An Interview

with Peter Jephson Cameron

by **Gracinda M . S. Gomes** [CAUL and DM-FCUL, Universidade de Lisboa]

Peter Cameron received a B.Sc. from the University of Queensland and a D.Phil. in 1971 from the University of Oxford, with Peter M. Neumann as his supervisor. Subsequently he was a Junior Research Fellow and then a Tutorial fellow at Merton College, Oxford. He was awarded the London Mathematical Society's Whitehead Prize in 1979 and is joint winner of the 2003 Euler Medal of the Institute of Combinatorics and its Applications, http://www.lms.ac.uk/content/list-lms-prize-winners and http://en.wikipedia.org/wiki/Euler_Medal.

Peter Cameron is the author of over 300 papers and has written 7 books as well as various lecture notes, with more than 130 collaborators; counts with 34 Ph.D. students, and 9 "honorary" students, as well as many more Master's students, http://www.ams.org/mathscinet/search/author.html?mrauthid=44560.

Tell me about your way into Mathematics. Did you always want to be a mathematician?

I never seriously wanted to be anything else! But I didn't realise that you could be a mathematician as a job until I went to University for an interview for admission as a student. Before that I thought I would have to work in some field like Engineering or Physics that contained some mathematics. But I saw the people on the other side of the desk and thought, they are mathematicians, I could be one too!

Some of my early childhood memories are mathematical. I grew up on a dairy farm, and we took the milk to the cheese factory on a horse-drawn cart. I remember sitting on the back of the cart counting to a thousand. A bit later I discovered how to sum geometric progressions while chasing the cows in to be milked. This was a job that didn't need much concentration: just sit on a horse and follow the cows. So I could let my mind wander and think about adding up powers of 2, and 3, and so on.

How did you get interested in Algebra?

I think I have always been better at the discrete than the continuous. If combinatorics had been a university subject when I was a student, I may have been seduced by that! As it was, algebra suited me very well; I liked the way it was highly structured. I did my undergraduate honours project on the simplicity of the groups PSL(2,q) (though I took this from Dickson's book, he calls these groups LF(2,q), which was a bit confusing to me later). The purpose of a group is to act on something, and it is always interesting to play off the group and the structure it acts on against one another; one learns interesting things in this way.

A couple of years ago I had a student who did a project on Sylow's proofs of his theorems. Sylow's original proof of his first theorem was phrased in terms of double cosets; now we would write it in terms of group actions. That was a stunningly beautiful proof, and is now my favourite of all the many proofs of that theorem. Very briefly, you show that if a group G has an overgroup which has a Sylow p-subgroup, then G also has one. By Cayley's theorem, every group of order n can be embedded in the symmetric group S_n, and S_n can be embedded in GL(n,p), which obviously has a Sylow subgroup (the upper triangular matrices).

In which way is your recent research going?

As usual, in many different directions. I have never been good at concentrating hard on one problem until I solve it; someone comes along with another interesting problem, and I can't resist having a go.

There are several big things going on at the moment, all in the area between algebra and combinatorics. One project is to understand the algebraic properties of roots of the chromatic polynomials of graphs. Partly as a result of the connection with statistical mechanics, we know a lot about the location of these roots in the complex plane, but much less about, say, the degrees of the splitting fields, and their Galois groups.

Another is the work that brings me to Lisbon, my joint work with João Araújo and others on connections between semigroups, permutation groups, and various parts of combinatorics. João believes that, as a result of improvements in our understanding of groups, it is time to revisit the study of semigroups through their groups of units. The connection between transformation semigroups and permutation groups is especially close.

It turns out, too, that various concepts of optimality of block designs in the theory of experimental design in statistics can be expressed in terms of Laplacian eigenvalues of graphs. This is an area which also connects with random walks, electrical networks, isoperimetric problems, and other hot topics in network theory.

Between your many results, do you have a particular dear theorem?

There are two theorems of mine that I particularly like. One, with Jean-Marie Goethals, Jaap Seidel and Ernie Shult, was not a new theorem (Alan Hoffman had essentially the same result but with a very complicated proof which was never published), but our proof was new. The theorem describes all graphs for which the least eigenvalue of the adjacency matrix is -2 or greater. The novelty in our proof was to use the classification of the finite-dimensional root systems, from the theory of simple Lie algebras.

The second was my first venture into the realm of infinite permutation groups. John McDermott asked for an analogue of the Livingstone-Wagner theorem, about groups which act transitively on the set of k-subsets for all k, but are not k-transitive for some k. I was able to give a complete description of these groups: they preserve or reverse a linear or circular order on the underlying set. My proof was a typical finite group theorist's proof; immediately afterwards, Graham Higman came up with a proof using ideas from model theory and compactness. He called the lectures he gave about it "a Cameronian commentary".

I am also proud to have a constant named after me, from my work on sum-free sets, which also gave me Erdős number 1 (*see* Fig. 1).

And how do you see the importance of algebra in mathematics and in other fields of knowledge?

Algebra is the best example of how the abstract method has revolutionised mathematics and its applications.

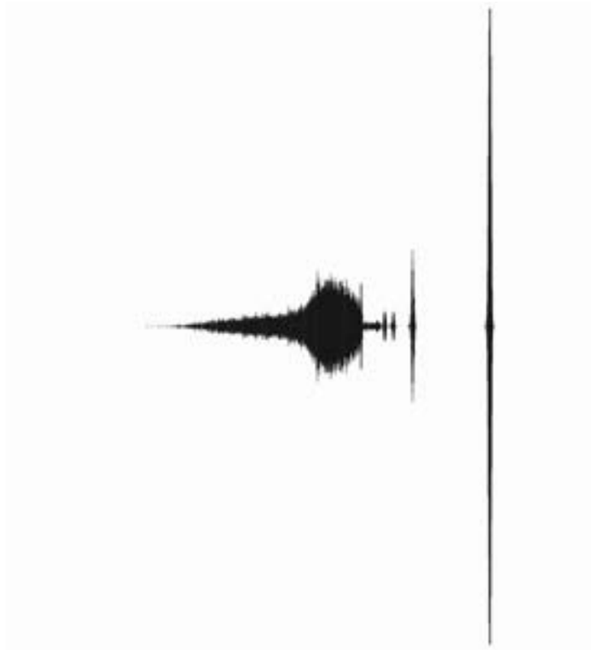


Figure. 1.—An approximation to the density spectrum of a random sum-free set. We choose a sum-free set of natural numbers in order: if n is the sum of two numbers in the set, then n is excluded, otherwise we toss a fair coin to decide whether to include n. The spikes on the right of the picture can be explained; for example, the biggest spike corresponds to sets of odd numbers, which occur with probability about 0.218 ("Cameron's constant"). The shape on the left, however, is still a mystery.

Douglas Adams, one of my favourite authors (who wrote "Hitch-Hikers' Guide to the Galaxy"), said "Algebra, for instance (and hence the whole of computer programming), derives from the realisation that you can leave out all the messy, intractable numbers." Numbers, matrices, permutations, symmetries, all obey a few simple laws; anything we can deduce from those laws (which is an impressive amount) will hold in all of these structures. A few years ago, my department went back to doing something we had not done for a very long time: teaching abstract algebra to first-year students. I was given the job of designing and presenting the course. The students found it hard going, but worked very hard, and the results were good.

I am a Professor of Mathematics, and proud of that title. My work has taken me from model theory (in logic) to measurement theory (in mathematical psychology). A thread of algebra runs through all of these things.

I probably don't have to tell your readers about the importance of, and impact of, mathematics in our life today. Angus Macintyre, the immediate past president of the London Mathematical Society, argues that the economic impact of elliptic curve cryptography (which is responsible for the security of cash dispensers, among other things) far outweighs anything most disciplines have to offer. This is an important issue now, when the paymasters are interested in the economic impact of our research. But there are many other mathematical top-

Figure 2.—A Latin square, used in agricultural research at Rothamsted Experimental Station. Latin squares are the Cayley tables of quasigroups. This picture was provided by Sue Welham.

ics which also have practical importance, such as Latin squares (see Fig. 2).

Some interesting directions of research in algebra?

I am glad to see that various generalizations of groups, whose theories grew up more or less independent of group theory, are now moving together again. A very good example was the talk by Michael Kinyon, in July 2011 in Lisbon, which I talk about later, combining semigroups and quasigroups.

As well, there is a lot of Algebra underlying developments in mathematical physics, such as conformal field theory. But to my mind, the most interesting thing that has happened to Algebra during my career is the re-focusing of group theory following the Classification of Finite Simple Groups. Some people thought that finite group theory would fade away; this hasn't happened, since we have found so many interesting things about the subgroup structure and representation theory of the almost simple groups. Also, some areas of infinite group theory, notably locally finite groups and profinite groups, have been re-fashioned by our new knowledge of finite groups.

How do you expect the interplay of semigroups and groups to develop further?

It is probably unwise of me to make predictions about semigroups; I don't know so much about them. But the work I am doing suggests that it is time to look again at the group of units of a semigroup, or at its automorphism group, and to use the much stronger information we have about finite groups in order to make progress.

A longer term goal would be to do something similar with infinite transformation semigroups. Infinite permutation groups are a particular love of mine, and I would like to see some of the recent work in this area put to use.

In a different area, I have seen that the relationship between the semigroup and the group given by the same (inverse-free) presentation is being studied. I have a recent paper on set-theoretic solutions of the Yang-Baxter equation from statistical physics, in which this situation arises naturally (and the group given by the presentation has a natural homomorphism to a permutation group).

You are a very popular lecture and supervisor, how important is for you to teach?

I very much enjoy teaching. In some ways it is a greater challenge than research. Rather than just finding an argument that convinces me, I have to convince many people with different backgrounds and expectations. It is very useful that some theorems have many different proofs: some students get the hang of one, others catch on to a different one.

I have learned a lot from my students, probably far more than they have learned from me. It is always better when students are involved in the decision about what to work on; I prefer not just to lay down the law on this. It does become more difficult, as funders now prefer us to have specific projects laid out, and give grants to students to work on these.

Your many research students, are they all academics? Or have they opted for other kind of jobs?

Not all of them have become academics, though some have very successful careers in the academy. Some of my students have done their PhDs part-time, which is much more difficult but means that they don't have to look for a job at the end. Some have gone into commerce, or the civil service, others (I am happy to say) into schoolteaching and curriculum development.

When I was a student, the assumption was that a PhD always led to an academic job. But this is no longer true. I meet many people in the research council who have PhDs http://www.epsrc.ac.uk/

Do you have an advice for the students who are finishing their PhD? With nowadays job situation some feel rather concerned.

It is not an easy time to be finishing a PhD! In the longer term, things are likely to get better; a pendulum will always swing back eventually. But if you are starting out on your career, this is not comforting advice.

In my own case, a post-doctoral fellowship was a wonderful opportunity to do whatever I wanted, to learn new things, and to start really enjoying doing mathematics. Not all post-doc positions give as much freedom as this, but most supervisors understand that a young mathematician needs to spread her/his wings, and most people judging the outcome of a research grant also realise this and are not too strict if the original objectives haven't been met, as long as some good work has been done. I encouraged my most recent post-doc to broaden his interests, and now he has a lecturing job in a good department. So I think the advice is: if you can get a post-doc position, make the most of it!

And what about the ones who are dueling between their wish of taking a PhD and looking for a job immediately?

I would never take on a PhD student without giving a couple of warnings; in particular, there is no promise that it will lead to a successful career, and certainly not to a big salary! I think that someone who does not feel the inner compulsion to do mathematics is almost certainly better off looking for a job. But if the candidates decides that they are committed, I will do the best I can to help turn their dream into reality.

Have you been the head of a research group? What are your thoughts about running a group?

I was director of pure mathematics at Queen Mary for several years, but I have never officially run a research group. What happened was that people came to work with me, or to study, and a strong group of researchers just happened without any bureaucratic interventions. In particular, starting from almost nothing, a very active group in combinatorics now exists in my department.

Now it is difficult to run a group in this "hands-off" way, as universities introduce performance management and group leaders are expected to use the stick as well as the carrot. I am happy that I don't have to do this.

Keeping the blog http://cameroncounts.wordpress.com/ brought the students even closer to you and to mathematics?

Not so much students as ordinary people. I have discovered a large number of acquaintances, some of whom I have met, some are just pen-names, who respond to exposition of mathematics, or who ask me questions.

A lot of what I blog about is expository: I have a long series about the symmetric groups, for example. These are the posts that keep up their popularity after months and years when other more topical posts have faded into obscurity. I used to get this kind of satisfaction from writing books, but blogging is so much easier, and the responses come much quicker.

At the university, some defend that the number of just research places should be increased, how do you feel about this? Teaching and research can be dissociated in a good university?

I feel very strongly that dissociating teaching and research would be a bad mistake. There are a very few brilliant researchers who I would be reluctant to put in front of a large first-year class, but for the most part, the same people are good at both teaching and research.

Everybody benefits from this arrangement. In preparing teaching, or in questions from students, I get a supply of

Figure 3.—With my supervisor, Peter Neumann, and some of my students, at my 60th birthday conference in Ambleside.

Standing: Michael Giudici, Pablo Spiga, Dugald Macpherson, Eric Lander, Cheng Ku, Fuad Shareef, Sarah Rees, David Cohen, Colva Roney-Dougal, Robert Bailey, Carrie Rutherford, Thomas Bending, Fatma Al-Kharoosi, Thomas Britz, Francesca Merola, Emil Vaughan.

Seated: Julian Gilbey, Taoyang Wu, Debbie Lockett, Josephine Kusuma, Sam Tarzi.

Figure 4.—With João Araújo at CAUL

research problems. If I find a new piece of mathematics and I am bursting to tell people about it, it often finds its way into my teaching. And I don't think students will ever understand what mathematics is really about unless they come into close contact with the best researchers.

In your page http://www.maths.qmul.ac.uk/~pjc/MTH6128/study.pdf there is a "letter" of advice to the students that come to the university. Do you feel that the students find adjusting to the university harder nowadays?

Yes. I think there are several reasons for this, but let me say to start that it is not true that students are less talented these days. An important factor is that schools do not prepare students for independent thought. The pressures on schools to achieve good exam results are so strong now that it is in everyone's interest, pupils and teachers alike, to be able to respond mechanically to exam questions without stopping to think for too long. Besides, this has the effect that pupils believe that the teacher's job is to help them get good exam results, not to make them think. So students arriving at university need to have their expectations changed.

The number of students going to university has greatly increased, while the proportion of the population with the ability and interest to do a mathematics degree probably has not. At some point ten years or so ago, word got around that a mathematics degree was the best way into a well-paid job in the finance industry. Not even the economic crisis has destroyed this expectation.

How did your connection to Portugal start? And how do you do see its development?

It started without warning in a talk by my PhD supervisor Peter M. Neumann, who discussed a question sent to him by João Araújo, and his answer to it. At almost the same time, I was working with a former student Cristy Kazanidis on highly symmetric cores (graphs with no proper endomorphisms), and also I was visited by another former student Robert Bailey who reported to me a conversation he had had with Ben Steinberg at a bus stop in Ottawa (interrupted by the arrival of Ben's bus) about a related topic. The upshot is that a group of us, with João as the driving force, began working on a connection between synchronizing automata and permutation groups, which rapidly grew almost beyond control! Amazingly enough, at that point I had never been to Portugal. Since then I have been three times and plan to return soon, and this last one has been particularly fruitful with three papers about to be finished!

Who can say how it will develop? It seems that interesting things will continue to happen; and now I have discovered for myself what a beautiful city Lisbon is, I will certainly be coming back whenever I can!

Last year CAUL and CIM, in collaboration, organized the conference "Groups and Semigroups: interactions and computations" in which you were one of the main speakers, what did you think of the impact of this meeting in the field?

I mentioned above how good it is that groups and semigroups are coming together again at last.

There were two particular interactions that made the meeting very worthwhile for me. One was meeting John Meakin again. John and I were students together at the University of Queensland, and then went different ways, and our paths didn't cross until 2005, when we were both invited speakers at Groups St Andrews. This time John had a whole raft of questions which he thought would catch my interest. He was right, though I haven't got very far with them yet.

The other was Michael Kinyon, who works on the other kind of generalisation of groups (that is, quasigroups

and loops), and might have been expected to be at the conference on those which was happening in Prague at the same time. But he came to Lisbon and told us about a very interesting cross-fertilisation between semigroups and loops. Just as a loop has a multiplication group, so Michael's more general structures (which he called "semi-loops") have a multiplication semigroup.

It was also very interesting to see that even people who work at the most theoretical end of group theory are turning to computation in their research, to make and test conjectures and even to help prove theorems. This is a trend which will continue!

You are a traveler; would you like to tell us about a special trip/episode?

There are so many stories I could tell, and some of the best are possibly embarrassing or dangerous to tell. Mathematicians form a universal fellowship, and wherever I go, even in places with authoritarian regimes, the mathematicians treat me like one of them, and I see the place from the inside. Seeing places as different as Iran and Japan from the inside is an amazing experience: skimming stones on the Caspian Sea at sunset as the night fishermen were setting out, and the tea ceremony in Tokyo escorted by the partner of a colleague.

One thing that remains with me happened on my visit to India in 1988. I was staying at the University of Bombay, and they arranged for me to make a visit to Poona to give a talk. I went up and back by train. While I was there, the algebraist Devadatta Kulkarni took me round the city on the back of his scooter. One of the days of my visit happened to be Christmas Day, but it was a busy day at the mathematics department, since a big conference was beginning the next day. So, two students were given the job of looking after me and taking me round the town, to temples, markets, and so on. I found out on talking to them that, as well as studying for their PhDs, they were both teachers at the local high school, doing something like 20 contact hours a week! I tried to repay my debt to them by talking about mathematics, going through a paper they were reading and helping them with some of their difficulties.

I keep travel diaries on many of my trips, and put them on my web page if they are not too scurrilous! The story of my Indian trip, and a later trip to India, are both there. http://www.maths.qmul.ac.uk/~pjc/travel/

Along the years, you have been seriously interested in sport, music, literature, painting, which are your hobbies nowadays?

Sport was probably my most serious interest — I was Australian Universities champion at cross-country running when I was a student — but, as I get older, I find that injuries take longer to heal, so I do more walking than running now. I try to go for a long walk at least once a week (anything from 15 to 50 kilometres). London is a good city for walking, since the transport system is centralized, so it is easy to escape in any direction. Also, I have rediscovered photography. Digital compact cameras now are probably as good as the SLR I had when I was a student, and I am building up a good collection of photographs of places where I walk.

I play the guitar (I learned this at university where I played in a band). Since I play by ear, I am not restricted in what I can play. The guitar is a good barometer of my stress levels; if I go for months without picking it up, I am in a bad way! London is also a good city for music since every great musician (like every great mathematician) comes to visit.

I didn't read much at school, but discovered literature at university, and now I am an avid reader; maybe I am addicted to print.

An e-reader fan or do you prefer the "real thing", the paper book?

For me, a real book is better. Maybe you like what you grow up with! When I first had an e-reader, I tried using it for keeping slides of my talks, so I would know what was coming next; but I found I was never using it. The advantage of an e-reader is that you can get classics free or very cheaply. I am currently reading Gibbon's "Decline and Fall of the Roman Empire".

I would say that you are a free spirit; would that have its deep roots in your upbringing in Australia?

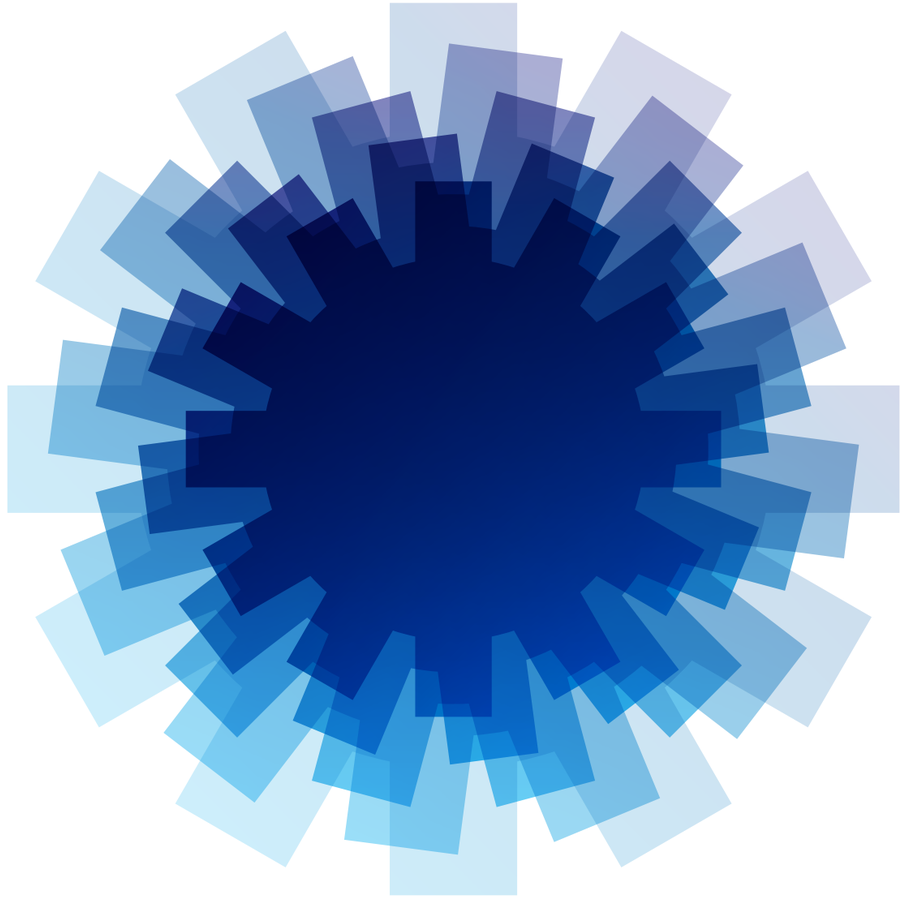
A hard question. Australians are, in fact, very conventional people. We introduced the term "tall poppy", meaning someone who is better than others at something and has to be cut down to size. I suppose this means that I learned to do what I wanted to do without making a song and dance about it. But it was also true that, growing up in the country, I learned that if nobody else could be found to do something, I could always simply do it myself. Travelling to the other side of the world to study and making a new life there must also have helped make me more independent.

Thank you Peter, it was a pleasure to interview you.

Lisboa, April 18, 2012

The 86th European Study Group with Industry

by Manuel B. Cruz [LEMA, Laboratory of Engineering Mathematics, School of Engineering of Porto's Polytechnic]



7 - 11 May, 2012
ISEP - School of Engineering | Polytechnic of Porto

The 86th European Study Group with Industry took place from May 7 to May 11, 2012 at ISEP, the School of Engineering of Porto's Polytechnic, organized by the Laboratory of Engineering Mathematics (LEMA) (*see*: http://www.lema.isep.ipp.pt/esgi86/). This meeting has counted with the participation of several experts with a large experience in this type of events. By the 5th consecutive year, Portuguese researchers and academics tried to strength the links between Mathematics and Industry by using Mathematics to tackle industrial problems that were proposed by industrial partners (*see*: http://www.ciul.ul.pt/~freitas/esgip.html).