# Mathematical minds

**Natashia Boland***

*Gazette: When did your interest in mathematics begin?*

*Boland:* I find it hard to remember a time when I wasn't interested in maths. It was always my favourite subject at school, but even before that I know I liked it. My mother claims it was the early coaching she gave me involving chocolate 'Smarties'! I think subtraction meant I got to eat some ....

*Gazette: Were you encouraged to do and did you enjoy mathematics at school?*

*Boland:* Yes and yes. I had a series of motivated and supportive teachers, although to be fair, I enjoyed English, literature and music very much also. But mathematics was always my favourite. The teachers I had at high school, especially Janet Hunt, who is something of a national figure, played a huge role in sustaining that and making sure I could develop my interest and abilities in mathematics.

*Gazette: Did your parents encourage you to become a mathematician?*

*Boland:* They encouraged my interest in mathematics, and to some extent did encourage me to become a mathematician, a decision I made around age 6. I had earlier expressed a desire to be an engineer — I played constantly with lego, meccano and so on — but my mother told me that being an engineer was boring! So since maths was my favourite subject, I asked if I could 'just do maths'. When told 'yes', the decision was made. (Of course I now know that being an engineer can be very interesting too.)

*Gazette: What did you study at university? And why?*

*Boland:* I studied maths because I loved it, and computer science because I was worried maths might not get me a job! It turns out that these areas converge, and I have a hard time saying definitively about many fields of study whether they should be classed as 'computer science' or 'maths'. My research is still at the junction of the two, and I continue to enjoy close collaborations with computer scientists. From a practical point of view, I now know that maths skills are highly valued in the job market, and that maths can lead to a wide variety of careers. But I would also say that, in my view, doing maths without computer science is like buying a car with a great engine but no wheels — you can't go anywhere very exciting! Having strong computer programming skills and a good understanding of computer science is an essential adjunct to my area of research.

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*Gazette: On the subject of your research, in which areas of mathematics do you work?*

*Boland:* I work in operations research. It applies mathematics to solving problems in the real world involving decision-making, trying to make best decisions in the face of limited resources or other constraints. Many situations in transportation, scheduling, planning are well addressed with operations research. It is also about the study of mathematical structures motivated by such problems. So it embraces both mathematics per se, and applications. It is embedded in valuable and pervasive software packages used routinely by companies, for example, to plan airline crew and aircraft movements, to schedule production in factories, or to route vehicles for deliveries. It is increasingly being used for making complex decisions in environmental management, and healthcare.

*Gazette: What led you to a PhD?*

*Boland:* Intellectual curiosity, and love of my subject. By the end of honours, I could clearly see how much mathematics lay still to be discovered — and still does. I think I am an explorer at heart, and doing research is very much about exploring the unknown. As well as simply loving doing maths and wanting to do more of it, I know that I also felt I would be very bored in a regular job. I had had a couple of good vacation jobs at companies, and even though they were on the more technical, challenging end of the spectrum, I could well see that if I tried to keep doing that I would be bored. I like variety, the opportunity to think creatively, and as I said before, to explore — doing research offers all of this, and more.

*Gazette: What was your career path from PhD to Professor? Were there challenges to overcome along the way?*

*Boland:* After a brief stint working with a Melbourne-based company on airline planning software, I took up postdoctoral research fellowships in Canada and the US, one year each respectively. I then returned to Australia to take up a permanent academic position at the University of Melbourne, where I remained for 13 years, ultimately promoted through to Associate Professor. For the last five years I was at Melbourne Uni, with the support of Professor Peter Taylor, the Head of the Department of Mathematics and Statistics, I founded and directed Melbourne Operations Research, a consulting and contract research practice operating on behalf of the University (and the Department). This practice undertook mathematical modelling and developed solutions for a variety of business and industry clients. Just over two years ago I left to take up a role as Professor of Applied Mathematics at the University of Newcastle, taking the opportunity to build up an academic group working in operations research.

I would say that there were significant challenges along the way. Managing the diverse and demanding workload of an academic is never easy. In my field of research, it is also difficult to make progress without substantial and specialised computer programming assistance, which is too time-consuming to fit into a normal academic workload. Thus capable PhD students or research staff are critical for developing one's research ideas. This requires both good luck in attracting

PhD students with the right skills, and research funding. I found the latter difficult to obtain in my early years as an academic — grant funding is always scarce and highly competitive — and I owe my ultimate success in that to the great mentors I had at the University of Melbourne, (most especially Peter Taylor), and to the industry partners willing to invest in my research program.

*Gazette: What led you back from North America to Australia?*

*Boland:* Gum trees! I was deeply homesick when out of Australia, and it was primarily the landscape, the bush, the culture of Australia — multiculturalism and egalitarianism — that I came back for. Lower salaries in academia, greater administrative and teaching workloads and lack of infrastructure and research support compared to the options I might have had in the US seemed to be the price I had to pay to live in Australia, and I have so far been willing to pay it.

*Gazette: You've worked on a range of successful industry projects. Have you considered moving from academia to industry?*

*Boland:* I have on several occasions considered that, and also considered moving to the CSIRO, which also has a strong research focus plus strong industrial links. My reasons for not moving were complex, and varied in each case. I think the key factors keeping me in academia have been the ability, to a large extent, to set my own agenda, and my enjoyment of teaching and research supervision. I like very much seeing people develop their abilities and skills, and facilitating that. I find it very rewarding. And university life offers a lot of opportunity for that.

*Gazette: You were mentored during part of your career by George Nemhauser, a world leader in discrete optimisation. What do you value from this relationship? How did this shape your career?*

*Boland:* My PhD had been in the continuous side of optimisation. While I was in the final stages of completing it, I attended a workshop that George gave at an international conference on discrete optimisation, or rather integer programming. I loved it immediately — the power of the applications in the real world, the discrete and combinatorial flavour to the mathematics — and decided to change my research field as a result. Making the transition from continuous to discrete took some time — the two areas rely on quite different types of mathematics — and George further supported me in doing that by giving me a postdoc to work with him and his group at Georgia Tech in the US, which I did in 1994. I learned many valuable things from working with George, too many to list. He is still an inspiration and if I can accomplish even a small portion of what he has, I will be grateful.

*Gazette: What is the best career advice you have ever received?*

*Boland:* I've had probably four clear pieces of career advice given to me.

The first was to go overseas for postdoctoral research after my PhD finished, which my PhD supervisor Alistair Mees strongly encouraged me in. Doing so had significant personal costs, and I wouldn't necessarily recommend it for everyone, nor do I believe it is as important now as it was 15 years ago. Nevertheless I would

recommend that all young academics gain some international experience, in whatever form they can manage. The confidence that comes from knowing you can mix with the best, from all over the world, and make a contribution at that level, and the contacts and collaborations that follow, are priceless for a rich and happy academic career.

The second was to find a niche — specialise in one key area, technique, or application and become the world's best in that. I have not been able to follow that advice — it is excellent advice, and a perfect recipe for academic success. But I don't have the constitution for it. I love variety too much, and enjoy exploring new things too much.

The third was to apply for promotion. I hate the process, and delayed going for promotion for much too long. But one of my mentors at Melbourne Uni, Professor Rachel Webster, continued to pester me to look after my career in this way — and I am ever grateful to her for that.

The fourth was to continue to apply for grants, even in the face of the ongoing lack of success I was experiencing. Professor Peter Taylor was instrumental in encouraging me to keep doing this, and in suggesting different ways of going about it.

*Gazette: Of what achievements are you most proud?*

*Boland:* I am proud of the PhD students I have supervised, of the results they achieved in their research and the growth they experienced in the process. I am also pleased at having been able to do work that makes a difference in the world, of the tools, concepts and insights I've been able to give to business and industry over the years. I'm particularly happy that I've been able to build the group that I now have at the University of Newcastle, in operations research, and I am looking forward to seeing all the members of it blossom. In terms of specific research results, probably the work that has been ongoing over a number of years in constrained shortest paths has made the most significant contribution to international research. But I am pleased to have been at the forefront of development in a number of different areas at various times, including column generation stabilisation, optimisation in mining, and aspects of stochastic programming. It is exciting to be active in unfolding a new area of activity and starting to see its potential.

*Gazette: In which direction is your research heading?*

*Boland:* Since coming to Newcastle, the importance of integrated, complex logistics planning and scheduling activities has been highlighted by the local coal export supply chain. Newcastle is home to the world's largest coal export terminal, and the logistics planning group for the operation is a major supporter of the current and ongoing research of my group. The logistics challenges in the coal chain have thrown up many fascinating and difficult mathematical questions that I am looking forward to answering in coming years.

Newcastle is also a major centre for energy generation, and this has led to my involvement in research involving power networks, electricity distribution networks,

and renewable energy network design. Power flow is highly nonlinear and continuous, whilst infrastructure design choices, such as the number of generators of each type to install at each location, and network structures, are discrete. This interplay presents interesting mathematical challenges and there is now an up-swell of international research in this area.

These practical motivations are highlighting the importance of robust optimisation — planning so as to hedge against uncertainty — and of scheduling, and the challenges of working properly with continuous time in an effectively discrete setting. Quite a few of my current research interests are in this latter direction, thinking about how to identify the important times to schedule things, without exhaustively searching through all possible times.

*Gazette: Why do you do mathematics?*

*Boland:* That is a very hard question to answer. Why does a fish swim in water? It seems very natural to me to do it, and I know I would miss it terribly if I didn't.

*Gazette: Do you have obsessions or interests outside of mathematics?*

*Boland:* The thing I probably spend most time on outside of academic life is bush-walking. I enjoy that very much and try to get in a good walk of some kind at least once a week. For a number of years I did quite a lot of yoga, but a recent injury has set that back for the last year. I have a long-standing interest in psychology, and in Eastern philosophy, and especially the junction of the two. But as in maths, I like variety in everything, and from time to time enjoy a range of different things, including good food — both eating and cooking, good books, art, music, travel. Last but not least, I am very happily married and enjoy, above all, time spent with my husband. This sometimes overlaps with my mathematical interests, as he is in exactly the same field as I am!

Natashia L. Boland received her BSc (Hons) in Mathematics and Computer Science and her PhD in Mathematics from the University of Western Australia in 1988 and 1992 respectively. After six months working on airline applications of operations research for a Melbourne software company, she took up research fellowships at the University of Waterloo (1993) and Georgia Institute of Technology (1994), before joining the University of Melbourne in 1995. Moving to the University of Newcastle to take up the position of Professor of Applied Mathematics in 2008, Natashia continues to develop her research program in operations research and its applications.