NeMeSiS News 2014

Newsletter of the

ANU-AAMT National Mathematics Summer School

Horas! Mejuah-juah!

Welcome to the 16th edition of NeMeSiS News! We hope that you enjoy reading it. Please let me know what you think.

I am always looking for contributions for NeMeSiS News. I want it to be as relevant, enjoyable and entertaining as possible, so please email me with any feedback, ideas or submissions that you may have. I would love to hear from you, and I promise to reply to your email!

Merryn Horrocks (editor)

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CAN YOU HELP?

As you are aware, NMSS needs all the support that you can give. The school only remains viable because of the donations of past students and their parents. I urge you to make a tax deductible donation if at all possible.

You can now donate via the ANU Philanthropy website:

http://philanthropy.anu.edu.au .

Search for "Larry Blakers" or "NMSS" to find the NMSS donation portal. All money will be donated to NMSS and you will receive a receipt immediately.

Thank you for your continued support of NMSS.

Behind the Scenes

Firstly, I'd like to thank all the alumni, high schools and parents of students who made donations in the last year. NMSS would not survive without your continued financial support. I would especially like to thank those alumni who each made donations of $1000 or more (most of whom requested to remain anonymous). Even though we charge each student $1400 to attend (and they also have to pay for airfare) we still make a loss of almost $20,000 each year. These large donations do help to cover some of this loss. If you are able to help NMSS financially please consider doing so, and we have streamlined the process for making donations. You can now make donations online and receive your tax invoice immediately. Please go to http://philanthropy.anu.edu.au and type NMSS in the search box, or look for the Larry Blakers Memorial Fund.

We have also made it much easier to update your contact details online, you can go to http://nmss.edu.au/update.php.There's even a box on the form to let us know any exciting news you might have

Finally, the Chief Scientist and the Australian Science Teachers Association have launched a magazine that contains stories and interviews with current and former students of various programs who excel at mathematics or science. Check it out at http://australiasfuture.com/. You may notice some familiar faces.

Leon Poladian, NMSS Director

A Puzzle

The angel and devil game (posed by Conway) is played on an infinite chessboard. Play alternates between the angel and the devil. The angel starts on some square on the board, and each move flies to a different empty square that can be reached in no more than n moves of a chess king. The devil blows up one square on the chessboard (not containing the angel) each move. The angel can fly over destroyed squares but cannot finish a move on them. The devil wins if the angel can't move. The angel wins if it can always move and cannot be blocked in by the devil.

When n = 1, who wins, and what is the winning strategy? What about for n >= 2?

Damjan, Joan and Mia

Norm, Denise and Sebastien

NMSS Lecturers

This year, two of our scheduled lecturers couldn't make it to NMSS, - because they were having babies!!!

Congratulations to Damjan Vukcevic and Joan on the birth of Mia, and to Norm Do and Denise on the birth of Sebastien.

Nick Beeton gave a guest lecture this year, and he has also given us an update on what he has been doing.

Nick Beeton

After attending NMSS in 2002, and again in 2003 as an EG, I moved to Sydney to complete my science degree and Honours in Applied Maths, looking at nonlinearities in acoustic waves such as ultrasound. I then came back to Tassie to do my PhD writing mathematical models on Tasmanian devils and the facial tumour disease that is threatening them with extinction. After that I was lucky enough to be offered a research position here at the university looking at biodiversity and how we can help preserve it in the face of climate change and invasive pests. That position ends at the end of the year so I am keeping my eye out for the next step in my journey as a scientist!

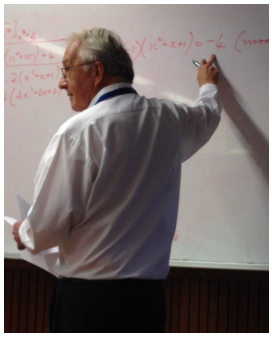
Nick Beeton

NMSS 2014 for Teachers

On the second Monday of NMSS 2014, 14 school teachers from NSW were treated to a 2-hour lecture/tutorial on Number Theory, run by Terry Gagen. The teachers were taking part in a two-day professional development workshop called 'NMSS for Teachers'. The workshop was developed by Terry, Garry Webb (Head of Welfare, NMSS), and Nikky Vanderhout from the Mathematical Association of NSW, and was run as a pilot program in 2014.

The workshop aimed to give teachers an understanding of what NMSS is about, and how their students could benefit from attending. It was an 'immersion-style' course, with the teachers sitting in on the NMSS lectures and tutorials.

Terry's mission in his Monday session was to give the teachers a 'condensed' version of what the NMSS students had covered in Number Theory Lectures 1 to 7 so that they could follow the NMSS lecture that they would attend. It was also to give the teachers an insight into students' experiences as they struggle with unfamiliar problems. He succeeded brilliantly, with many participants rating his session as one of the highlights of the workshop. A typical comment was 'Terry was wonderful; he reminded me of the joy of learning new mathematical concepts'.



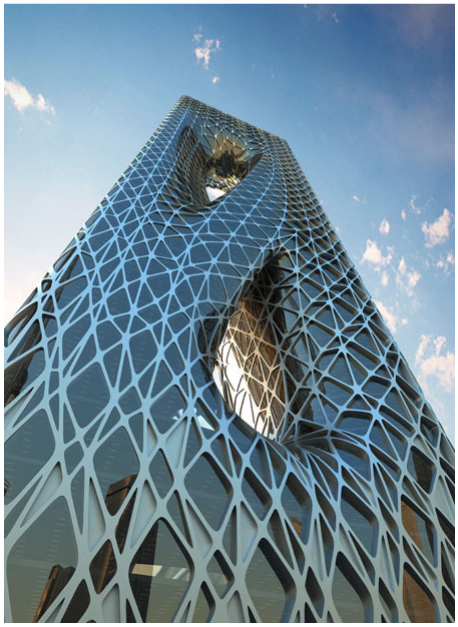
Terry Gagen

The workshop was rated highly successful overall, and planning is currently under way for a similar activity next year.

Garry Webb

Mathematics in Architecture

As many would already know, mathematics and architecture have a relationship that spans back to ancient times. In those times the architect was also the engineer and builder. In the nineteenth century, however, these roles began to separate into what are now quite separate professions. With this specialisation, the degree of the mathematics and computations within the life of the architect steadily diminished. Structural engineers became responsible for computing the loads to ensure structural firmness. Specialist engineers of all types soon followed. Geotechnical engineers analyse and design the foundation conditions whilst mechanical engineers design and calculate the air conditioning, passenger lifts and other building systems. In recent times an energy assessor specialisation has even developed to determine energy performance.



Sunrise Tower in Kuala Lumpur by Architect Zaha Hadid

However the use of mathematics within architecture is currently having somewhat of a resurgence. Over the last decade or so, as computer aided design and robotic manufacture has become more ubiquitous, architects have been exploring how mathematics can once again influence the very form of a building.

One emerging technique which is quickly being described as a new architectural style is parametricism. This is a term used to describe an object designed by arranging and manipulating a family of elements using a finite number of parameters. The results of this process can produce some of the most eye watering and fluid like structures we have ever seen. If you ever have to convince someone that mathematics can be beautiful, I would suggest the work of internationally acclaimed architect Zaha Hadid as a very good starting point.

Another example of mathematics being used to design architecture is in The Water Cube project from the Beijing Olympics by PTW Architects. As you may remember this resembles bubbles stuck inside a box. Not only is this a striking and memorable structure, but it is also environmentally and structurally sound due to its lightweight construction. The outer surface of the Cube is a beautifully complex combination of different sizes and shapes which comes from a relatively simple idea. It uses a 3D packing of similar shapes for easier construction, and then rotates it away from our usual three axes. Taking vertical slices through this rotated structure is what gives the seemingly random pattern.

Architecture endeavours to respond to the society it is created for. Undoubtedly the global community is struggling to deal with the environmental challenges of our warming climate. As part of this response architects are always looking for ways to do more with less. By using mathematical optimisation techniques building fabric can be designed to provide structural support with minimal materials and weight. In larger buildings such as airports optimisation is also used to reduce surface areas, materials and maximise functional space.

Architecture and mathematics both have a very long shared history. Over this time mathematics has opened up new pathways for architecture to explore. The recent developments in parametricism, optimisation and other techniques show how much these fields can collide.

For those wanting to find out more I can recommend the book, “The New Mathematics of Architecture” by Jane and Mark Burry

Michael Smith

NMSS 2014

This reflection has been incredibly difficult to write for me. I simply don't know how to condense one of the most amazing experiences of my life down into a few inanimate words on a page, but I'll try:

When I applied to the NMSS, I wasn't sure what it would be like. The application process was easy enough – a single page – but the wait was awful. I remember checking my email several times a day to see if I had heard anything. When I was actually accepted, I was more surprised than anything else. Me? Really? Then the nerves set in: Would I make friends? Would it be worth it? Would it be fun?

The answer to those questions turned out to be a resounding YES!

From the moment I arrived (late, nervous and jetlagged), I was welcomed instantly. My tutor group was happy and friendly, and they helped me get acquainted with my surroundings and the maths. With their help, I was able to navigate both the campus and the idea of number theory. (What's a ½ in $\mathbf{Z}_7$? 4? What?)

Quickly, we all settled down and began to form what I'm sure will be life-long friendships. I'm not sure at this stage which aspect of the school I enjoyed more: the maths, or the socialising. I'd certainly never seen this kind of maths before! Number Theory challenged me and whet my appetite for more: 12 hours of lectures and 24 hours of tutorials was not enough! Chaos theory and projective planes were each quirky in their own right, but by the end of the courses, they finally clicked. Chaos theory used to be this mystical, unknown thing to me before I came to NMSS and realised that, "Hey, I can do this too!"

I wasn't sure what there would be to do in Canberra. However, the times I spent with my friends jumping off the 5m platform at the pool, or falling over at the ice rink, or visiting the National Library and Parliament House became some of the most memorable afternoons I've had. I will never forget how much fun we all had together.

I'm grateful to the staff and tutors at NMSS for this wonderful experience. Through NMSS I was able to learn more about myself, and the world of maths. NMSS has given me to confidence to want to study maths at university and beyond. I only wish that it had been longer: the end was the hardest part. We all had unanswered curiosities, unfinished relationships that were hard to leave behind.

Thank you everyone for the best summer of my life.

Charles Prior

Justin Koonin started his course on Groups & Symmetry with the more tangible and intuitively clearer idea of symmetry. We had a lot of fun constructing small, glittering Platonic solids from colourful plastic shapes and explored their properties & symmetries in real space, before proceeding to construct some proofs of their abstractions on paper.

We played with many more beautifully symmetrical structures, including Archimedean solids and Goldberg Caspar-Klug pseudo icosahedra, before moving into the abstract algebraic structures and locating our convex polyhedra in co-ordinate space.

Justin constantly surprised us with fun and useful things from his bag of tricks, from soccer balls to some neat permutation cycle notation to represent rotational symmetries.

Finally we brought it all back to group theory, and saw a little of the various applications of research in this area, like using polyhedra and group theory to predict virus structures.

I really enjoyed wrapping my mind around the concept of symmetry and groups, and stretching the links between physical representations and abstract algebraic structures. In a short week, Justin gave us a glimpse into the heart of group representation theory through teasing out the strands of algebra from geometrical structures, and letting us discover for ourselves the power of abstraction.

Holly Zhang