

## NeMeSiS 2002

"It was good because of the final concert ...  
 "Another good thing was how excited some of the lecturers got over the material they were teaching ...  
 "The only thing that was bad is when we all had to say goodbye. This was a sad moment ...  
 "I hope to be invited back next year."

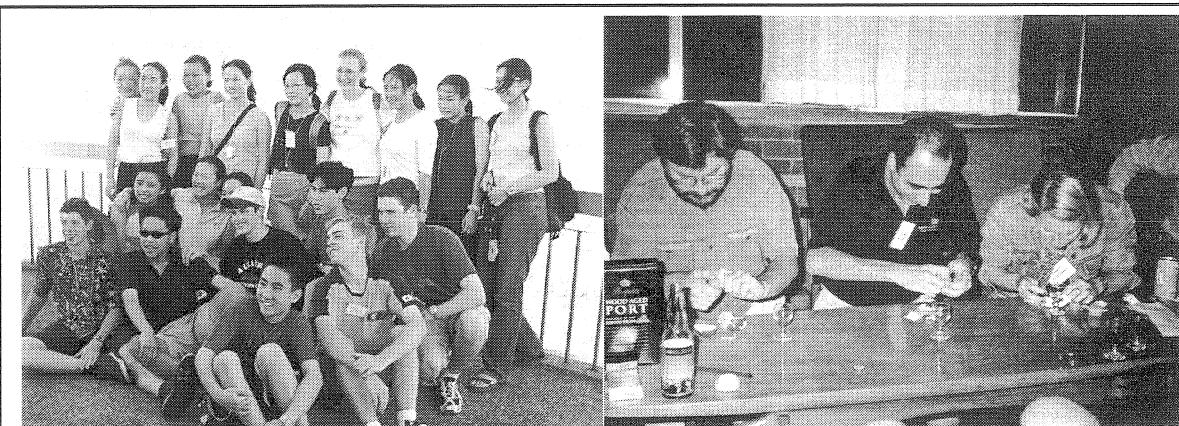
Jeremy Rhind

On arriving at the NMSS, I didn't realise that I was going to learn and experience so much more than Maths. I didn't realise that I was going to learn about a whole new deeper level of thinking. And I didn't realise that I was spending two weeks with one hundred of the most interesting and intelligent people in Australia. NMSS had quite a profound impact on me, in so many ways. Often weeks past by without and it is difficult to recall any particular events. But the events at NMSS I can recall with detail. When I first learnt that a half of one is four. When I tried to masquerade as an art critic. Paddle boating under the fountain on a beautiful Sunday morning. Observing that the shadow of that bicycle wheel isn't a circle no more. And finally understanding that all surfaces are just a combination of projective planes and doughnuts. But aside from the skills I acquired in Number Theory, Topology and Projective Planes, I gain a more important life skill at NMSS, the ability to think more deeply about simple things. The ability to break a problem down into its component parts, and solve it in a logical but innovative manner.

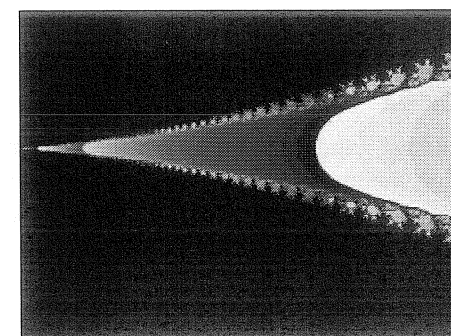
Clinton Mead

Later this year, Leon Poladian will be arranging a survey of past NMSS students to try to find out where and what they are today. We did survey people some years ago and our intention is to update our records in this respect. We will make available general details of this information to all respondents. The survey will be available by ordinary mail or on the Internet. As a result, it would be useful for us if those who have access to the Internet and are happy to use it could let us have contact details so that we can send the survey directly to them electronically. It also will save on NMSS funds.

NMSS greatly improved my skill in these two areas, which is of benefit in Mathematics, more importantly, it is a benefit in life in general. It allows me to think about problems and issues more effectively, and better understand them, and make more informed decisions, be it school, work or relationships. There is one other element to NMSS, the most important element to me, and that is the people. I never thought I would meet people like I met at NMSS, let alone so many, everywhere I looked. Just spending time with these people gave me a more optimistic view on life. I met dozens of amazing and wonderful people, with whom I had a great time, and will never forget. NMSS was an experience that deepened my understanding and changed my perspective of a lot of things, as well as being a lot of fun.



While NMSS students visit Black Mountain Tower ... the tutors compete to build Kinder Surprise Toys



## NeMeSiS News 2002

Newsletter of the National Mathematics Summer School

### Marhaba!

مرحبا

Welcome to the 4th edition of NeMeSiS News! If you have any questions, comments, ideas or submissions for the next issue, you can either tell Terry or contact Merryn (merryn@nmss.org.au). Thank you to everyone who contributed.

Merryn Horrocks

### "The Pleasures of Counting"

Yesterday, I looked again at Tom Körner's marvellous book, *The Pleasures of Counting*. Tom's been to NMSS twice now, and I hope that he will come again soon. It's a book I look at often, but this time I saw a chapter I had never noticed - Appendix I, Further Reading.

I often finish the Number Theory lectures at NMSS with a list of books I think students should look at, always beginning with Russell's *History of Western Philosophy*. Tom doesn't mention Russell, though his list agrees with mine in many places. It also contains many more that I don't mention. (One book he doesn't mention, but should have, is his own very interesting book *Fourier Analysis*, which is

hard mathematics, interspersed with the most riveting chapters on many amazing topics including, for example, The Age of the Earth and The Transatlantic Cable.) *The Pleasures of Counting* contains a marvellous discussion of Galileo on falling bodies. That is followed later in a chapter called Subtle is the Lord, by the story of the falling apple of Newton, which really did happen, apparently, (unlike the story of George Washington's interaction with the apple tree, which really didn't!), and then by the observation of Einstein that Euclidean geometry cannot hold in all equivalent accelerated systems. Tom continues:

"Just as the happy idea of Einstein was merely the germ of general relativity, so the realisation that 'the apple draws the earth as the earth draws the apple' was merely the germ of Newton's theory of universal gravitation, but it was the germ.

"Every day, everyone sees something fall. Three men, Galileo, Newton and Einstein looked at what everyone sees every day and saw the plan of the universe. Will there some day be a fourth?

"To see a World in a Grain of Sand  
 And a Heaven in a Wild Flower,  
 Hold Infinity in the Palm of your hand,  
 And Eternity in an hour."

I think all this does have real meaning for us in NMSS. It is Arnold Ross's 'Think deeply of simple things' revisited. We do concentrate on simple things at NMSS. I hope that in so doing, future enquiring minds can learn to tackle the really hard questions of science and humanity and its place in the universe. And even maybe find some answers!

Hilbert wrote "Wir müssen wissen, Wir werden wissen." (We must know, we will know.) What a sentiment for every young enquiring mind!

Terry Gagen

### A Puzzle

You are on a t.v. game show. The game show host shows you three boxes. Two are empty, but one contains a magnificent prize. You choose one of the three boxes, but do not open it. The host then opens one of the other two boxes to show that it is empty. You can now either keep the box that you chose originally, or you can change your choice to the other remaining box. What should you do, and why?

## Life after NeMeSiS

**Tony Haymet** has been a part of NeMeSiS many times. He first attended as a tutor in '77 or '78. In 1978 he worked with the first ever experienced group. He taught spectroscopy and representation theory and its applications to the symmetry of molecules. He has since returned several times to give interesting talks to the group.

Tony completed a BSc (honours) in theoretical chemistry in 1977 (after being dissuaded by Terry from doing honours in maths), followed by a PhD in chemistry from the University of Chicago in 1981. He then did postdoctoral research at Harvard University, before accepting his first academic job at the University of California in Berkeley in August 1983. Upon the retirement of Noel Hush he took up the Chair of Theoretical Chemistry at the University of Sydney in August 1991. Tony left Australia again in January 1998 and is now the Distinguished University Professor of Chemistry at the University of Houston.

Tony has done lots of interesting work. This has spanned several fields, but always seemed to involve water and entropy in some way. He has done work on hydrophobicity - the how/what of why oil and water don't mix - or do they? - C60, phospholipid bilayers,



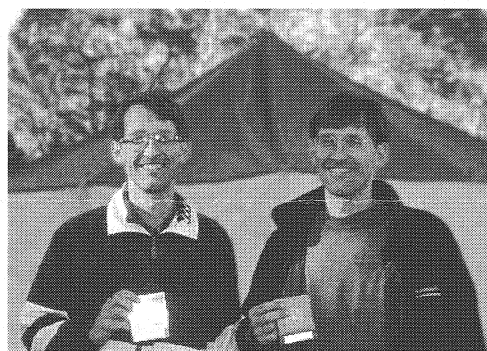
nucleation, and modelling the chemical reactions occurring in the atmosphere which contribute to urban air pollution. He has been for several fishing trips to the Antarctic and has discovered the molecular mechanism by which Arctic and Antarctic fish can live in water below the freezing point of their blood. In one of the talks that he gave at NMSS he discussed "antifreeze" in Antarctic fish (and its use in making creamy ice cream)!

For the last 10 years he has done experimental work, usually involving undergraduate students. Tony has supervised many PhD students and postdocs, who have gone on to become chemistry professionals and professors in Australia, Mexico, Slovenia, the Ukraine, and many states of the USA.

Maybe, if we promise enough water and entropy we can lure Tony back to Canberra for another summer school.

Leanne Rylands

**Richard and Andrew Stone** (NMSS 1984/85), now both working in financial mathematics, used their mathematical skills for something different when they won the rogaïne class at this year's NSW Emergency



Services Navigation Shield. They were given a map and the coordinates of around 40 checkpoints hidden in some 100 square kilometres of bush. They planned and optimised a route (a bit like working on the travelling salesman problem), and then spent the next 30 hours walking cross-country through remote bushland, visiting as many checkpoints as they could!

### CAN YOU HELP?

As you are aware, the NMSS needs all the support that you can give. The school is now without a major sponsor and 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. Cheques should be made out to the Australian National University (NMSS) and sent to Professor TM Gagen, Director NMSS, School of Mathematics and Statistics, University of Sydney, NSW, 2006.

Thank you for your continued support of NMSS.

## Mathematics and the Art of Buying a House

I have spent some time working at Residex, a small private company whose core business is the statistical analysis of residential property markets. In this article I'll describe one of the challenging statistical problems that Residex confronts.

If you are considering buying a particular house, you will want to know what you should expect to pay for it. One way of getting a good idea of the house's value is to wait until it gets sold. I'm sure you can see why this is a harebrained thing to do. If you are trying to sell a house you already own, the 'wait and see' method has even more serious drawbacks. It doesn't help to know a reasonable price after you have already sold it!

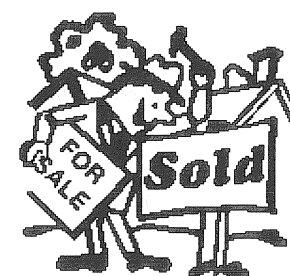
It is possible to hire an experienced valuer. They will estimate the property's value, taking into account all kinds of relevant information, like its physical attributes and condition, and its location. But this is often impractical: it is unlikely that a complete stranger will allow you to send a valuer into their home. And even when professional valuation is an option, it can be quite expensive.

Residex provides a cheaper and more practical alternative by using statistical techniques to estimate the property value. The only information they have to work with is a list of sales of homes since the late 1970s - the address of the property, when it sold, and for how much. So how do they do it?

The central idea is that the prices of houses that are physically close to each other tend to move together. This suggests that if we take the average sale price of recently sold properties in the local area, say over the last three months, it should provide some kind of *index* of house price growth in that area. For example, if I bought my house for \$200,000 in 1990, and the local average price has increased by 50% since that time, I would expect my house to be worth about \$300,000 now. This method is the one most commonly used by newspapers to report on the local property market.

There is a problem with this approach though. Suppose a new block of expensive luxury apartments has just been built in Randwick. It's likely that they will all get sold over a short period of time. The sale prices we observe during that period will be unduly influenced by these sales and so will not give a true indication of the average increase of property values in Randwick. If we use this data to estimate the price of my house (which isn't one of the new apartments), our estimate will probably be

too high. This phenomenon can severely reduce the accuracy of house price estimates, and Residex has spent many years researching ways to avoid it. If I explained their solution in detail, I would have to kill you ... so I'll just give an overview.



The main idea is that you should only ever compare a given property to *itself*. Taking an average of the prices of different properties is like comparing apples and kiwifruits - it simply doesn't make sense!

If a given house has only ever been sold on one occasion, it gives us *no information at all* about changes in property values in its neighbourhood. We can only get useful information from a property if it has sold at least *twice*.

Suppose I choose a short time interval in the past, say March-June 1988. There will be many properties that were *held* over that time period. Suppose my house was sold in 1975 and then again in 1992. Part of the growth of value of my property over this long period can be attributed to that short 3-month period.

Residex's approach is to combine all the contributions from different properties to estimate the 'average growth' over that short time period. Actually, the statistical model is designed so that all of the short periods are estimated simultaneously, so that inconsistencies in the data are washed out through all of the short time periods being considered. One interesting side effect of this is that adding new information about sales in 2002 can affect estimates of house values in 1990!

The short periods are strung end to end to create a price index. If your house sold for \$200,000 in 1990, and the price index increased from 1.0 to 1.5 since then, you would expect your house to now be worth \$300,000. The idea of using an index is the same before; it's just that now we are using a different index.

Of course, this explanation is a simplification, and even the sophisticated methods that Residex use have some serious drawbacks. Still, it's a huge improvement on the 'inspired guessing' method, and like all good research, the system is always considered to be a work in progress.

David Harvey