that were implemented on a national scale in the last two decades, which have negatively impacted student learning experiences – the infamous "Numeracy project" among them. This is doubly sad since there is compelling evidence showing very poor life outcomes in health, wealth and wellbeing for those with low levels of numeracy (see https://workresearch.aut.ac.nz/research/low-literacy-and-numeracy-research).

In fact it has been shown that while both are strongly correlated poor numeracy has worse outcomes than poor literacy! Other studies indicate our levels of numeracy likely impact our economy by more than 2% p.a. (a few billion dollars a year in lost productivity, forgoing the obvious opportunity gains). And don't get us started on OECD skills outlook for future economies and the role mathematics plays in them, with the NZ Productivity Commission saying our country should simply import those with the skills we need. Apparently, properly educating our children is either too expensive or too hard – better to let another economy do it. So our children should do what exactly?

Year 9 maths - achievement by ethnicity
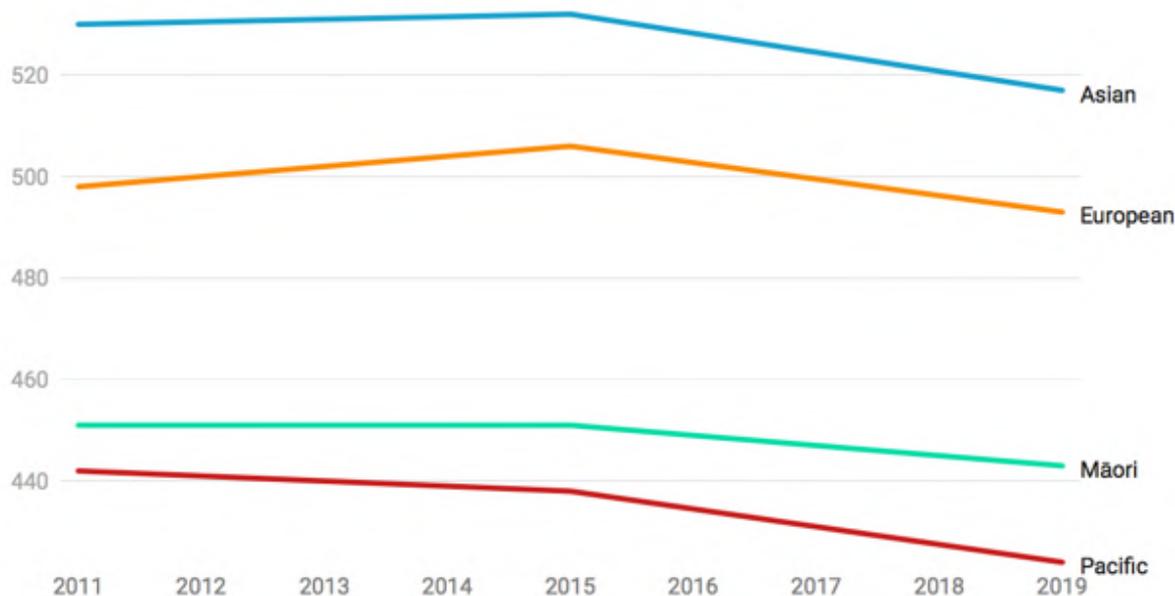
Source: Trends in International Mathematics and Science Study (TIMSS) · Get the data · Created with Datawrapper

The Panel's 56-page report makes 14 recommendations that are centred on four themes:

Slippage: This central theme describes how year on year many of our students fall away from the trajectory described by the current Mathematics and Statistics curriculum. It leads to outcomes such as fewer than one in ten 14-year-olds are in classes where the majority of their peers are working at the appropriate curriculum level. Indeed, if most ākonga students achieved the current curriculum levels in the suggested timeframe, they would be well-positioned to succeed in mathematics and statistics and use mathematics effectively in their daily lives, but this is not what happens in reality.

Teacher discipline and pedagogical knowledge: In Aotearoa New Zealand very few primary teachers have specialised in mathematics or mathematics teaching, and only 14% of Year 5 teachers have specialised. Yet, studies have shown that teacher knowledge "well beyond the student level" is essential to be able to plan how to implement the curriculum, answer questions meaningfully, make connections, and make the most of the teachable moments. The Panel considered both the necessity of and difficulty in supporting and enhancing teachers' discipline and pedagogical knowledge and made concrete recommendations.

Leadership: The Panel recognised the need for a more centralised approach to support coherence and clarity around teaching and learning. This includes fixing the problem of significant numbers of under-prepared teachers in mathematics and statistics and simplifying the selection and delivery of suites of excellent supporting material written by content-matter and pedagogical experts – it currently falls on unsupported teachers to choose within a vast array of available material. There is a question about whether the good intentions around localisation of the curriculum have gone too far - with localisation damaging the ability of the curriculum to be nationally coherent.

Inequity: The evidence shows our current mathematics and statistics education system as a whole perpetuates, indeed grows, inequity. While a general characteristic, it must be addressed specifically within the context of mathematics and statistics teaching and learning. The Panel did not expect that all students will achieve equally, or study mathematics and statistics with a passion, but they do expect that all students will have an opportunity

to develop a positive and productive relationship with mathematics and statistics in order to develop the skills and knowledge that will realise the opportunities and life outcomes such engagement delivers.

The report emphasised the importance of improving mathematics and statistics outcomes for all learners, thereby bringing benefits to us all. "Failing to invest now will cost us all, as a society, a great deal. This is not just about learners, teachers and schooling, it is about the wellbeing of Aotearoa New Zealand as a nation".

It appears that many New Zealand mathematicians are blissfully unaware of the seriousness of the situation apart from those with children whose mathematics assignments have been supplemented with messages from a teacher or a principal suggesting we are not to teach our children "the basics" such as how to multiply numbers at home as the methods have evolved. We have literally been told that 3 x 4 is not the same as 4 x 3 by mathematics teachers, and a principal of a decile 9 school in Auckland. The situation is dire! Have a look at the figure below with the data on student performance on a set of questions assessing the basics against students of the same age from 70 other countries.

Item label	Type	NZ % correct	International Average	Comment
27 x 43 =	MC	16	53	Last
Add 385 to 5876	CR	26	67	Last
804 divided by 6	MC	58	74	5th lowest
Number added to 73 with sum of 1068	CR	25	49	3rd lowest
3126 + 845 + 72 =	MC	39	72	Last
6 x 312 =	CR	30	65	3rd last
2.34 + 0.2 =	MC	19	29	
927/3 =	CR	19	46	3rd last

Note that MC means multi-choice with four possibilities, so 25% or less is worse than random guessing.

The systemic failures of our education system are manifold; they are especially pronounced in mathematics. These failures are going to take decades to rectify. We, the NZMS members, as a community of mathematicians representing the discipline, should pay more attention to mathematics education in New Zealand schools and insist on high-quality teacher training and pedagogical practice that is both informed by research and based on evidence so as to prevent the implementation of educational fads. Such research should be conducted according to scientific standards that afford transferable, generalisable conclusions to avoid reforms that, despite good intentions, when not properly supported, ultimately do harm when unplanned and untested side effects emerge.

Tanya Evans and Gaven Martin

MATHEMATICAL MISEPONYMY

The Pell Equation

The Pell equation (Pell's equation, the Pellian), for a given positive integer n, is the equation $x^2 - ny^2 = 1$ in the two unknowns x and y and integer solutions (x, y) are sought. Here I shall rely a lot on the 1912 PhD thesis of E. E. Whitford, [3][7]. The first sentence of [3] states the equation but the second recalls another miseponymy:

> As will be shown, John Pell had but little to do with it; and yet, to attempt to rename it would be like trying to give another name to North America because Vespucius was not its discoverer.

Whitford goes on to offer the following explanation for the miseponymy (citing [1]):

> The name originated in a mistaken notion of Leonard Euler that John Pell was the author of the solution which was really the work of Lord Brouncker. Euler in his cursory reading of Wallis's algebra must have confused the contributions of Pell and Brouncker. Wallis gives Pell credit for certain researches in indeterminate analysis, but where $Ay^2 + 1 = x^2$ is discussed only Brouncker's methods are set forth.

So who did discover the Pell equation? Not surprisingly it doesn't really seem to be a simple matter of identifying **the** person. Before addressing this further it is worth noting that if one can find reasonably large solutions (x, y) then from simple algebra $\frac{x}{y}$ gives a good approximation to $\sqrt{n}$ (and if you prefer geometry then this is the same as saying that (x, y) is close to the asymptote of the hyperbola defined by the Pell equation). For example $(577, 408)$ satisfies Pell with $n = 2$, and $\frac{577}{408} = 1.414215\ldots$ while $\sqrt{2} = 1.414213\ldots$. Whitford refers to tablets from Babylon 4000 years ago that list square roots suggesting that solutions to the Pell equation appeared that long ago. The Greeks and Indians were also interested in square roots and $\frac{17}{12}$ and $\frac{577}{408}$ were both used as approximations to $\sqrt{2}$ around 400BC.

Both [2] and [3] mention Diophantus and Archimedes as being likely to have investigated some examples of the Pell equation: the solution to Archimedes's cattle problem really involves solving such an equation, though Whitford doubts whether the cattle problem was proposed by Archimedes or even in his time and "if he did propose it then he certainly could not solve it," giving the first 30 and last 12 digits of the number of yellow bulls and omitting the 206502 digits between. Unlike [3], however, [2] is rather definite in declaring who really started it all: "it is fair to say that Brahmagupta was the first to study this equation."

In any case both [2] and [3] discuss Brahmagupta's contributions, but even then these two sources do not quite agree. Both describe methods known to Brahmagupta for generating arbitrary solutions from specific ones but then diverging:

- [2] states "Brahmagupta's lemma was discovered by Brahmagupta in 628AD";
- [3] states "we can hardly suppose that they originated with Brahmagupta."

In any case it seems to have been well-established a thousand years before Pell and Brouckner came along.

References

[1] L. Euler, *Letter to C. Goldbach IX*, in P. H. Fuss (ed), *Correspondance mathematique et physique de quelques celebres geometres du XVIIIieme siecle*, St Petersburg, 1843.

[2] J J O'Connor and E F Robertson, *Pell's equation*, `https://mathshistory.st-andrews.ac.uk/HistTopics/Pell/#:~:text=where%20n%20is%20a%20given,related%20to%20Pell's%20equation.`

[3] Edward Everett Whitford, *The Pell Equation*, Doctoral Thesis, Columbia University, New York, 1912, `https://quod.lib.umich.edu/cgi/t/text/text-idx?sid=b88432273f115fb346725f1a42422e19;c=umhistmath;idno=ABV2773.0001.001.`

David Gauld

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[7]On page (ii) you are invited to buy a copy of the thesis for $1, postpaid!

PROFILE

Michelle Dalrymple

(The permission of the Prime Minister's Science Prize Secretariat to use published material on this annual Prize is gratefully acknowledged.)

Dr Michelle Dalrymple, Mathematics and Statistics Faculty Head at Cashmere High School in Christchurch, is the 2019 Prime Minister's Science Teacher Winner. This prize was formally announced in mid-2020. Michelle is the first Mathematical Sciences teacher to win this award since it began. It serves to highlight the fact that Mathematics and Statistics features strongly in the STEM grouping of subjects.

Michelle's nomination for the prize says her teaching stands out because it is strongly based on cutting-edge mathematics and statistics education research, while maintaining originality, creativity, and fun with strategies that are relevant and inspiring for her students. Her fascination with Statistics was sparked at the University of Canterbury. Over twenty years ago, Michelle successfully completed her PhD in Statistics at that University under the supervision of Irene Hudson, now Professor at the Royal Melbourne University of Technology. Her work is grounded in strong personal mathematics and statistics content knowledge and the research, theories, and practices of mathematics and statistics teaching, growth mindset, positive pedagogies of care, and culturally responsive teaching. Michelle's teaching also reflects New Zealand-focussed and international research literature and practical classroom-based resources.

Her pet dogs are even involved in exercises like random sampling by video, which has been a hit with her students and on her blog which she shares on social media.

Within her school, Michelle shares her experience, growing the expertise of other teachers towards all students flourishing academically and personally. Whilst at a regional and national level, Michelle has made substantial contributions in a range of Ministry of Education and NZQA development teams that have led to improved outcomes for students nationwide. She has also facilitated many professional development workshops for teachers around the country and at conferences.

Recent events at Cashmore High School show things continue to expand. Her faculty has finally moved into a delightful new Mathematics and Statistics block earlier this year (post-earthquake rebuild), and Michelle reports that "teaching continues to be thoroughly rewarding, enjoyable, challenging and busy". She leads a faculty of 17 other staff. They have recently been involved in piloting the new Numeracy standard, which will be a co-requisite as part of the NCEA changes, and over 400 Year 10 students completed their digital assessment in October.

In the wider community, Michelle gave a keynote address (online) for the Auckland Mathematics Association in September last year (the topic was "Setting up and maintaining a successful class") and was the inaugural "current teacher" keynote speaker for Auckland Statistics Teachers' Day in November last year (with topic "10 teaching activities: whanaungatanga - teaching through relationships"). This year, Michelle was a member of the The Royal Society Te Apārangi Expert Advisory Panel on Mathematics and Statistics, and that report appeared in October.

Michelle Dalrymple continues to demonstrate hands-on leadership across the spectrum of secondary teaching in Mathematics and Statistics and the Mathematical community are proud to congratulate her on her ongoing success.

Graeme Wakes

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

Promotion Robin Hankin was promoted to Associate professor in October.

Grant success Associate Professor Willem van Straten and Dr Patricio Maturana-Russel are Associate Investigators on a Marsden Fund Council Award project led by Renate Meyer from the University of Auckland. The project will contribute toward the study of gravitational waves using the Laser Interferometer Space Antenna (LISA), an international project led by the European Space Agency (ESA). This project will make core contributions to gravitational wave science and facilitate participation by New Zealand scientists in the LISA mission, a space-based gravitational wave detector being developed by ESA.

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

It's official! The Mathematics Department at the University of Auckland has been officially declared a "location of interest". That's a good thing, right?

But seriously, 9 days into our most recent lockdown there was an announcement there had been a covid positive case in the department on Tuesday 17 August. Fortunately they were already double vaccinated, there was no transmission of covid on campus, and the affected person has recovered well.

All teaching and assessment was online for more than 7 weeks of the semester, and no staff or students have been on campus for over 3 months. We are all zoomed out.

To keep us from being completely bored, the Curriculum Transformation project continues to investigate all possible futures for how a university might approach teaching and learning, and there is a restructure of research support that is going to direct research funding away from departments and towards large transdisciplinary research centres.

On the plus side, the department is launching two new degree programmes in 2022:

Jointly with Economics we will be offering a 3 year BSc in Quantitative Economics. Currently the only ways to double major in maths and economics are to do a BA or a conjoint BCom/BSc. This new programme allows to do a double-major in maths and economics within the BSc.

We have also developed an inter-faculty Masters of Mathematical Modelling (MMathModel) programme, which includes a flagship 180 point masters, but also has a graduate diploma and a post-graduate certificate as options. It has been co-designed with Engineering Science and features core course from both departments.

Congratulations to our two staff who were successful with their Marsden proposals.

Claire Postlethwaite's project is "Beyond survival of the fittest: population dynamics of cyclic competition networks" with Associate Investigators Hinke Osinga, Alastair Rucklidge (University of Leeds) and Cris Hasan (University College Cork).

Jeroen Schillewaert's project is "A geometric study of exceptional symmetry" with Associate Investigators Hendrik Van Maldeghem (Ghent University) and Anne Thomas (University of Sydney).

The biggest activity taking place in the department (albeit virtually) is the aptly-named Herenga Delta 2021 Conference (also called the 13th Southern Hemisphere Conference on Teaching and Learning of Undergraduate Mathematics and Statistics). See https://www.herengadelta.org/

Rachel Passmore, on behalf of the department and the Kalman trust has coordinated the Kalman teacher awards. A list of winners is here https://www.aucklandmaths.org.nz/2021-kalman-award-winners/

Our former student Hongjia Henry Chen has been awarded the Clarkson Medal of the Global Undergraduate Awards for his BSc(Hons) thesis on mathematical billiards, supervised by Hinke Osinga. Henry's thesis focused on periodic orbits of quadrilateral billiard tables, the square, rectangle, and parallelogram. By combining techniques from geometry, dynamical systems, and bifurcation theory, the thesis provided alternative proofs of classical results for square billiards with additional insights for rectangles and made new connections with number theory. You can read more here https://www.auckland.ac.nz/en/news/2021/11/09/global-win-for-university-of-auckland-science-student.html

Staffing

There has been some turnover in professional staff. Gemma Todd and Shamim Shadfar have left and been replace by Dahye Kim and Joy Rane respectively.

Bernd Krauskopf's research fellows are on the move. Andrus Giraldo is going to the Korea Institute for Advanced Study in Seoul. Stefan Ruschel is moving to the UK.

The University of Groningen is publishing a series of interviews with female alumni as part of their celebrations that Aletta Jacobs started her studies 150 years ago. Aletta studied Medicine and is the first female student (UG, PG, and PhD) in The Netherlands, starting on 20 April 1871 and finishing with a PhD on 8 March 1879; hence, she was a contemporary of Kate Edger. They publish a new interview each week and Hinke Osinga was invited for the first batch of three women. You can find the interviews at https://www.rug.nl/alumni/about-alumni/alettajaar/in-de-voetsporen-van-aletta

Igor' Kontorovich and a number of PhD students in Mathematics Education had a writing retreat at Vaughan Park, Long Bay, Auckland (pre-lockdown).

Jeroen Schillewaert gave (online) talks at the Oxford Combinatorics world relay in June, a conference in honor of Ruth Charney at Ohio State University in July, Groups, geometry and complexity (Newcastle, UK) in August, and Buildings in Magdeburg, Germany in October.

Melissa Tacy is teaching a mini-course at the AMSI Summer School in early 2022.

Priya Subramanian has arrived in NZ and spent her MIQ in Rotorua. She is a Senior Lecturer in Applied Mathematics working in dynamics, pattern formation in physical systems, and soft matter quasi-crystals. Her previous postion was a Hooke research fellowship at the Mathematical Institute in Oxford.

Rod Gover delivered (virtually) a 3 lecture mini-course at SCREAM: Symmetry, Curvature Reduction, and EquivAlence Methods (Norway). He will give a 2 lecture mini-course and one research lecture at the Erwin Schroeodinger Institute in Vienna for the Programme "Geometry for Higher Spin Gravity: Conformal Structures, PDEs, and Q-manifolds" (FCG21).

Steven Galbraith participated in a Banff workshop on isogenies. His PhD student Qin Ling got an MIQ slot and arrived in NZ in October. He is the Programme Chair of the CT-RSA 2022 conference. He is invited to give an (online) plenary lecture at the 2021 Vietnam Institute for Advanced Study in Mathematics Meeting on Mathematical Aspects of Computer Sciences (VM-MACS 2021).

Finally, Bakh Khoussainov (Computer Science), who was the most recent NZMS-LMS Aitken Lecturer, will be spending the majority of the next couple of years at the University of Electronic Science and Technology of China (UESTC) in Chengdu, Sichuan, China.

Steven Galbraith

DEPARTMENT OF ENGINEERING SCIENCE

Professor Rosalind Archer will be leaving the University to take up a position as Head of the School of Engineering and Built Environment at Griffith University in Australia. Within the Department of Engineering Science, Rosalind was Head of Department for seven years. She held the Mercury Chair in Geothermal Reservoir Engineering and is Director of the Geothermal Institute. Within the Faculty, Rosalind leaves a substantial legacy as a co-founder of Women in Engineering (WEN), a long-term member of and current Chair of our Equity Committee, and currently the Deputy Dean of the Faculty of Engineering. Rosalind has served on the Engineering New Zealand Governing Board for several years and is currently President of Engineering New Zealand. The Department is very grateful for Rosalind's enthusiastic and considerable contributions over many years, in teaching to large classes and small, developing and growing postgraduate programmes, supervising students and providing pastoral care, researching in Engineering Science, and for showing leadership and providing strategic direction. We wish her every success in her future endeavours.

The article *Healthcare Pathway Discovery and Probabilistic Machine Learning*[8], which was authored by Dr Andreas Kempa-Liehr, Dr Michael O'Sullivan, Christina Lin, and their collaborators from Auckland DHB, Waitemata DHB, and Orion Health, has been selected as one of the four best papers in the field of Clinical Information Systems Research for the year 2020 by the International Medical Informatics Association[9]. The paper was selected out of 2,787 publications after receiving five independent reviews supporting the selection.

Dr James Tidswell defended his thesis *Modelling emissions and energy use in traffic equilibria*. The Department would like to offer its congratulations to his achievement.

Andreas Kempa-Liehr and Piaras Kelly

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Covid Restrictions

As of writing this is our third day back at work after almost 10 weeks of lockdown, in two bites, at level 3. As before in 2019 lockdown has really been "locked out", in that special permission was needed in writing to get into the University. The library has been completely shut, with requested books couriered to ones home address. Teaching has been completely on-line, as has examining and any related meetings. Construction of the new Student Centre however continued apace. On returning to work on Wednesday 17th November,

we were welcomed back with a basket to nibbles and drinks!

New tutor appointed

The new tutor is David Chan. He starts work here in January 2022, and further details will be given in the first Newsletter next year.

Student conference hosted by Waikato

The annual graduate and postgraduate mathematics and statistics student conference was arranged on-line this year. The local organizers were Julia Gasston, Zac Isaac and Adam Ghafouri. On the technical front all went smoothly, in-spite of the normal challenges. There were around 30 presentations and some awesome invited speakers: Associate Professor Daniel Delbourgo, Professor Roy Kerr and Dr. Lucianne Varn from Stats NZ.

The conference went very well given the last minute changes to online. There was great participation and a many folk getting involved in the social activities - disappointing however that meeting in person was not possible. There was plenty of time for networking and getting to know one another while learning about each others research.

The awards for speakers were:

- RBNZ Peoples choice: Pedro Henrique Barboza Rossetto

- Runners up peoples choice: Josh Bardwell

- Top Honours/ Masters Talk: Aden Jowsey

- Top in pure maths: Josh Bardwell

- Top in applied maths : Pedro Henrique Barboza Rossetto

- Top in statistics: Helen Smith

Thanks to Julia for this report.

Zac Isaac begins his PhD research

New PhD student, Zac Isaac's topic is modelling the transmission of light through to a fetus in the womb. This work is being supervised by Jacob Heerikhuisen and is in conjunction with Vincent Reid's research group in the School of Psychology.

Covid modelling for the Waikato DHB

Even though Waikato has been largely invisible when it comes to government briefings, the DHB covers a very large area, from near Taupo in the south and most of the Coromandel in the north east. It also covers a significant proportion of NZ's population and has the largest hospital campus in NZ situated in Hamilton. Hence it thankfully has now come to the covid modelling effort at the request of the DHB. A group within the Department comprising Han Gan, Chaitanya Joshi, Jacob Heerikhuisen, and Sean Oughton, is getting underway with this work.

Kevin Broughan

MASSEY UNIVERSITY

INSTITUTE OF FUNDAMENTAL SCIENCES

At Massey Manawatū it's been another one of those very much not business-as-usual semesters since we've all been working at home and teaching online since the latest round of lockdowns began back in August. As a result, we've seen significantly more of each other outside of work (at the local pub) than at the office of late! We admire the resilience of our colleagues at universities in Tāmaki Makaurau who have been living under significantly more challenging restrictions for a very long time now.

A significant upcoming change for our group is that we are going to be joining forces with our colleagues on the Albany campus as part of a single team, starting from next year. We'll be a group within the newly-minted cross-campus "School of Mathematical and Computational Sciences". While we already work closely together in delivering our shared courses, we're looking forward to seeing what possibilities this new school will present.

We are also looking forward to the upcoming annual Manawatū-Wellington Applied Mathematics conference on Dec 1, especially with the postponement of this year's colloquium. Thanks to Prof. Robert McLachlan for his hard work in putting this online event together.

Richard Brown

SCHOOL OF NATURAL AND COMPUTATIONAL SCIENCES

Annalisa Conversano has been promoted to Senior Lecturer.

Gaven Martin has been awarded a Marsden Fund grant entitled "Modern Analysis and Geometry."

Winston Sweatman participated in the International Astronomical Union Symposium 364 "Multi-scale (time and mass) dynamics of space objects" and was a member of the Scientific Organizing Committee. Although we would have preferred to be in person it was still good to meet online. Participants spanned a 23-hour range of time-zones.

Alona Ben-Tal will be leaving Massey University in January 2022.

Carlo Laing

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

We have some good news from our students and Professors. Dr Emma Greenbank has been appointed as a postdoctoral associate at the University of Limerick in Ireland on a 2 year contract. Her research is related to applied mathematics and in particular on how to employ asymptotic analysis and fluid mechanics in explaining geophysical phenomena. Emma, studied at Victoria University and finished her Bachelor of Science degree, MATH major in 2014. She worked towards her MATH Masters in 2015 and graduated in her PHD in MATH last May 2021. She has been a MATH Tutor and a marker since 2013 and was offered a role as a Senior Tutor in 2019. Emma has played an active role participating in different MATH events such as the MATH Challenge, the NIWA Science Fair, Porirua College after school programmes to name a few. Emma's dedication and contribution has been incredibly valuable to our school. Recently, an article related to her joint work with Prof. Mark McGuinness was published in NY times at `https://www.nytimes.com/2021/09/11/science/volcanic-bombs-surtsey.html`. Emma Greenbank is lead author on a manuscript arising out of her PhD, which has been accepted for publication in the Proceedings of the Royal Society of London Series A. The title is "A theoretical model of Surtseyan bomb fragmentation", and a copy may be viewed on arXiv at `http://arxiv.org/abs/2108.07997`. Congratulations Emma!

On Tuesday 3rd August the Inaugural Professorial lecuture for Richard Arnold took place. You can now view a recording of that lecture here: `https://www.wgtn.ac.nz/events/2021/08/inaugural-lecture-a-distractable-astronomer-learns-some-statistics` In this inaugural lecture, Professor Arnold from the School of Mathematics and Statistics discusses some of the statistical questions he works on, including seismology, clustering and reliability. He explains how statisticians think about the world, and why their thinking seems so different to everyone else. He comments on the growing presence and significance of statistics in the modern age, alongside the paradox of public distrust in evidence.

Prof Mark McGuinness has been asked to be the ANZIAM Lecturer at the 2022 Australian Mathematical Society Conference at UNSW, and is a plenary at the 2021 NZMASP conference in Tauranga in November. Prof Mark McGuinness will also be one of the keynote speakers in the Manawatu-Wellington Applied Mathematics Conference (MWAM-21). The Applied Mathematics Conference is organized between the Massey University Palmerston North and Victoria University of Wellington every year. This year is organized by the Distinguished Professor Robert McLachlan (FRSNZ) and Massey University.

Another student success comes from Nitay Ben Shachar, who was Mark McGuinness' and Joe Trodahl's Masters student here last year, and who has managed to get to the University of Melbourne in between lockdowns this year to begin a PhD with Prof. John Sader. He has settled into Melbourne life, as much as one can these days. He is working in exciton science and nanoelectromechanics!

Lindsay Morris has been awarded a PhD degree for his thesis "Spatio-temporal modelling for non-stationary point referenced data". He was supervised by Dr Nokuthaba Sibanda. A summary of her thesis follows: Data observed at specific locations across space are called point referenced data. A common assumption made when modelling point referenced data is that the correlation between observations depends only on the distance between their locations. This assumption is not always appropriate. Lindsay Morris' research proposes three new methodologies to account for this assumption in a flexible way: partitioning the locations into sub-regions using a clustering algorithm; modelling the correlation between point referenced data using networks; and using geographic random forests. Lindsay's research also develops a test to assess the goodness-of-fit of geostatistical models.

Another Wellington science fair was organized by NIWA with the help of Te Herenge Waka. This outstanding event is a wonderful opportunity for students to showcase their talent and enthusiasm for science, and to gain recognition for their excellence and innovation. This year there were 204 participants with projects ranging in every field of STEM. Students projects reflected scientific rigour, innovation, environmental and social sensitivity. Some were in machine learning, some in chemistry, some in physics. Most of them used to some extend mathematics as it was expected. Trying to distinguish the best project is a difficult job. The judging criteria are mainly the following: (i) scientific method and originality; (ii) thoroughness and effort; (iii) technical and graphical skills; and (iv) presentation. For more information and for a list of the winners please visit `http://www.sciencefair.org.nz/`.

Dimitrios Mitsotakis

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Congratulations to *Rua Murray* on the award of the University Teaching Medal 2021. The UC Teaching Medal is the University's highest award for teaching

excellence and is only awarded from time to time. It recognises Rua for his outstanding and sustained contribution to teaching and teaching leadership at UC and to the wider community across New Zealand. The commentary on Rua's award mentions that he has made a real difference to thousands of students at UC and that colleagues will continue to benefit from his insights, mentoring and passion for teaching.

Rua has previously been recognised with a UC Teaching Award, an Ako Aotearoa National Sustained Tertiary Teaching Excellence award for sustained excellence and as a Senior Fellow of the UK Higher Education Academy. He is currently involved in a project briefing the Ministry of Education on mathematical literacy for New Zealand schools.

Alex James and Mike Plank

Rua Murray receiving the UC Teaching Medal from Chancellor Susan McCormack

Congratulations to *Alex James* and *Mike Plank* on the award of the University Research Medal 2021. Alex and Mike are recognised for their ground-breaking work developing a series of mathematical models that have informed the Government's response to the Covid-19 pandemic in New Zealand. They are key members of the national team of scientists at award-winning research centre Te Pūnaha Matatini, and their modelling expertise has been used to understand the potential impact of the virus on Aotearoa's most at-risk communities. They have often shared their knowledge with the public through articles and media interviews.

Congratulations to *Alex Gavryushkin* and Michael Witbrock (University of Auckland) who have been awarded a Marsden Fund Standard grant for their project "A new way to study gout in Māori and Pacific populations". The project will develop a novel computational tool for learning the genetic variations associated with the cause of gout. The PIs and their team develop an attention-based approach to genome-wide association studies. It contributes to the long-term aim of developing a widely applicable tool that can be used for many different diseases.

Congratulations to *Phillipa Gourdie* who won a UCSA College of Engineering Lecturer of the Year Student Choice awards.

August saw the arrival of two additions to staff families. *Blair Robertson* and Emma had their third child, Grace Elizabeth, born in early August, and in late August *James Bartlett* and Rachel also had their third child, Joanna Elizabeth. Congratulations to both families.

In August *Robert Culling* was appointed to a continuing lecturer (teaching) position. Robert had been in the School on various contracts since 2020.

Chris Stevens joined the School in September as a lecturer in mathematics. He completed his PhD at Otago in 2016 on mathematical and numerical relativity. He then undertook several postdocs at Rhodes University, South Africa, before obtaining a permanent lecturing position in the mathematics department there. Chris returned with his family to NZ taking up a postdoc in early 2020 at Otago. Chris' research interests are in mathematical and numerical relativity specialising in global properties of space-times and solving Einstein's equations on the computer in a variety of different contexts. He is also interested in applying mathematics, algorithm development and scientific programming to real world problems. This is accomplished together with Jörg Frauendiener from the University of Otago through their company SCRI (Scientific Calculations for Research and Industry).

Also in September the School welcomed *Sasha Gavryushkin* as a Post-Doctoral Research Fellow. Sasha is one of the research leads in *Alex Gavryushkin's* MBIE Endeavour Smart Ideas Grant, involving the implementation of a phylodynamics software platform for evolutionary analysis of somatic sequencing data. She obtained her PhD in Computational Biology from the University of Auckland in 2017 and also has a PhD degree in Mathematics from Novosibirsk University in 2010. Sasha's research interests are in genomics data analysis and the development of statistical and computational methods for such analyses. In particular, she has developed Bayesian MCMC methods for reconstructing phylogenetic trees and evolutionary pa-

Chris Stevens

rameters and variant scoring methods that are used in genotype-phenotype association studies.

Former staff member *Bill Taylor* passed away, suddenly and unexpectedly, of a heart attack, at the end of September. He was 76. Bill was a lecturer in the School of Mathematics and Statistics from 1970 until his retirement in 2010. He is remembered, among many things, for his delight in mathematical curios, logical puzzles, and number theory.

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Jörg Frauendiener and *Matt Parry* are AIs on the Marsden grant "Gravitational Waves: Sources and Signals" that was awarded $3m. The project is led by Renate Mayer from the University of Auckland, and it includes a number of further researchers from the University of Auckland, Auckland University of Technology, Victoria University of Wellington, University of Canterbury, King's College London, Observatoire de la Côte d'Azur (France) and University of Göttingen (Germany). Well done, and good luck for your project!

Congratulations to *Tim Candy* on his promotion to Senior Lecturer, and to *Matt Schofield* and *Phil Wilcox* on their promotions to Associate Professors.

A new mathematics prize of $500, the John Clark Memorial Prize, will be awarded annually to the student with the best Honours research project at the Department. Thanks to a donation from our colleague *Austina Clark*, the prize has been established in memory of her late husband *John Clark*. John had been at the Department from 1970 until his retirement in 2013. But even afterwards, he came to his office very regularly and continued his work. Through his research in algebra and his collaboration with ring theorists around the world, he became an accomplished and internationally respected mathematician. John had a great sense of humour and a delightful turn of phrase, always delivered with his special Scottish twinkle.

John Clark (1943–2017)

Congratulations to the Mathematics and Physics "Green Problem Solvers" team for receiving a 2021 Green Your Scene award from the University. The team, which includes the Department's *Tim Jowett*, *Leanne Kirk*, and *Sarah Wakes*, helps to make the University a more sustainable and healthier place. Projects include a worm farm that converts organic waste into fresh, useful compost, saving electric energy, plastic recycling, book swap, encouraging people to use the stairs and an appreciation board in the common room.

Laurel Hubbard was named University of Otago Sportswoman of the year. Laurel, who takes 300-level computational modelling and mathematics papers at the department, became the first openly transgender woman to compete at the Olympics when she contested the women's 87+kg at the Tokyo Games this year. Congratulations, Laurel!

Jörg Hennig

PhD SUCCESS

Lia Jisoo Lee (University of Auckland)

Title: Electrical Impedance Tomography using Nonconforming Mesh and Posterior Approximated Regression

Supervisors: Professor Tom ter Elst and Dr Marie Graff

Abstract: Electrical impedance tomography (EIT) is an imaging technique where the internal electrical conductivity distribution is reconstructed, using current and voltage measurements on the boundary. The contributions of this thesis are largely in three parts.

In the first part of the thesis we present the formulation of the EIT problem using a nonconforming mesh. This is in contrast to the standard approach which uses a conforming mesh. The benefit of employing a nonconforming mesh, however, is that finer discretization can be employed on a localized region which is computationally more efficient. We mainly use the mortar element method as the numerical scheme, which is the state-of-the-art nonconforming finite element method today.

In the second part of the thesis we focus on a situation where computational resources are severely limited yet the solutions to inverse problems need to be obtained quickly. Such is the case in process tomography where the solutions need to be obtained in the scale of milliseconds, in an online manner. The inverse problem in this thesis is addressed in the Bayesian statistical setting. The idea presented is to pose the Bayesian inverse problem as a statistical forward problem via the construction of a regression model. The regression model is constructed using samples of the unknowns and the data measurement, drawn from the related likelihood function and prior distribution. We call this the posterior approximated regression model.

In the third part of the thesis we are interested in the prior modelling of discretized non-Gaussian random fields. By far the most used type of prior distribution in Bayesian inverse problems is the Gaussian distribution. However Gaussian priors tend to produce smoothing effects on the maximum a posteriori (MAP) estimate which can lead to underestimations of the unknowns. We investigate whether this can be partially resolved by fitting non-Gaussian prior distributions that are longer tailed than the Gaussian.

The proposed formulation, method and strategy are verified via various simulated numerically EIT problems on two dimensional domains.

—

Anton Baykalov (University of Auckland)

Title: Intersection of conjugate solvable subgroups in finite classical groups

Supervisors: Eamonn O'Brien and Jianbei An

Abstract: Consider the following problem stated by Vdovin (2010) in the "Kourovka notebook" (Problem 17.41):

Let H be a solvable subgroup of a finite group G that has no nontrivial solvable normal subgroups. Do there always exist five conjugates of H whose intersection is trivial?

This problem is closely related to a conjecture by Babai, Goodman and Pyber (1997) about an upper bound for the index of a normal solvable subgroup in a finite group.

The problem was reduced by Vdovin (2012) to the case when G is an almost simple group. Let G be an almost simple group with socle isomorphic to a simple linear, unitary or symplectic group, and assume that G contains neither graph nor graph-field automorphisms of the socle. For all such groups G we provide a positive answer to Vdovin's problem.

—

Joshua Ritchie (University of Otago)

Title: Two applications of the Cauchy problem in general relativity

Supervisors: Florian Beyer and Jörg Frauendiener

Abstract: The Cauchy problem plays an important role in both analytical and numerical studies of the Einstein field equations. Here we discuss two particular applications of the Cauchy problem within the framework of General Relativity. In the first of the two problems, we investigate how one can solve the Einstein constraint

equations as an initial value problem. For this, our primary focus is on the asymptotic behaviour of the unknowns and how it may be "controlled". In particular, we provide analytical and numerical evidence that it is possible to control the asymptotic behaviour of the unknowns. In the second of the two problems, we investigate the asymptotic behaviour of solutions of the Einstein equations with a minimally coupled scalar field near the Big Bang. Our primary focus here is on understanding what effect the addition of a potential has on the asymptotic behaviour of the scalar field.

—

Lindsay Morris (Victoria University of Wellington)

Title: Spatio-temporal modelling for non-stationary point referenced data

Supervisors: Dr Nokuthaba Sibanda

Abstract: Spatial and spatio-temporal phenomena are commonly modelled as Gaussian processes via the geostatistical model (Gelfand & Banerjee, 2017). The geostatistical model has the benefit of modelling the spatial dependence structure using covariance functions. Most commonly, the covariance functions impose an assumption of spatial stationarity on the process. That means the covariance between observations at particular locations depends only on the distance between the locations (Banerjee et al., 2014). It has been widely recognized that most, if not all, processes manifest spatially non-stationary covariance structure Sampson (2014). If the study domain is small in area or there is not enough data to justify more complicated non-stationary approaches, then stationarity may be assumed for the sake of mathematical convenience (Fouedjio, 2017). However, relationships between variables can vary significantly over space, and a 'global' estimate of the relationships may obscure interesting geographical phenomena (Brunsdon et al., 1996; Fouedjio, 2017; Sampson & Guttorp, 1992). In this thesis, we considered three different approaches for accounting for non-stationarity in both spatial and spatio-temporal processes. We first proposed partitioning the spatial or spatio-temporal data into sub-regions using the K-means algorithm based on a set of appropriate geographic features. This allowed for the fitting of separate stationary covariance functions to the smaller sub-regions to account for local differences in covariance across the study region. Secondly, we extended the concept of covariance network regression to model the covariance matrix of both spatial and spatio-temporal processes. The resulting covariance estimates were found to be more flexible in accounting for spatial autocorrelation than standard stationary approaches. The third approach involved developing geographic random forest methodology that uses a neighbourhood structure for each location based on the K-means algorithm. We found that clustering based on geographic measures such as longitude and latitude ensured that observations that were too far away to have any influence on the observations near the locations where a local random forest was fitted were not selected to form the neighbourhood.

REPORTS ON EVENTS

Christchurch Maths Craft Day

Sunday 23 May 2021
The Great Hall in The Arts Centre

Maths Craft New Zealand's third Christchurch Maths Craft Day was held on **Sunday 23rd May** in The Great Hall and The Teece Museum of Classical Antiquities, both located in Christchurch's historic Arts Centre. Over **1,500 visitors** explored maths through crafts at our free day-long event. They enjoyed 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.

Our helpful volunteers engaging with the public at the craft stations during the 2021 Christchurch Maths Craft Day.

This was our first major public event since COVID-19 disrupted our plans in 2020, and our first in Christchurch since 2018. We were thrilled to welcome back the public to the beautiful heritage setting of The Great Hall, and to see that enthusiasm for our events has only grown in our absence. Our first visitors to the Christchurch Maths Craft Day arrived even before our doors opened at 10am, with the flow of visitors continuing steadily throughout the day, and with more arriving even as we were preparing to close at 5pm. This year, in addition to the usual crafting tables on the raised stage at one end of the Hall, at which visitors sat and worked together on their chosen craft, we also included craft tables in the Hall itself. These extra tables were more accessible for those less able to climb the stairs to the stage, but also meant more people were able to sit and work on their craft and think about maths in comfort. All of the craft tables were busy all day long, with our friendly and keen volunteers circulating with advice, encouragement, and materials. People stayed for hours, exploring the crafts at the stations with help from our volunteers, and enjoying the many maths craft objects on display at the

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stations and in display cabinets. The Hall was busy all day, and indeed the main feedback on our exit survey – apart from enjoyment of the day itself – was a request for us to move to a larger space next time. We agree that we have probably outgrown this beautiful space, and we will with regret look for a larger venue for our next Christchurch Maths Craft Day.

Crowds fill The Great Hall in the afternoon and every seat is occupied!

The festival attracted media attention, with a segment appearing on TV3's Newshub on the same day (https://www.newshub.co.nz/home/new-zealand/2021/05/university-of-canterbury-use-arts-and-crafts-to-help-kiwis-learn-maths.html), and interviews with our Director, Dr Jeanette McLeod, and two of our speakers, appearing on Radio New Zealand's *Our Changing World* and *Afternoons* soon after (https://www.rnz.co.nz/national/programmes/afternoons/audio/2018802771/crafty-maths).

Katy Gosset from RNZ interviews Professors Hinke Osinga and Bernd Krauskopf.

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The journalists interviewed some of our many visitors, and filmed people working in family groups to understand beautiful mathematical concepts while working with their hands to make beautiful craft objects. The footage and interviews captured the feel of the event, with people of all ages, genders, ethnicities, and backgrounds working together in an atmosphere of serious fun.

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 four mathematician crafters and were attended by over 160 visitors of all ages. The first lecture was given by Maths Craft New Zealand's Director Dr Jeanette McLeod, a pure mathematician from the University of Canterbury. Her entertaining talk, entitled "Four Colours Are Enough", was a riveting look at the history of the infamous Four Colour Theorem and its links with knitting, quilting, colouring, and her own craft story. The next lecture was given by a new speaker for Maths Craft giving his first ever public lecture, Dr Michael Langton of the University of Canterbury. His engrossing talk on "Zigzags, Fractals, and Pleating" wove together mathematics, family history, and craft. Finally, we were delighted to welcome back as speakers Prof Hinke Osinga and Prof Bernd Krauskopf, who have given many popular talks at Maths Craft events. Professors Osinga and Krauskopf, applied mathematicians from the University of Auckland, gave a compelling joint talk entitled "Chaos in Crochet and Steel" about how their research inspired the creation a beautiful crochet object and a collaboration with an artist to make a stunning mathematical sculpture.

Dr Michael Langton gets his audience to try some origami during his entertaining talk "Zigzags, Fractals, and Pleating".

We were excited to collaborate once again with **The Teece Museum** by having a craft station in the museum with a specially-developed craft activity which 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 led people through the hidden but beautiful mathematical symmetries and algorithmic thinking behind the creation of meanders. By running this craft activity in The Teece Museum, visitors were able to explore the mathematics of meanders while surrounded by beautiful examples from The Logie Collection housed in the Teece. This is the third time 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.

Maths Craft New Zealand and the School of Mathematics & Statistics at the University of Canterbury are the proud custodians of **The Derrick Breach Collection of Polyhedra**. At the Christchurch Maths Craft Day we were privileged to be able to share once again a number of objects from the collection with the Maths Craft audience. 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. The dedicated Derrick Breach Collection display cabinet was surrounded by fascinated visitors all day long.

The Breach Collection on display.

The third Christchurch Maths Craft Day was a big success, with over 1,500 enthusiastic people of all ages and backgrounds spending the day exploring maths through craft. Our exit survey results show high levels of enthusiasm and engagement. For example, 91% of respondents said that they "loved" the day, and over 91% said they would "definitely" do something like it again. In answer to the question "what did you think about mathematics before the event?", 6% of people said they didn't like maths and 30% said that it was only "okay", with 64% arriving at the event liking mathematics. However, by the end of the event 83% said they liked maths, while only 17% said it was okay, and no-one said that they disliked it. Survey comments include "Everything was great", "Keep it up", "Well organised", "Fab environment", and "It was awesome!". It was wonderful to have another successful event in our home town of Christchurch, in the stunning setting of The Great Hall, and to build on our relationship with The Teece Museum. We thank all of the sponsors of the 2021 Christchurch Maths Craft Day, and look forward to our future events with excitement.

Visit mathscraftnz.org   Tweet to #mathscraftnz   Email mathscraftnz@gmail.com

GENERAL NOTICES

NZMRI 2022 Summer Workshop

The NZMRI 2022 Summer Workshop is scheduled to take place in Akaroa, January 8–13. The theme for the workshop is Number Theory and Related Topics. There will be a variety of talks aimed at postgraduate level students.

Further details including registration information are available at the following link: `https://www.math.canterbury.ac.nz/~f.voloch/nzmri.html`

Phil Wilson

New Zealand Journal of Mathematics Special Issue

As you may know the NZJM is published jointly by the NZ Mathematical Society and the Department of Mathematics at the University of Auckland. Late last year it was decided to publish a special volume in memory of Vaughan Jones with Marston Conder, Rod Downey, Gaven Martin and me as editors. The first tranche of articles has been published with more to be added as they become available. The authors are some of the invited speakers for the summer workshops that Vaughan founded in the mid-90s together with some of the organisers of the workshops.

The volume is published at `https://nzjmath.org/index.php/NZJMATH/issue/view/7`

David Gauld

Mathematics in Industry Report

A world-wide coordinated website has been created, centred on the Centre for Industrial and Applied Mathematics, University of Oxford. It will provide an international catalogue for recording of, and announcing, upcoming activities and especially be a record of outcomes of reports from problems presented at future Study-Group workshops such as NZ hosted at the five previous MINZ workshops 2015-19. It does not preclude subsequent post-event publication, in say the ANZIAM Journal Series E as has been the custom lately.

MIIR was set up with initial sponsorship from the European Consortium for Mathematics in Industry, and is supported by an international network of Advocates, who act as national champions and encourage local submissions to MIIR.

An international group is coordinating its beginning phase with Graeme Wake being the initial NZ link as an "Advocate". Others can be added. The website is available at `https://www.cambridge.org/engage/miir/public-dashboard`

The undersigned welcomes comment and any questions.

Graeme Wake

Heidelberg Laureate Forum 2022

The 9th Heidelberg Laureate Forum (HLF) will take place in Heidelberg, Germany between September 18–23, 2022.

At the HLF, all winners of the Fields Medal, the Abel Prize, the ACM A.M. Turing Award, the Nevanlinna Prize, and the ACM Prize in Computing are invited to attend. In addition, young and talented computer scientists and mathematicians are invited to apply for participation. The previous HLFs have been an exceptional success. The HLF serves as a great platform for interaction between the masters in the fields of mathematics and computer science and young talents. Over the course of the week-long conference, young researchers will be given the exclusive possibility to profoundly connect with their scientific role models and find out how the laureates made it to the top of their fields. As described by a young researcher, "The balance between scientific sessions and

informal meetings, as well as discussions on the most up-to-date subjects was just perfect! As a young researcher, this was an experience I'll not ever forget, and I believe the contacts I made will have a positive impact on my future career."

Applications for participation at the 9th HLF are open in three categories: Undergraduate/Pre-Master, Graduate PhD, and PostDocs. The application period for the 9th HLF runs from November 11, 2021, until February 11, 2022.

Young researchers at all phases of their careers (Undergraduate/Pre-Master, Graduate PhD, or PostDocs) are encouraged to complete and submit their applications by February 11 (midnight CET).

The IMU Adhering Organizations and national mathematical societies can also nominate young researchers. Nominated persons get "priority treatment", but, since there may be too many nominations, they have no acceptance guarantee.

See the webpage `https://application.heidelberg-laureate-forum.org/site/index.php` for the online application and nomination forms.

The deadline for application is February 11, 2022.

Please note that in compliance with European data protection law all previous login information and nominator accounts were deleted. During the nomination process you will be asked for an Org-ID, which is IMU79342 for the IMU.

For questions regarding requirements and the application process, please contact Young Researchers Relations at: yr@heidelberg-laureate-forum.org.

All applications that are completed and submitted by the deadline are meticulously reviewed by an international committee of experts to ensure that only the most qualified candidates are invited. There are 100 spaces available for each discipline of mathematics and computer science. All applicants will be notified by the end of April 2022 whether or not they are invited. If meeting in person is not safely possible, a digital alternative will be developed that creates spaces for effective, sustainable interaction.

Helge Holden (Secretary General of the International Mathematical Union)

NZIER Insights on the importance of mathematics for the New Zealand economy

The NZIER has produced two Public Good Insights that explore why maths matters and ways to improve maths learning in schools `https://nzier.org.nz/publication/declining-maths-scores-is-a-problem-for-the-new-zealand-economy`

Phil Wilson

NZMS NOTICES

Deadlines for applications for Financial Assistance

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 2022 are: 15 February, 15 May, 15 August, and 15 November. You should hear back from the Council within a month of the deadline. The types of grants are as follows.

NZMS Student Travel Grants

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: http://nzmathsoc.org.nz/?assistance.

Draft minutes of the 47th Annual General Meeting of the NZMS

Virtual meeting on Zoom, 7th December 2021.

Present: Liz Ackerley, Evelyn Benson, Alona Ben-Tal, Florian Beyer, Richard Brown, David Bryant (Chair), Tim Candy, Lisa Clark, Marston Conder, Daniel Delbourgo, Graham Donovan, Rod Downey, Tom ter Elst, Tanya Evans, Steven Galbraith, Alex Gavryushkin, Noam Greenberg, Brendan Harding, Joerg Hennig, Astrid an Huef, Stephen Joe, Brandon Jones, Vivien Kirk, Bernd Krauskopf, Carlo Laing, Melissa Lee, Martino Lupini, Tammy Lynch, Aidan Mason-Mackay, Mark McGuinness, Robert McLachlan, Jeanette McLeod, Alna van der Merwe, Dimitrios Mitsotakis, Songbao Mo, Clemency Montelle, Fabien Montiel, Rua Murray, Eamonn O'Brien, Hinke Osinga, Mike Plank, Claire Postlethwaite, Nicolette Rattenbury, Jeroen Schillewaert, Dominic Searles, Charles Semple, David Simpson, Jandre Snyman, Duttatrey Srivastava, Isabelle Steinmann, Jonny Stephenson, Cathy Hassell Sweatman, Winston Sweatman, Melissa Tacy, Rachel Tappenden, Steve Taylor, Chris Tuffley, Geertrui Van de Voorde, Gabriel Verret, Graeme Wake, Sarah Wakes, Zihao Wang, Phil Wilson (Secretary).

Apologies: Stephen Marsland, Peter Donelan, Graham Weir

If your name is missing from the list of attendees, or if you have any correction to make, please email the NZMS Secretary at dimitrios.mitsotakis@vuw.ac.nz.

Meeting opened at 1515hrs. David Bryant welcomed everyone to the AGM.

1. **Previous AGM:** The minutes of the 46th Annual General Meeting (1 December 2020) were accepted as a true and accurate record of the meeting. *(Moved from the Chair, passed.)*

2. **Matters arising:** There were no matters arising.

3. **President's report:** David verbally presented highlights of his President's Report, which can be read on the NZMS website. In addition, he also thanked NZMS members involved with the recent Royal Society panel on mathematics education.

4. **Treasurer's report:** Presented by David in the absence of the Treasurer, Stephen Marsland. The report, available on the NZMS website, was taken as read, with David highlighted some key points. These follow.

    (a) There has been very little expenditure since the bulk of our spending is on travel, which has not been possible due to covid. David is not concerned.

    (b) Stephen highlighted that a potential area of risk is the current low interest rates and therefore a low income from investments. Again, David's understanding is that this should not be a problem. We will assess the situation in half a year and see if we need to diversify our investments.

    The Treasurer's report was accepted. *(Moved from the Chair. Passed)*

5. **Appointment of auditors:** The current auditor, Nirmala Nath from the School of Accountancy, Massey University, was re-appointed as Auditor. *(Moved from the Chair. Passed.)*

6. **Membership Secretary's report:** The report, available on the NZMS website, was taken as read. Annual fees are to remain unchanged for 2022. The report was accepted, and a vote of thanks to John Shanks was passed. *(Moved from the Chair. Passed.)* David also noted that we will be revisiting the possibility of Department-level membership in the new year.

7. **Election of NZMS Council members**

    (a) Departing Councillors: the following have completed their terms:
        - Melissa Tacy — Auckland (2018–2021)
        - Phil Wilson — Canterbury (2018-2021)

    (b) Incoming Vice President: Melissa Tacy is the only nominee (nom.: Graham Donovan, David Bryant) and is declared elected.

    (c) Election of Councillors: an election was held for one vacant Council position. The nominees were:
        - Dimitrios Mitsotakis — Victoria (nom.: Astrid an Huef, Noam Greenberg)
        - Jeroen Schillewaert — Auckland (nom.: Marston Conder, Eamonn O'Brien)

    The ballot was conducted by anonymous poll in sli.do, with Phil Wilson and Rua Murray acting as returning officers. The vote was tied. A motion was passed that both nominees be elected, as Council has the power to co-opt members. *(Moved from the Chair, passed.)*

8. **Forthcoming colloquia:**

    2022 Canterbury

    2023 Victoria

    2024 Joint AMS/NZMS/AustMS Auckland

    2025 Waikato

    2026 Otago

9. **Update on Forder and Aitken lecturer:** The list of Forder Lecturer candidates (speakers that are coming from the UK to New Zealand in 2023) has been received and will be circulated early in the new year. Members will be able to vote in an online poll. The Aitken Lecturer (NZ to UK) for 2022 is Lisa Clark and at this stage, the plan is to go ahead with the lecture tour of the UK in June, and so we wish Lisa all the best of luck for that.

10. **Report on the NZ Journal of Mathematics:** The report, which can be read on the NZMS website, was accepted. *(Moved from the Chair. Passed.)*

11. **Correspondence:** none.

12. Any other business:

(a) David mentioned that the Society will consider potential changes to the constitution and bylaws in 2022. These are in two areas:

    i. The first is to reflect the work that has been done to improve representation and reduce bias related to gender diversity and identity. Much excellent work has already been done behind the scenes by a wide range of people, and David would like to see some of that reflected appropriately in our constitution and bylaws.

    ii. The second is to amend the constitution to acknowledge the Society's obligations under the Treaty of Waitangi. We will be guided by information from the Royal Society.

David assured the members that they will be given the information required to work over the issues, and to make sure that we get it right — changing the constitution is not something we want to do lightly. There will be opportunity to discuss, debate and refine our positions on the above, with those and David's target is have a debate organised in such a way that we can aim for a consensus decision at the next AGM.

(b) From the floor, Robert McLachlan noted the final sentence in the Treasurer's report, which says, "we need to support early career researchers with the money generously donated by the Kalman trust." Robert wanted to ask the Council to consider how they could support early career researchers in any way, noting that now that travel is not happening there may be some other initiatives that they could look into. David responded that Melissa Tacy has been in charge of starting a number of ECR initiatives. Melissa also noted that if anyone has any good ideas about something we could do with the funding that we would have spent on travel for early career researchers, then to please get in contact.

The meeting closed at 1553hrs.

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>
> Susanne C. Brenner, SIAM President and Boyd Professor, Louisiana State University

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Society for Industrial and Applied Mathematics
3600 Market Street, 6th Floor, Philadelphia, PA 19104-2688 USA
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