

A Conversation with Peter Hall

Aurore Delaigle and Matt P. Wand

Abstract. Peter Gavin Hall was born in Sydney, Australia, on 20th November, 1951, and grew up in the Sydney suburb of Oatley. He received a Bachelor of Science with first class honours from the University of Sydney in 1974, a Master of Science from the Australian National University in 1976 and a Doctor of Philosophy from the University of Oxford in 1976. In 1976–1978, he was Lecturer in Statistics at the University of Melbourne. During 1978–2006, he served as Lecturer, Senior Lecturer, Reader and Professor of Statistics at the Australian National University. He became Professor of Statistics at the University of Melbourne in 2006, Australian Laureate Fellow in 2012 and was Director of the Australian Research Council Centre of Excellence for Mathematical and Statistical Frontiers in 2014–2015. In 2005, he commenced a one-quarter professorial position at the University of California, Davis. Peter has published 4 books and more than 600 research articles. He has made seminal contributions concerning the bootstrap, rates of convergence, functional data analysis, martingale theory, measurement error models, nonparametric function estimation and smoothing parameter selection. Honours include the following: Officer of the Order of Australia; Fellow of the Australian Academy of Science, Fellow of the Academy of the Social Sciences in Australia, Fellow of the Royal Society of London, Fellow of the Institute of Mathematical Statistics and Fellow of the American Statistical Association; Corresponding Fellow of the Royal Society of Edinburgh, and Foreign Associate of the U.S. National Academy of Sciences; honorary doctorates from the Université catholique de Louvain, the Universidad de Cantabria, the University of Glasgow and the University of Sydney; the Committee of Presidents of Statistical Societies Award and the Guy Medal in Silver from the Royal Statistical Society. He married Jeannie Jean Chien Lo on 15th April, 1977. His mother, Ruby Payne-Scott, had a distinguished scientific career as the first woman in radio astronomy and her story is published as *Under the Radar. The First Woman in Radio Astronomy: Ruby Payne-Scott* (2009) Springer. In 2015, Peter was diagnosed with acute leukaemia. He passed away on 9 January, 2016, in Melbourne, Australia.

This conversation took place in Melbourne, Australia, on 11 March and 1 April, 2015.

Key words and phrases: The Australian National University, the University of Melbourne, the University of Oxford, the University of Sydney, photography, Ruby Payne-Scott, steam locomotives, student activism, Trans-Siberian Railway.

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FIG. 1. *Peter's mother, Ruby Payne-Scott, as an undergraduate student at the University of Sydney in the 1930s. During the 1940s, Ruby had a distinguished career as the first woman in radio astronomy and her story is told in Goss and McGee (2009).*

FAMILY BACKGROUND

Matt: I believe that you were born into a scientific family and that, in fact, your mother, Ruby Payne-Scott (see Figure 1), had a distinguished scientific career curtailed by your arrival into the world.

Peter: An excellent source of information about my mother is Goss and McGee (2009). She was very strongly influenced by an aunt who apparently taught at Fort Street Girls' High School in Sydney. My mother stayed with her, and the aunt provided a lot of moral support to her. This seems to have been necessary because she didn't get the moral support she needed, particularly as a young woman, from her family. Her father was a bookkeeper. It's an apocryphal story that she went home for university holidays at one point, with her books, and then returned home from somewhere to find her books had gone. After making enquiries, she discovered that her brother had destroyed her books. Her brother was just going through school in the usual way and apparently didn't have ambitions to go to university, whereas my mother, I think, was actually at university at that time. I believe she was admitted to university at age 16. He was very annoyed that she had this opportunity and aggressively took it up, whereas he wasn't offered it and didn't seek it.

Matt: And your father?

Peter: My father was a lovely man. He had an enormous influence on me and I didn't realise that until after he had died. I still think about him every day. He began his working life in, I think, a furniture factory

in Sydney, or as a French-polisher/furniture-maker in Sydney; it must have been in the 1920s. At some point, he decided to become a telephone technician. I have always suspected that it was when the furniture factories began to be automated, or the machines in the furniture factories began to be driven by electricity, not by muscle power, and I think he must have seen the writing was on the wall. My father made a lot of the furniture at home, and he really enjoyed that, and I enjoyed traipsing around the house after him, learning about various pieces of equipment and how to use it to make furniture. Almost universally, the equipment he used was manual. It wasn't until the late 1960s, for example, that he bought his first electric drill, whereas most people had electric drills well before that point. He really liked doing things by hand.

Matt: I believe that your parents were very fond of the Australian bush.

Peter: They were both foundation members of the Sydney Bushwalkers Club. I remember seeing many times the little badge with the flannel flower. My father always maintained an interest in doing that sort of thing, and he was by no means constrained to the Sydney Bushwalkers. Dad was very much dedicated to creating national parks and maintaining parkland in its natural condition, but he did that through a variety of organisations and societies. Sydney Bushwalkers, by the time I came along, was for Mum and Dad more of a social club (Figure 2). We would go on camps together, and I remember we would sing songs around the campfire at night.

Matt: Could we talk a bit more about your mother's career? She worked for the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Peter: My mother was very engaged in left-wing politics. She was, in effect, a trade union representative for CSIRO employees, as is discussed in Goss and McGee (2009). If Japan hadn't attacked Pearl Harbor and forced America into the war, it's probable that we'd be speaking Japanese now. The Japanese were planning to invade from the north. When the Australians proved rather resistant and stubborn, the Japanese changed that to invading through the South Pacific, coming across the Tasman Sea and seizing Australia that way. Australia set out to try to defend herself, unsure that America would ever enter the war. She was forced to develop radar herself. It was being developed separately in the U.S. and the U.K., and of course in the axis powers like Germany; they had advanced radar. Australian scientists set up radar off the coast of Sydney, at Dover Heights.



FIG. 2. *Bushwalk, Easter 1941, shortly after Peter's parents met each other. Bill Hall is second top left, standing next to a eucalyptus leaf gatherer. Ruby Payne-Scott is sitting in the centre of the photo looking toward Bill.*

The idea was that the Japanese would attack from the sea, which of course they did when they had a chance during the war. It didn't make much sense to set up radar anywhere else than looking eastward. The Allied powers also noticed that these fixed, rigid radar receivers and reflectors received a lot more activity when the sun rose, because there were radio transmissions from the sun; the sun had transmissions in radio wavelengths, and my mother realised that radar activity went up when sunspots were present—that there was a high correlation between activities in the relevant spectra, or the relevant parts of the electromagnetic spectrum. My father, who loved my mother terribly, used to tell this story. She was out on a bushwalk once and looked at her watch at some point and said, "I have to get back quickly." And people said "Why do you have to get back? It's a Sunday afternoon." And she said, "Ah, but we expect there to be sunspots this afternoon and I want to record them and what their intensity is and frequencies of radiation are and things like that." This led to a paper in *Nature* with (leading Australian radio astronomer) Joe Pawsey. So returning from the bushwalk relatively early was scientifically worthwhile.

My mother was very non-abstract, and I could never imagine myself, after being raised at her knee, becoming a pure mathematician. She used to tell a story, which I later found came from a book that was written during, or shortly after, the Second World War, about scientific research in the U.K. It was a novel. The idea

was to improve the ballistics of shells fired from a gun that was towed behind a truck, or something like that. The serviceman responsible said to the guy loading the shells into the gun and firing them "Did you notice anything different about shell number 27?" And the guy said "No. It just went 'bang' like all the others." And the serviceman said "That's funny—according to my calculations, it had a negative muzzle velocity." Of course, the joke in this was the sheer impossibility of him still being alive if these calculations were right, and that the mathematician, the serviceman, who did the calculation, hadn't used that basic fact. She used to use this story as emblematic of the impracticality of mathematicians. She was convinced of the importance of mathematics for discovery in nature, but she was not convinced that mathematicians were the right people to do it.

Aurore: I think you said once that when she was trying to understand something, she would pick an example, whereas you would rather take a generality.

Peter: That's true. Sometimes I'd be struggling with something in my school work and I'd go and see her and I'd say, you know, I'm supposed to prove that this is less than that, or something like this. And she'd sort of take a look at it and take a look at what I'd done. She'd say "Why don't you try a few examples?" I remember my mother, throughout our lives, used to joke about this different approach, but of course my mother had a point, and often you could get intuition from your

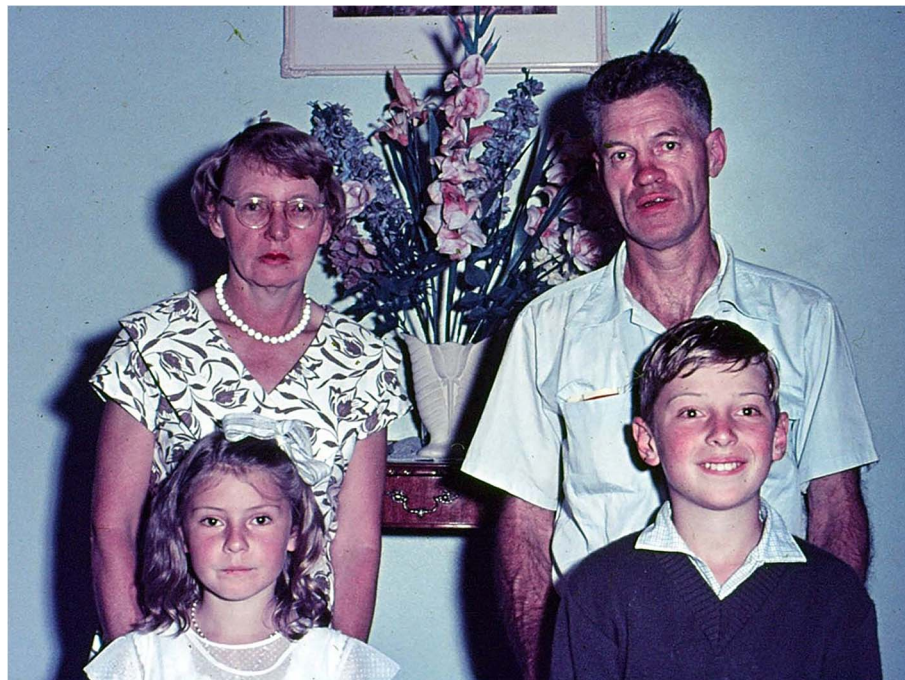


FIG. 3. Peter as a young boy, with his parents Ruby and Bill and his sister Fiona, circa 1960, at the traditional family Christmas Eve gathering in the Hall's home in Oatley.

natural understanding of the world around you by looking at special cases. That doesn't come nearly as easily from looking at general circumstances. I've always remembered that, and it's always been something that's helped me in my work.

My mother had a broader interest in science and in technology more generally than I shall ever enjoy. However, I did inherit some of her interest, particularly in physics. I think she was the second ever female physics master's graduate at the University of Sydney. For a while, she worked for AWA (Amalgamated Wireless Australasia). Now the name AWA only exists as a shop front. In those days, they used to design radio valves, and she used to be one of the designers of those valves.

Matt: This was during your upbringing?

Peter: No, before I was born. When the war broke out, Australia was quickly isolated. The Japanese captured Singapore and, therefore, it was not possible to communicate with England. A lot of Australian troops were trapped in Singapore and the Middle East, particularly in North Africa. Their attention was redirected toward Rommel and his troops.

This proved a formative lesson for Australia. I believe that the Australian Government tried to convince Churchill to allow troops back to Australia, but Churchill wanted them in Africa to defend Europe. The

Australian Government would have wanted them to come back to at least Burma to keep the Japanese at bay.

Matt: There is folklore within the Australian science community that your mother was forced to quit her career when you were born.

Peter: She wasn't allowed to be married and working at the status she had. My mother had tried to have a child before I was born. The child was stillborn, and my mother just went back to work after some time off. But when I came along, everything went successfully, and it became impossible to conceal her pregnancy. And my mother had been a trade union representative, or was a trade representative with CSIRO. She was a firebrand. She was a blonde, but because of her ferocity in industrial matters they used to refer to her as Red Ruby. I was inside her, and she'd had this rather unpleasant dialogue with Clunies Ross, who is famous today as a bureaucrat/scientist who set up large parts of CSIRO and other large government science organisations, but my mother found him very conservative and anti-feminist. And he wanted her booted out, like that, and probably taken to court or something, because she had broken Commonwealth law in continuing to work while pregnant and actually while married. She had concealed her marriage from the Commonwealth government. But in those days, CSIRO was run by Fred

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17th July, 1951

PERSONAL

Miss R. Payne Scott,
Division of Radiophysics,
CHIPPENDALE, N.S.W.

Dear Miss Payne Scott,

I have just seen a letter from Dr. Pawsey which tells me that, due to the imminent arrival of your baby, you will not be able to carry on with your research work. This event must be giving you a great deal of pleasure but I can well imagine that you regret having to leave off research, at least for the time being.

Unfortunately we cannot give a married woman leave without pay, but I can assure you that I at least would be very pleased to see you return to Radiophysics in due course. I hope the event goes off successfully.

Yours sincerely,

F.W.G. White,

CHIEF EXECUTIVE OFFICER.

FIG. 4. Letter from F. W. G. White, Chief Executive Officer of CSIRO, on the departure of Ruby Payne-Scott from CSIRO when she was pregnant with Peter.

White. I went around to see him once, many years ago, when he was still alive, with his wife; he lived in Canberra. For many years, CSIRO was headquartered in Melbourne, and he wrote my mother a very nice letter (Figure 4) saying "Unfortunately, we cannot give a married woman leave without pay, but I can assure you that I at least would be very pleased to see you return to Radiophysics in due course. I hope the event goes off successfully." That must have enraged Clunies Ross, who wanted my mother well out of there. When my mother died, this letter was almost the only official document that was left among her papers, and that shows how positively the letter was received. After I was born, my mother continued to go to conferences in Sydney, because she could get there travelling by train and bus, but in the end it became too difficult. She

used to leave me in the office with two secretaries. I always loved those rubber stamps, airmail stickers and things like that. And I used to really enjoy myself, making patterns.

Matt: So your mum could have gone back to work after you were born?

Peter: She could have gone back. When it became public knowledge that Miller Goss was working on my mother's biography, I received a phone call from an Australian film producer, a woman, wanting to produce a film about my mother. She told me how she was going to do it, and I said, "Well, that's not right. We have this letter which shows that my mother could have gone back to CSIRO." Also, there is this issue of raising the family; she wanted to have the pleasure of being with the family while it grew. The opportunity for a work-

ing mother to do that was very slim in those days. If you just saw her correspondence with Clunies Ross, it's probably easy to come to the conclusion that CSIRO was probably the last place with which she wanted to have an association. But Fred White was a much more astute manager—he must have liaised with Joe Pawsey and others to appreciate that this was a scientist worth keeping a connection with, so he attempted to do that. But it is absolutely true that during the war, when she concealed her marriage from her CSIRO managers, she was breaking the law.

Matt: Can you tell us a bit about your sister, Fiona?

Peter: My mother was a very independent woman—very independent. I never encountered anyone quite like her during my time at school. I assumed that the mothers of my friends were the same, but I later found that was not the case. My sister inherited my mother's independence. My sister is brilliant; she's so creative. She's just amazing (Ewington, 2005).

She was absolutely determined to become an artist. She wasn't sure what sort of artist she wanted to be. I assumed that because she wanted it, it would happen. For anyone else, that would be complete rubbish. In those days, to become an artist, you had to go to technical college. Fiona had at one point thought she might study architecture at the University of Sydney, which meant she had to get passes in science and mathematics and so on at school, and my mother, who was extremely proud of my sister and thought she could do anything, was nevertheless concerned that she wasn't working hard enough—she didn't enjoy science or mathematics as much as I did.

Matt: Opposite poles.

Peter: Opposite poles. My sister disagreed with my mother partly because the two were so much alike. My sister and my mother loved each other very much, but they were often in dispute. And my mother would say to her “Look, you don't need to ever look at a science textbook or a mathematics textbook after you've finished school, but at school you must look at them enough in order to be able to pass the exams at such-and-such a level, because you need those to go into university.” And my sister would scoff at this and say “Ah, it's just science and mathematics—who cares anyway?” Well, of course, she didn't study and she got very good marks.

Aurore: She had very good marks?

Peter: Yes, she did well.

Aurore: Without studying?

Peter: Yes.

Matt: Did she do the Higher School Certificate?



FIG. 5. A sculpture by Peter's sister, Fiona Hall, titled “Breathing in the Afterlife.”

Peter: Yes, we both went through that.

Matt: And then what did she do after the Higher School Certificate?

Peter: She went to East Sydney Technical College, where she studied painting. She really is good, and was made an Officer of the Order of Australia for her contributions to the arts (Figure 5).

Aurore: You have also received this honor. Did your mother have the Order of Australia?

Peter: My mother never would have accepted it. In those days, they were knighthoods offered by the British Government, and my mother would never have accepted that sort of recognition. My mother died in 1981. My father died some years later, in 1999. He was in a nursing home in Wollongong before his death. Wollongong was a bit out of the way for either my sister, who lived in Adelaide, or me, who lived in Canberra, to get there regularly. And so what happened in the end was my sister and I came to this agreement: if she was ever near Canberra on a weekend, then we would drive to Wollongong. So this is how we would visit my father together. Once, as my sister and I went down to see him, when we were getting into the car in Canberra to drive down, she produced a VHS cassette case. This was in the days when VHS was really the way to go for your TV movie and things like that. My sister asked me would I smash open this cassette case so that she could take the tape out, and I said,



FIG. 6. Miller Goss, Fiona and Peter, at the launch of the biography, *Under the Radar, The First Woman in Radio Astronomy: Ruby Payne-Scott*, co-authored by W. Miller Goss and Richard X. McGee, November 2009, the University of Sydney.

“Yes, sure, happy to do this.” But I was a bit mystified. It turned out she would get these cassette tapes for almost nothing from the VHS rent-a-movie stores, and she had a project at that time, which was making sculptures from the VHS tape. And she got into the car with this split VHS cassette with the tape coming out each spool, and a pair of heavy wooden knitting needles, and by the time we had got to the nursing home in Wollongong, she had produced a very good likeness of a person’s bust just by knitting the tape that came out of the two sides of the cassette. And to me, it was remarkable. If it had been me, I would have to take measurements and so on, and I’d have to think about where to start and where to finish, and so on. And even then, it would be a disaster. Whereas Fiona just sat down in the back seat of the car and this thing just appeared out of nowhere. It’s as though it came from outer space. And it’s just intuition. It’s remarkable that a person can do that sort of thing, just through their understanding of human shapes and so on.

CHILDHOOD INTERESTS

Aurore: I believe both you and Fiona had an interest in photography as teenagers, but who was first?

Peter: I was very interested in photography as an end to recording steam trains. I was before her, I believe—I don’t think she will dispute this. But she became

fascinated with my photography—not with the subject matter at all, but with the magic of black and white photography. You take a black and white negative and you process it and it changes from a negative into a positive in the developing tray and you have a lot of control over it; you can make parts of the print darker or lighter or so on.

Aurore: So you were developing the photography yourself?

Peter: I was doing it all myself, yes. Everything, the processing of the film and the printing of the photograph and the enlarging of the photograph was all done by myself. And my sister asked me how to do this. That proved fatal. She wanted to use the laundry, because we would do all our photography processing in the laundry, and it had to be done at a time when it was dark, so you couldn’t do it during the day, and particularly during summer, that really restricted the period when you could use the laundry. We got into terrible fights about this, and I remember my mother, practical as always, went and got a calendar—one of those calendars you got at a grocer’s store—and she stuck it up on a wall and said, “Anybody who wants to use this laundry has to mark on the calendar the day and the times two days in advance. Otherwise, you don’t have any say in who uses the laundry at what time.” And it worked extremely well. My sister went

on quickly—I became more interested in the technical side, and she was given a medium format camera as a birthday/Christmas present. But yes, her eye for composition was just spectacular. I learned a lot just by watching her take photographs. The people I took photographs with, some of them were good, some of them were not, but none of them were as good as Fiona.

Aurore: I believe that you also enjoyed cycling as a child.

Peter: My mother and father wouldn't allow me to have a bicycle. They thought it was inherently dangerous. And I must admit, reading news reports these days, I'm inclined to agree with them, and maybe they saved my life. Anyway, I had a friend who had a bike, but because there were two of us and only one bike, we couldn't really race. We used to meet after school, but we couldn't really have competitive races. So what I suggested was we ride around "the block" in Oatley. The block is a large piece of land that's got a sloped bit and a hill on one side, and the other side is more of a steady gradient. We only had one watch between us, and what we decided was that we would try to cycle around this block in a time that was as close as possible to a specified time, without having the watch.

Aurore: So instead of trying to cycle as fast as possible, the goal was much more sophisticated.

Peter: Yes, to take a certain time to do it. And I must admit I enjoyed it. I'm not a naturally competitive person. Somehow, when you're riding against somebody in a trial, or a bike race, it becomes more aggressive than this arrangement with the single watch we had. And I think we both enjoyed this.

Matt: Did you play any competitive sports as a child?

Peter: I used to play backyard cricket at home but I was never very good at it. I also used to play rugby at school. But again, I wasn't very good at it, and I only played for one of the house teams at the school—I didn't play for the school itself.

Aurore: And I think you said that today, you have absolutely no interest whatsoever in sport.

Peter: I have no interest. I can get engaged, but really, I'm not interested. I was on the tram once, not so long ago, just a year or so ago, from the university to the city, and this man about my age sat beside me, and he said, "What did you think of the match last night?" And I thought crapes, was there a match last night? Was it cricket, was it . . .? I don't know how I got out of this—I think I might have got off one stop early to walk the rest of it.

Matt: Let's talk a bit more about your interest in trains.

Peter: I'm always interested to know what people's first vivid memories are of their life. For me, the first vivid memory is of the steam trains coming up the hill on the railway line through Oatley. It has been through various, slightly different alignments, including gradients of 1 in 40; I think it's now been eased to 1 in 80. That used to be the ruling gradient. And when you got off the train at Oatley Station, you walked down a ramp, and you were level with the running gear, you know, the pistons and cylinders of a steam locomotive as you walked along. And the impression you got of power and invincibility, particularly if you're a five- or six-year-old boy, just standing here hanging onto the railing and watching this train struggle up the hill, it was just—to me it was enormous. More generally, as I got older, but not all that much older, partly through the upbringing of my very politically aware parents, I began to see the railway as a force or at least a means of travel which transcended different classes.

In 1953, after the Coronation of Queen Elizabeth II, in her visit to Australia, she would have got on the train in Central Station, this beautifully polished and scrubbed train, and would have gone out past the backs of all the tenement houses, the houses of the labourers, the cleaners, in (inner Sydney suburb) Redfern. Then you would get into suburbia, and then at Waterfall—or perhaps in those days at Sutherland—you'd break into wilderness, and then you'd go through Heathcote Primitive Area, the national park there, and you're suddenly into what is—I don't think it's technically rainforest, but it is absolutely beautiful to be part of, particularly if you're driving through in the morning. This is the path the Queen took. She started off in splendour, getting into her special train with mahogany panels and so on, and then she went past the most seedy working class parts of Redfern and then suddenly there's a change of pace into suburban Sydney, and suddenly you're into this lovely national park wilderness until you finish up in the coal mining area of New South Wales, which even in those days was pretty grimy.

There's no form of transport that has such a parallel with different classes. Even today, the railway somehow unites political and class divisions of a country that no other form of transport does. There's a certain power just behind the perspective of a railway train, of the train disappearing into the background along straight lines of perspective. These things give it a feeling of power and unstoppable that other forms of transport don't enjoy.

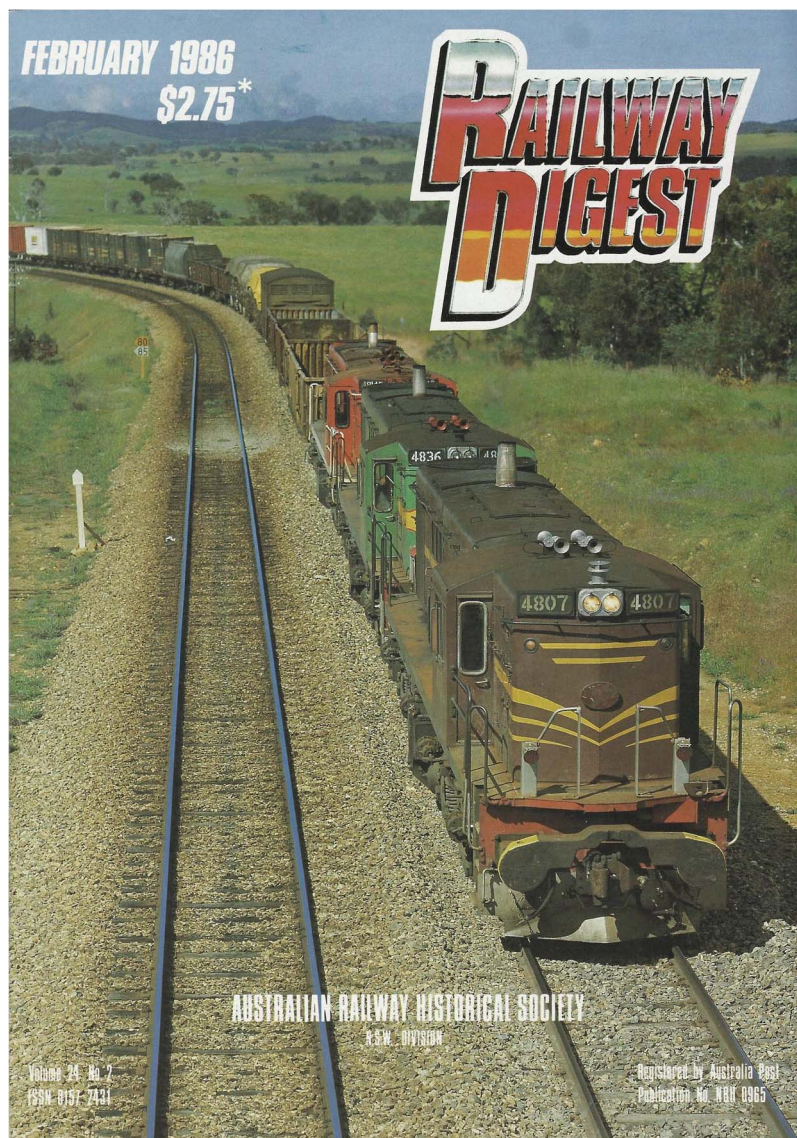


FIG. 7. A photograph of Peter's that made the cover of "Railway Digest," published by the Australian Railway Historical Society. The photograph is of a train with three 48 Class engines and was taken by Peter in 1985 near Oolong, north of Yass, New South Wales, Australia.

Matt: Now you had a teacher at Sydney Technical High School that was also a train enthusiast, or train photography enthusiast.

Peter: Ah yes, Bob Booth. He passed away during the Joint Statistical Meetings in Miami. He had a really strong positive influence on me. He influenced my photography, not just composition and things like that, but also the type of cameras he bought and I purchased, too. He was a physics lecturer before I met him at the Sydney Technical High School—and I went on from that high school to the University of Sydney. Bob was an excellent teacher, particularly of the theoretical curriculum at Sydney Technical High School.

Matt: And many of the trains back then had steam locomotives?

Peter: That's right. I was born in 1951 and by the early 1960s, I was travelling around with relatively cheap cameras, photographing steam trains.

Matt: In the Sydney Metropolitan Area, or New South Wales in general?

Peter: Yes—New South Wales in general, but the Sydney Metropolitan Area, in particular. In those days, for a shilling—what became 10 cents in 1966—you could travel from the far extremities, or one far extremity to any other in the Sydney Metropolitan area, if you were a school student. We used to do that a fair bit. I had a school friend, Bob Simpson, who was a Scot.

His mother and father were both migrants from Scotland, and I think he was probably born in Australia, but he could put on a Scottish accent really quickly. Anyway, it turns out that Bob's uncle was an engine driver, and Bob was also interested in steam trains. We prevailed upon his uncle once, one Saturday, when he was rostered to work on the train from Central Station probably down to Wollongong and then on to Kiama. And we arranged to have a ride in the cabin. This was my first ever cab ride in a steam locomotive. The idea was that we would get into the train at Central Station, and we went from Oatley up to Central, got in the train, then we'd go down to Waterfall, then Bob would get in the cab from Waterfall to Helensburgh, and then we'd change places, that is, he'd get back into the train and I'd get into the cab from Helensburgh to Otford; these arrangements being made because we didn't want to be in the cab while the train was going through a built-up area—strictly, the driver was breaking the law by having us. There are many other cases where we broke the law, too. Some of my memories of these rides are as strong with me as the day they occurred. And just riding in the cab of a steam locomotive—a rather old one; this must have been in the early to mid 1960s; the engine would have been built in the late 1880s—riding from Waterfall to Otford, it just was so beautiful. The morning was crisp, cool-ish, but brilliantly sunlit.

Matt: It's a beautiful stretch.

Peter: A beautiful stretch of line. My friend Bob Simpson was in the cab from Waterfall to Helensburgh, and so he went down that path where on the left is the Pacific Ocean and on the right is this dirt track which was known in those days as McCauley's Creek Road. And then when we got to Helensburgh, Bob got off and ran back and I walked forward to get into the driver's cabin, and I still remember this vision of the engine that was framed under the footbridge at the south end of Helensburgh Station, and it's framed by the bridge going over it, and off to the left, you can't quite see the sea I think from there, but you're up fairly high.

Matt: Obviously, the cab rides are very important—a special memory of yours from your childhood. So as a teenager did you stay overnight in country New South Wales as part of these train journeys, or did you always just do day trips?

Peter: I often stayed overnight, but I'd been introduced to camping at a young age by my parents, so I began to go out to the country in New South Wales with a tent and sleeping bag.

Aurore: Just by yourself, or with a friend?

Peter: I think I would occasionally do it with just myself, but later I did it with friends from school.

Aurore: Was that also at that time that you developed your affection for cats?

Peter: My love of cats was developed at home, because my mother had a love of cats. We never bought a cat, or anything like that. Neighbours or friends had cats which wandered in and we adopted, and I've always loved cats. You'll recall my mother's story about her brother destroying her books. I think, when she told me this story, I said "How did you recover from that?" And she said, "Well, I did this several times in my life when the blow was very hard. I went and got our cat and I sat in the toilet with him, and I buried my face in his fur and I cried." So you can see that love of cats was very much a part of my mother's life. My father, on the other hand, had virtually no passion for pets. He used to refer to them, but in a jovial way, as time-wasters. So when we were at home, somebody would ask "Well, where's the cat?" And my father would say "I haven't seen the time-waster for the last few hours" or something like that. Not long after my mother's death the cat that we'd had for about 10 years also passed away. My father looked after this cat while my mother was alive, but I don't think he had any intention of replacing it when my mother died. However, at home in Canberra, there was a kitten that showed up. Obviously, a stray, so Jeannie and I put out some food—I think it must have been scraps from the table—on a piece of newspaper outside our back door. The next morning we found that the kitten had not only eaten the food, but all of the newspaper that had been touched by the food; it was so hungry. We decided we had to do something; we couldn't just leave the kitten and hope that somebody would pick it up. We had planned to go up to Sydney the following weekend, so we took the kitten with us to give to my father. My father must have felt rather confronted by this—you know, "Why are you giving it to me" kind of thing. Then I think he must have understood that we were giving him the kitten because Mum would have taken it in. He accepted that, and he looked after this cat for maybe 15 years until that cat took ill and died (Figure 8). We didn't try that trick again on him, but he—I told you he was a carpenter—he made this cat a box for taking it to the vet from time to time. He made this box so beautifully out of polished timber, with brass hinges and a latch on the door. You could see from the care that he'd put into making the box that he had grown fond of the cat. He got converted to being a cat lover because his wife had been a cat lover.



FIG. 8. Peter and his father, Bill, with Squeaker, the kitten that Peter and Jeannie gave him, circa 1989.

SCHOOLING

Aurore: Tell us about your school days.

Peter: I went to Sydney Technical High School, which was not all that far from where I lived. It was just a short-ish train ride. At primary school, at Oatley, there were IQ tests. They determined whether or not you were streamed into one of the selective high schools. As a result of these tests, you could then go to a high school which streamed you into an advanced curriculum. The class you were in there was determined further by the IQ test and the regular exams, and you would go into classes A, B, C or D, depending on how you performed there, too. My memory is that I think I might have always been in the A-level, in the highest class for mathematics and probably also for science, but not for English and French. When I went to high school, the first year involved various languages, of which I remember only Latin and French, and I remember not being particularly good at either. So when I came to the second year, I must have gone into the B-level for French, and I dropped Latin altogether. And I stuck with French all the way through then, until my Higher School Certificate.

I also did, along the way, the School Certificate in the middle. And at that point I was rather enthusiastic about becoming a draftsman. I see this as reflecting my sister's inclination toward art. But for some reason

I had no inclination to continue that after the School Certificate.

Aurore: So you'd rather turn to mathematics and physics at that point?

Peter: Yes.

Aurore: You once mentioned that there was one guy who was in competition with you.

Peter: There was a person, John Wormald, who went on to become an engineer. He was a lovely guy—I liked John a lot. There was also John Page, who went on to study medicine, and then in particular oncology, and last I looked he was practising at Manly in Sydney. John Page was a polymath, unlike me—I used to try and find something I really enjoyed and devote my energies to it, whereas John seemed to be happy to devote his time and his effort to just about everything simultaneously, and I could never understand how anyone could do this. He was very successful—he was school captain, for example. John Wormald was more like me, I think. The competition got much tougher when I got to university.

In those days, your position in the state, in the Higher School Certificate, was publicly known. It was listed in the newspaper, and in maths I was somewhere in the top 20.

I should also mention Roger Renton, who is the only person from my school years with whom I've kept in touch. Roger was determined to study medicine, and he did. He was very smart, but he didn't love mathematics for its own sake as I did. The day the results were published in the newspaper, Roger and I had planned to go down to the Southern Highlands to take photographs of trains, and we caught the 1.10 a.m. mixed train from Sydney, down to Bundanoon where we got off. In those days, the *Sydney Morning Herald* would go out in these early morning mixed trains, and so we had to sit in the carriage, which was a mixture of compartments for first or second-class passengers, as well as for small levels of freight, all put into the one carriage, knowing that they also carried the copies of the *Sydney Morning Herald* that had our exam marks in them. And when we got to Bundanoon, they threw those papers off, and we had to wait then until the guy from the news agency in Bundanoon came and we bought a copy each of the newspaper. We must have determined that we had marks that were good enough to get us into university. And I think it was those marks that somehow put me among the top 20 to 30 in the state.

UNDERGRADUATE YEARS

Matt: When you started at the University of Sydney, were you able to stay in your family home and just commute?

Peter: Yes. That's one of the reasons I chose the University of Sydney, whereas to go to the University of New South Wales it would have required an extra bus trip. In those days, people tended to choose the university they went to much more on the basis of convenience.

Matt: Since you were born in 1951, it would have been around 1970?

Peter: Yes, something like that.

Matt: I believe that you got involved in student protests around this time.

Peter: We hear a bit about student demonstrations today—usually poor Mr. Pyne (Australia's Federal Minister for Education) is dragged into a corner and confronted by students who—I'm afraid I would be the same if I was a student today—who don't think that much of him and his plans for funding universities. What's completely different today, compared to, say, the mid 1960s, is that the issues that you were fighting for then were life and death ones.

For example, think about conscription, which must have begun about the time Australia became involved in Vietnam. I am reading *The Justice Game* by Geoffrey Robertson (Robertson, 1999), who says that, in 1964, "Conscription was conducted as fairly as a lottery: only those twenty-year olds whose birth-dates were drawn out of a barrel were called up. Old school-friends who had not made it to university and draft exemption started to go missing, presumed dead, in unpronounceable provinces of South Vietnam, . . . This gave student politics a kind of steel—if we were old enough to fight an unjust war, we were no longer prepared to be treated like children." And it really was a matter of life and death—people were separated by the fact that one went to university and the other didn't. The one who went to university got an exemption, and the one who didn't was sent off to Vietnam, and about 50 percent of the fatalities in Vietnam were of conscripts.

I'd already had a run-in with police when I was at school. I'd been arrested, for want of a better name, for trespassing on railway property to take photos of trains with my friend, Bob Simpson, with whom I went for my first cab ride on a steam locomotive. I didn't treat the policeman very nicely at that time, and so they said that unless one or both of our fathers wrote

to the Department of Railways, they would see that we were prosecuted to the full extent of the law. We were both under the age of 18, and it was certainly very frightening. I felt that I didn't want to get into trouble again. And so when I was a student, I remember going to—there were these things called moratoriums and demonstrations—moratorium marches that were held. Starting from about 1970, maybe a bit earlier than that, I began going on those when I was at school. I continued it when I was at the University of Sydney. We used to form up at the front of the university and march from there into the city, where we'd meet and groups would come in from the city itself, and we'd block the streets and we'd listen to speeches by politicians, Tom Uren particularly, who died in 2015. This was a time when students on the streets of Paris were using penknives to pick out the cobble-stones to throw at police. The demonstrations were held, I think in 1970. There was also the shooting by National Guardsmen at Kent State University in the U.S. Some young students, probably my age at that time, were shot dead. I remember walking, marching, into the city opposite Town Hall, and I think we were addressed there by Tom Uren, and the police were on horseback. The police on horseback were very well trained, although a week later they rode into a crowd of demonstrators in Adelaide and caused some injury. We had banners on quite thin-ish sticks, and the policemen seized the poles and broke them, and I thought "They're just doing this to stop us from getting our point across, and that's not good, but it's not terrible." But what they were doing was breaking the poles up into smaller lengths so they could beat us with them. And I remember being devastated by this—I'd never seen that sort of thing happen before, and because the poles were actually quite flimsy, it was quite easy for the police to break them on their knee, and they would just lay into us. I didn't hear of any injuries afterward, but there must have been some. And it's the only time in my life I've ever seen a man attack a woman.

And they would just beat these young students, who were probably about 17 or 18, and I really was shocked. I tried to escape; what I did was I saw that around to the one side of Town Hall, there was a little group of shrubs, and I went in there to hide, and when I got in there, I found all these police in there with sticks, and the police were undoing the badges on their jackets, and I thought "These buggers, they're doing that so they won't be identified." And then I got out of there pretty damn quick; I didn't want to be beaten by a badge-less copper. So I went back into the crowd, and

in the end I was not ever hit by a policeman with either a fist or a stick, but I remember that incident being reported in the press the next morning where a journalist had noticed the police were removing their badges, and the journalist asked the police why they had been doing it, and the police said “The police badges have very sharp corners—we don’t want the students to be hurt during the demonstrations.” And this came to my mind during demonstrations at the University of California, Davis, a while ago—I don’t know if you remember, there was an incident where policemen sprayed tear gas from a canister—I think it was tear gas, it might have been mace—directly from a canister at students, almost at point-blank range. And I was outraged by that. In the U.S., the main criticism was directed against the chancellor of the Davis campus—they insisted that she step down, which she refused to do. And I felt that it was unfair of us to ask her to step down. I thought the link between this policeman’s action and her being chancellor of the University of California, Davis, was a bit too stretched for her to be held responsible for this incident. But nevertheless, that was a serious incident at Davis, and it indicated that in years gone past, student demonstrations had been about much more serious things, and carried out in a more worrying way than they are today. Australia pulled out of Vietnam entirely by 1972, I think, and the Americans pulled out entirely by 1975, I think. And so this terrible business went on for only a short period of time, and it certainly shaped my mind about student demonstrations and about what is worth fighting for and what’s not.

Matt: When I started my university years, I had no idea about statistics. What happened with you? Did you show up and say: “I want to study mathematics?”

Peter: Yes. I just enrolled in every mathematics course that was available, plus chemistry plus physics plus biology, so it was basically a copy at the university level of everything I’d done as a school student, except that I didn’t do English or French. I had entered university with the idea of becoming a theoretical physicist. I had studied much more theoretical physics at school than I was obliged to do simply because I became so interested in it. But I was interested in theoretical physics for the sake of physics, not for the sake of mathematics. Unfortunately, I found that physics was not well taught. The very first class was given by (eminent Australian scientist) Robert May, and he gave a brilliant lecture that would have motivated everybody to do physics for the rest of their lives, but other people taught the other lectures, and I discovered that it

was not rigorous enough for my liking, and the theory was not well motivated enough. On the other hand, in the first year, I really struggled with the mathematics because at school I’d been used to being top dog without too much trouble. And it wasn’t like that at university—I had to work hard to be top dog. I even found in some areas of pure mathematics, there wasn’t enough rigour for my liking, but you know, there are still areas today where I feel that I wasn’t taught well enough, and as a result I have a gap. One of those is complex variables.

Matt: So back to 1972, when you would have been a third-year student. Is it around that time you started to sharpen your focus toward probability and statistics?

Peter: Yes. I took four subjects in first year, and that was the minimum I could take. I only got a distinction in physics, which had been my passion when I started, and I got a credit in biology, so I wanted to drop physics and biology. I was so surprised by my high distinction in chemistry, which was the least liked subject. In mathematics, I had a high distinction. It had bifurcated into pure mathematics and applied mathematics, and there was this subject called mathematical statistics. And I wasn’t really keen on statistics; I didn’t really know what it was, although at home my mother had a nice textbook, written by a Japanese professor, which I looked at and it seemed to be quite interesting. But I studied a bit of statistics at school, and what I studied was just terrible. It was deadly boring.

Matt: And who was teaching second year statistics?

Peter: In those days, it was Harry Mulhall. I found him absolutely wonderful, because he emphasised the rigour of the theory. And I looked at it and I said, “Look, Peter, you don’t have many choices—you only have one choice, and it’s this thing called mathematical statistics.” So I said to myself “You’ve got to take that up.” So I did. I studied pure mathematics, applied mathematics and mathematical statistics. One course, what I found fascinating was Measure Theory. I really enjoyed that course. It was taught by John McMullan.

Aurore: Is that why you did a doctorate in probability rather than in statistics then? Is it because you liked Measure Theory so much?

Peter: No, it’s really because of the fourth year course. In the fourth year in Australia, you can major just in one subject, and I had to drop either pure mathematics or statistics/probability in order to continue in the mathematics area at the University of Sydney. I dropped pure mathematics and just did statistics and probability.

In probability, there was only one other student in the class; a logician from pure mathematics, who was kind of worried that he needed to know a bit of statistics and probability in order to be prepared for his future as a mathematician. So I went to see Malcolm Quine, who was the nominated lecturer for this course, which was of three lectures a week. We decided we'd each give a lecture. So that way the delivery of the courses would be taken care of, and we'd have to learn, because we'd have to learn enough about our lecture, in order to present it to people. You can't really learn much better than if you have to teach it to somebody else. So I thought, "This is good, sounds okay to me!"

I loved it. And the textbook was Kai Lai Chung's *A Course in Probability Theory* (Chung, 1968). It really opened my eyes to the wonderful world of probability. I still remember thinking to myself "What a beautiful thing probability is!" Just think of the secrets that random variables can have. They can be all independent, but have different tail properties. Think of the stable laws, for example. They're all independent random variables but they can be made to behave in all sorts of peculiar ways by changing the tail weights. Or think of dependent random variables, martingales—there is a chapter on martingales at the end of Chung's book. But also I had been asked to translate the relevant chapter of Paul Lévy's book on martingales (Lévy, 1937) and give a lecture on it as part of my undergraduate course at the University of Sydney. In those days, every student had to have a foreign language, and you had to show that you had mastered a foreign language in some way. And for me, being a rather lazy type, I didn't want to learn a new language and I said "Well, I studied French at school—I could probably translate a chapter of Lévy." And I did that, and my eyes opened up to dependent random variables by doing so. And so I became a probabilist—there are so many ways that you could start with a sequence of random variables that all have the same distribution. You add up the variables and depending on how you set these things up, they can have very different properties. And this was just beautiful, and it really took my breath away, and so I resolved that what I would do was a PhD in probability theory, and so it was all driven by passion and enthusiasm, nothing as practical as the applied mathematician who had suggested that I study for a PhD in applied mathematics because it could be useful to me in the future.

Aurore: So what's interesting is that back then you knew both statistics and probability, and you chose probability. Then later when you were forced into

statistics you realised you actually preferred statistics much more than probability, and you didn't realise that earlier.

Peter: Yes.

POSTGRADUATE STUDY

Matt: Why didn't you stay in Sydney for your doctorate? Did you want to get out of your hometown?

Peter: Ah, no. Well, to some extent, yes. I had very non-standard ways of doing things, that's the problem. I applied for a Commonwealth Scholarship to study for a PhD at any one of three British universities, and I applied for a scholarship at various U.S. universities, too. I sat for the Graduate Record Exam, which was necessary to get fellowships and so on at Berkeley. I'd done all this and passed the exam. For the U.S., I had to have my bank account notarised, so I did all this. But my mother didn't want me to leave home, and in particular didn't want me to leave Australia, and so I moved to the Australian National University. I showed up in Canberra just before Christmas in 1973. I started a vacation scholarship there, with the idea of working with Chris Heyde, who had been recommended to me.

When I arrived, Chris was overseas at Stanford on sabbatical leave, so I presented myself to Pat Moran and Roger Miles. I really liked Pat, and he lived for only about 15 more years, but during those 15 years he was very helpful to me, very supportive. And through him, I became interested in applied probability, and I proved a result, which I found counter-intuitive originally. Later on, I figured out why it had to be true. As Pat had always been so supportive of me, I went to see him for morning tea, and I said to him, "I just want to explain to you this result that I've proved." I explained it to him, and he said "It can't be true—it's so obviously false. Just think about it in this line—it's obviously incorrect." And I said "Ah, no, that line doesn't take into account this." And he thought it through again and he said "Ah, you're right! It's obviously correct! I'm surprised you had to work on it at all!" He was a lovely guy. I really enjoyed my time with him.

When Chris Heyde came back to Australia in early March or at the end of February 1974, I approached him and told him I'd won a CSIRO scholarship, and I'd do a PhD, but I had also applied to a number of places abroad. And he said, "Okay, well, let me see if I can interest you in something." So I enrolled as a PhD student under his supervision, and he interested me in martingales. I very quickly began getting results, and began getting limit theorems, because I was passionate about these sorts of things.

I had called my mother up, it must have been the end of February; I'd spoken to Chris—"I've decided to stay in Australia, and I've written to all these places and told them thanks very much for your kind consideration, but I'm going to stay in Australia." So I just withdrew from those places, and that was it. Anyway, the phone rang one night. I picked it up and there's Mum on the phone. And she said "I thought you told me that you'd withdrawn from all the places you'd written to." And I said "Yes." She said "Are you sure?" And I said "Yes, I told them." And she said "Well, how come I've got this letter from Brasenose College at Oxford?" And I thought "Jesus Christ, I'd forgotten about them!" Because what I'd done, every Monday I would go to this room in the Chancellery at the University of Sydney—this is when I was an undergraduate—and I'd look at whichever new scholarships had come in during the previous week. And I'd do a photocopy of it; I remember being excited, because photocopies were relatively new technology. And so I'd filled in the form and sent it off and that's all I'd done. I don't even think I kept a photocopy of the form. I remember distinctly thinking that if I wanted to withdraw, I had to write them a letter. And that required a lot of trouble, and it required me to spend the money on a stamp, and as a vacation scholar, I received almost nothing, so I think my distinct feeling was, well, you're not going to get that thing, so why do you waste your time and money withdrawing from something that doesn't exist? So I never did that, and in the end I got it. This must have been April 1974.

Matt: What happened then?

Peter: By that time, I had got some results in the work with Chris, as I indicated. Originally it was supposed to be for a PhD, but then after deciding to go to Oxford, I converted to a master's by research. Here, a lot of credit is due to Chris. In the early days, he was very good to me. When I found out about Oxford, I went and told him. Chris said, "What are you going to do about it?" I said "Well, it looks kind of fun, so I'm inclined to take it up." Chris knew much more about the world than I did at that time, and he said, "Okay—what are you going to do about the PhD you've been doing with me?" And I said, "Well, I haven't quite worked that out. I guess I have to stop that, and we've just got to regard that as being work that's never going to see the light of day in terms of getting published" and so on and so forth. And Chris said, "No we don't. You're going to write that work up as a master's thesis." And I said, "Well, that's very generous of you to say that I could do that, but I don't really fulfill all the requirements." I said, "I've got to start at Oxford in September,

and I've also got to have two years between when I enroll at the ANU and when I submit the thesis." However, as a master's student, you didn't actually have to be around in Australia for two years, whereas you had to, at the time that you were officially on the books, as a PhD student. So Chris said, "It's not a problem. You convert to a master's degree—you just leave everything as they are, and leave me with the printed copies of the thesis that you want to submit. Then go off to Oxford, and I will submit it in two years from the day on which you enrolled as a master's student at the ANU." Chris didn't have to do that—he could've been really nasty to me, but he was really very good to me.

Aurore: And then your D.Phil at Oxford went so fast that you finished it before even graduating from the ANU.

Peter: Something I had to be careful of was that I didn't step on any toes of research programs that Chris wanted to undertake, so I basically went in a slightly different way although I thanked Chris for his help—when I look back on things, he was really very generous to me.

Matt: Back in those days the ANU had two statistics departments—one in the Institute of Advanced Studies and one in the Faculties—on opposite sides of the campus. In which department were you based?

Peter: I arrived in Pat Moran's department in the Institute of Advanced Studies while Chris was overseas on sabbatical and I had a little office there. And when I decided to become an ANU PhD student with Chris in the Faculties department, we had to decide where my office would be, and I said, "Look, I've already started work. I've got an office in the Institute of Advanced Studies. I've got myself a bike and I can easily get myself from one side of the campus to the other." So we resolved to keep the office arrangement, but I needed an adviser in the Institute of Advanced Studies department, and that was Pat Moran. Pat offered to be my advisor. I remember when I explained all this to Pat, he said "Chris Heyde's a very good choice." He was very supportive of Chris, full of praise for Chris's work.

TRAVELLING TO OXFORD

Peter: Then I went off to Oxford in September 1974. I'd always wanted to go across Russia by train, and this gave me an opportunity to do it. As a youth I'd promised my mother that I'd go with her, but of course that never happened. I flew from Sydney to Bangkok to Hong Kong to Tokyo and then went by taxi to Yokohama. Things went quite smoothly in Hong Kong—I was able to buy a new camera, and it was better than

anything I'd had before. When I got to Tokyo, I ran into a bit of trouble because I didn't have a visa for going to Japan. I said, "I wasn't told by my travel agent that I needed a visa." And they told me "Well, you don't need a visa as long as you leave by the same port as you enter, but you're planning to leave by Yokohama and you entered by Tokyo, so you're in trouble." But the Japanese were really nice in that whole mess. They said, "You can either fight this ruling and spend a few weeks in jail until your court case comes up, or you can agree to be deported from Japan for travelling with the incorrect papers, and we'll deport you to Russia. Specifically, we'll deport you to Nakhodka, which is the Russian fishing village to which your ship from Yokohama will sail." And so I said "I'll take the latter option—it looks like the best one." So I was officially deported and there was no mark in my passport whatsoever about this incident. I caught a train from Nakhodka. You weren't allowed in through Vladivostok, because it was the headquarters of the Soviet Pacific fleet. And from Nakhodka, I caught a train to Khabarovsk, which is up in the Soviet east. I got on the train that left Vladivostok. I travelled in hard class, where there were four seats across the carriage with room for a corridor. It was really quite comfortable for a student who was 22 years old.

Matt: Did they have steam trains?

Peter: Yes. At one town we came to, I got out and took some photographs of the train I was on, as the version of the train from Moscow arrived from the other direction. It too had a P36 on the front. P36 was a grand old passenger express locomotive from Trans-Siberian Railway times, so I took a fair number of photographs. Before I left Australia, I had read an article about travelling in the Soviet Union and taking photographs of trains. It was written by a guy who's still writing books on trains around the world, and he said that you have to hide around buildings and so on, and make sure you don't get caught taking photographs, whereas I'd decided I'd just go out and blatantly take pictures. I wouldn't try to hide somewhere; I'd just go there and take the photograph. Anyway, I remember because of this particular incident. I wanted to photograph this train that arrived from the opposite direction. Somebody yelled out at me to put my camera away, and I'm still not sure to this day whether he was a security guy telling me to put my camera away, or if he was trying to protect me from security guys. Anyway, I put my camera away after taking one photograph, and then I wandered quickly into the railway locomotive depot, took some more pictures in there and wandered back

to get on the train and went on. I think in many cases in my travelling life, I've been very lucky. I've done things which I wouldn't dare to do today; as a younger person, I seemed to have less to lose. So I've done all sorts of strange things like this and got away with it and never got into trouble.

Matt: Was this your first ever overseas trip?

Peter: Yes, it was my first time out of Australia. I went on to Moscow on the same train. People at the University of Sydney knew Vladimir Zolotarov quite well, and I had the address for his apartment, which overlooked the Kremlin. So the next day I boldly went up and knocked on his door and introduced myself as a friend of Oliver Lancaster, and so he arranged for me a tour of Moscow, guided by a student, whom I think was the brother-in-law of Boris Gnedenko. People were very kind to me, and Zolotarov asked me whether I would prefer to go to either the Moscow Circus or the Moscow Ballet, both being very famous. And I said, "Oh, I'd probably prefer the ballet." So he just gave me a ticket to the ballet—it was *Swan Lake*, and I had a wonderful time. Essentially, it was very expensive to stay in a hotel in Russia in those days, because you had to pay special, what they called, "Intourist rates," whereas if you stayed in a bed on a train, it was much less expensive. And so the only time I spent in a bed that wasn't moving was these few days in Moscow, and I wandered around a bit and took various photographs.

Matt: How did you get from Moscow to England?

Peter: I caught the train from Moscow to Paris. At the border, you have to change gauge from the five-foot gauge of Russia to the four-foot eight-and-a-half inch gauge. You go through Poland, and it's actually at the border between Russia and Poland that you change railway gauge, and my memory is that they changed the bogies under every carriage. I think in Australia we had these bogie interchange stations. It was only the bogies on the freight trains that were changed. If you were a pig, you could travel in comfort, but passengers had to get up and move to a new carriage. I went across Poland and then across East Germany, then into West Germany, then back to East Germany and then into West Germany once again. When I got to Paris, I resolved that I was going to see the Eiffel Tower. I studied French at school and I said "If there's one building in Paris that tells me I'm here, it's the Eiffel Tower." So I went off and saw the Eiffel Tower—I don't think I went up in the elevator or anything; I was really tired after the trip from Moscow to Paris. Then I got in

the train that goes out to Calais. And you go across the Channel—and I remember being terribly seasick.

When I got to London, I was exhausted. I remember putting my bag up on the rack on the train to Oxford and I said to the guy in the seat below “I’ve just arrived here from Moscow. I’m supposed to get off this train at Oxford. Would you mind waking me up when the train gets to Oxford?” And he said “Yes. Sure, I’m going there myself, so it’s not going to be a problem.” And we remained friends for about a year after that, in the sense that we would often meet for dinner, and so on. So I had a very nice introduction to Oxford.

OXFORD YEARS

Matt: When did you arrive in Oxford?

Peter: I arrived there on the 24th of September 1974. When I got to my college, I saw all these boxes with the name Peter Hall stacked in the entrance. They were the boxes I’d sent over myself from Canberra, so it wasn’t any surprise to see them there, except that the porter noted my interest in these boxes and said “Are these your boxes?” I said “Yes, I posted them to myself from Canberra.” And he said, “But you’re a student here at Oxford?” I said, “Not yet—I’ll enroll here.” And he said, “Ahhh!” It turned out there was an Englishman who’d been a student at Oxford who’d married an Australian woman. They were going to South Africa, where the Englishman had taken a job. The

woman’s parents had been sending over all her stuff from Australia, and the college was on the verge of sending my boxes onto Johannesburg when I showed up and claimed them as mine. This was the start of a very pleasant time at Oxford.

Matt: Living in a college?

Peter: In the first year, I lived in student accommodation that had been somewhat refurbished by my college. It was owned by my college, Brasenose College, but it wasn’t actually part of the college—my college dates back to 1509, and there’s really only one quadrangle that goes back to that time. There’s no way they could provide accommodation for everybody there. They try to provide accommodation for every one of their undergraduates in an old part of the college for one year out of the students’ two or three years.

When it comes to postgraduates, the college has to draw the line. I met there a chap called Patrick Scanlon. We became firm friends, and at the end of the first year we went looking for accommodation together and found it in North Oxford. Our landlady was Lydia Pasternak, the sister of Boris Pasternak who wrote *Doctor Zhivago*. Her father was Leonid Pasternak, who was a famous Russian impressionist painter. So that was how I spent my second year in Oxford.

Lydia was a poet. I enjoyed her poetry. I got to know her sister quite well; she lived further north in Oxford, and the sister was always in trouble, wanting a chauffeur somewhere. She had a car, but not a driver. I had a



FIG. 9. Peter and Jeannie, Oxford, 1976, when Jeannie returned to visit Peter before he headed home to Australia.

driver's licence, but didn't have a car. This relationship worked out well; I'd get to use her car sometimes, and in return I'd drive her someplace and pick her up later.

Matt: Can you tell us how you met Jeannie at Oxford?

Peter: This happened through the Mathematical Institute, even though Jeannie had no direct association with it. The Mathematical Institute put its graduate students together in rooms. I was in a room which I shared with a young Englishman who went on to be a very successful mathematician—Charles (C.J.K.) Batty, a young woman from Paris, Françoise Grand-Clément, and a couple of others. I began to get rather friendly with Françoise. She was doing a master's degree in group theory at Oxford. Jeannie and I met in 1974 through Françoise when Françoise invited me for dinner. Françoise and Jeannie were staying in the same graduate house, and as Jeannie had a room with a lounge, Françoise asked her if she could borrow her lounge room. Jeannie agreed and Françoise invited her too, which was how we met.

Aurore: Did you rub shoulders with any famous people at Oxford?

Peter: I knew Benazir Bhutto quite well. We would come across each other at dances and parties, particularly at St. Catherine's College. She travelled a great deal, but at a much higher level than I—she stayed in fancy hotels.

Matt: Can you tell us about your thesis at Oxford?

Peter: Yes. I got to Oxford, and John Kingman was really very kind to me. The first obstacle was being able to skip the master's degree there. I already had a master's waiting for me in the wings in Canberra, but I had money from Oxford for three years, so I could have stayed there for three years. A typical doctoral student at Oxford only has money for two years, because in the first year they have to support themselves by doing a master's thesis. I resolved to see what I could do about getting my doctorate in two years. John Kingman gave me a problem for my doctorate, but I did not really like it because I was really interested in convergence, and this problem wasn't so much about convergence.

As everybody moved offices after a while, within a few weeks I was moved into an office with John Biggins, who I still keep in touch with from time to time. When Kingman realised that I wasn't going to work on his problem, he gave it to John, who built his career around it. So it really turned out to be quite a profitable problem for John. I was interested particularly in rates of convergence. I had worked with Chris Heyde partly

in that area, and I also had developed an interest in martingales in that area, too. So I began to develop a thesis about rates of convergence of sums of independent variables, when the variables are independent but they don't have the other nice properties such as regularly spaced variance.

Aurore: That's why you started to read Petrov (Petrov, 1975)?

Peter: Yes. I became very interested in rates of convergence, and toward the end of my thesis I submitted a paper on convergence of moments. I sent it to the Australian Mathematical Society, and they did a very thorough and careful review of the paper which pointed out that all the results were covered in this book by Petrov, which I'd never heard of, because Petrov was published in Russian and German, in East Germany early in 1975, and I'd only submitted the paper in 1975. I became very impressed by that book, and it's been my bible ever since in some respects. Anyway, none of my work is useful or interesting to everybody all of the time. However, there's a sense in which, over your career, your work which is most important to you, that is, which gets you ultimate tenure and gets a position for you, is of that type, and you have to appreciate that when you're writing references for people. And the work that people make their career on, in a way, is very seldom their best work, but it can be the cornerstone of later career work, and that was true for me.

Aurore: So were your thesis results already in the book by Petrov?

Peter: No, the stuff that was really important in my thesis was really new, but I don't want to overstate its importance. I just want to stress the fact that it was original.

Matt: Was there a good cohort of people during your time in Oxford?

Peter: There was in a way, although it was more at Cambridge than at Oxford. The first year that I was at Oxford, 1974–1975, there was an absolutely brilliant cohort at Cambridge, including Bernard Silverman, David Aldous and Frank Kelly. Geoff Eagleson was also at Cambridge in those days; he was a lecturer there. So I went up there to see Geoff, because he was interested in martingales, and I met Bernard Silverman for the first time on that visit. Oxford was a very different place in those days. There was no statistics department; so statistics generally had a poor look-in. There was also a chap now at Cornell, Bruce Turnbull, at the Mathematical Institute.



FIG. 10. *Wedding day, Hong Kong, 15 April 1977.*

RETURN TO AUSTRALIA

Aurore: At the end of your D.Phil, you came back to Australia.

Peter: I came back to Melbourne in mid 1976 with the promise of potential tenure, but when I began poking around about the opportunity of having a permanent job, I was told that there wouldn't be any permanence beyond three years. Therefore, by the middle of the second year, I started looking seriously for a new position. I applied for all the jobs that became available. There were two jobs, one of which was at the ANU. I was really surprised by how long the ANU took to reach its decision—like with Oxford, I assumed that they'd completely ignored me, and I applied for a position at Macquarie University, which also took a long time to be resolved. But suddenly I got this phone call from Chip Heathcote. He said, "We'd like to offer you the job, but you're aware we've advertised it only in the area of biometrics," or something like that. And he said something like "The committee is very keen on having you, but it would like some sort of acknowledgement of your willingness to move into this area."

This was a very nice thing—it had a very good long-term positive outcome for me. And he said, "Would you mind moving into statistics?" And I said "Of course not." I make these serendipitous decisions. For example, I never told my mother I hadn't canceled the application for Oxford and I find that this naïvety somehow works for me in the long run. It's not intended to be naïve, but it somehow works out. Anyway, I always had that in my mind, and I remember the funny thing about what Chip had asked me to do was that there was no time limit—I could take a hundred years to move from probability to statistics, and apparently the department at the ANU would

be happy. Obviously, I felt that because of the lack of formal requirements, I could manage this. And any statistics/probability graduate from an Australian university knows a lot of probability/statistics—it's one of the virtues of a statistics education in Australia. So it wasn't all that difficult for me to move from probability into statistics.

Matt: Meanwhile, your master's thesis became a published book with Chris Heyde in 1980 (Hall and Heyde, 1980)?

Peter: No, that book contains more than what was in my thesis. Chris really worked hard on that book. I want to acknowledge that. So this move from Melbourne to Canberra was very beneficial to me, because I went into a research environment that was shaped by people like Ted Hannan and Pat Moran, and also by Chris Heyde and Joe Gani, who really developed the environment that educated me. It was an excellent environment for me. But this is the strange thing about my life, really: it was never planned in a strategic way. Everything that turned out well came by accident.

Matt: During the 1980s, you started to get a reputation as being a strong theoretician and you were targeted by overseas institutions.

Peter: I got job offers from places like Berkeley and Princeton, but I turned them down because I wanted to stay in Australia. I can't really explain to you why that is. I just always have had a strong feeling about Australia. When I was a student in Oxford, I used to correspond with my parents using aerogrammes, which don't exist anymore. You'd just write on an aerogramme, and you couldn't enclose anything else. I remember my father always used to break the rules by putting a eucalyptus leaf in the envelope. And every time I went to the mailbox to get my mail, and I saw that, I used to tear up. I never really wanted to leave Australia. I never found the cultures of Australia and the U.S. to be sufficiently close for it not to matter. And so that's really the reason I turned these places down. There are other reasons in each case. I also had other job offers, for example, from Cambridge, but I also declined them.

Matt: So you ended up spending 28 years at the Australian National University. But in 2006 you returned to Melbourne.

Peter: I felt under pressure from some university administrators for not bringing in enough research money. I was earning \$250K in outside funding each year, so I kept on doing what I had always been doing. I didn't try to do things any differently. But at the same time I kept a weather eye out for other options.



FIG. 11. Peter in 1978 sporting his trademark sideburns, which he kept until 1988.

Through the Centre of Excellence for the Mathematics and Statistics of Complex Systems, a research center that Melbourne professor Tony Guttmann set up, I had a connection with the University of Melbourne. I began to like the place. So I started to talk to the University of Melbourne, and in the end I signed with them and went down to Melbourne.

Matt: So you've got two different Melbourne stories—the 1970s Melbourne story, and that for your current position.

Peter: I feel that I gained a lot from both moves, from Melbourne to Canberra and later from Canberra to Melbourne. One of the reasons I decided to make the move to Melbourne is that I was on a review committee of the mathematical sciences in 2006, and I travelled around Australia and interviewed people in different universities. I realised that no one in any of the other universities brought in anything like the amount of money that the ANU wanted from me, and I realised that the University of Melbourne was the best resourced mathematical sciences group in the country, so at that point in time, in mid-2006 when I signed on the dotted line, I knew I was making the right move.

GETTING INTO STATISTICAL RESEARCH

Matt: Bootstrap methodology emerged in statistics in the late 1970s and early 1980s. I would have thought, given your skill set, that this was a very timely thing to have happened.

Peter: It was very timely, yes.

I have a paper in *Statistical Science* called “A Short Pre-History of the Bootstrap” (Hall, 2003) and that points out that in some senses, the bootstrap idea goes back to an English civil servant called John Hubback in 1927. He joined the Indian civil service as an Englishman, and went to India and had various positions. One

of his tasks as a relatively young civil servant was to estimate the production of hemp and certain cereal crops, and, as we statisticians know, he really had to get some sort of estimate of variance, because he had to estimate the variability about the mean. The mean you can get just by looking at long-term trends, but to estimate the variability is a challenge. And he came up with the bootstrap idea then. But what was remarkable about his work was he had dependent data, because he was interested in crops that grow in fields, and so there's a lot of correlation between what happens in one field and the neighbours, and his approach took account of that as well. So, essentially what he did was to develop the idea behind what today we'd call the block bootstrap. And now, if you look at the history from that point on, you'll find that several people had the same ideas, completely independent of Hubback, and Efron was one of those people. Hubback was the 1920s; Efron was the 1970s.

Matt: It was Efron (1979) that introduced it to statistics.

Peter: Yes, that's right. I read recently that it had been rejected first out, because he didn't develop the theory. Little did the poor referees know that it was going to take us a decade or two to develop a theory. But what Efron saw that nobody else really did, because they weren't at the right time, was that you can combine the power of modern computing, and the need to do simulations, to overcome the computational problems that Hubback had. Hubback essentially overcame the computational issues by having lots of Indians working for free, doing the calculations for him. I should also mention here the work in the U.S. Bureau of the Census. These people needed to account for variability in censuses, and they therefore needed to estimate variances. They used what we would call the “half bootstrap” today. So of course, what Efron, Hubback and John Hartigan did was rather different in this respect, too—re-sample with replacement. What the Bureau of the Census people did was to re-sample without replacement, and they would re-sample half the sample, then they'd work out the variance of the statistic computed for half the sample without any repetition. And from that, they could determine an estimate by “reverse engineering” to get a variance estimate of the standard statistics they were getting using the full sample. And they didn't know Hubback, and that's fine because these people were working in very different eras and very different contexts, and it would have come as quite a shock to them to make them aware of the work of the other people.

In the 1960s, John Hartigan went to the U.K. and lectured about the half-sample bootstrap, and I think he cited some of the Bureau of the Census work. But then Efron came along 10 years later, and he was more influenced by the work of Tukey, who saw the bootstrap as an analogue of the jackknife. All these people came to the bootstrap quite independently.

Efron really had the field to himself in the late 1970s. I was in Canberra then. In the early 1980s, I went to a talk that Terry Speed gave. He'd just come back from the Joint Statistical Meetings, so this talk must have been around September. And being a rather pushy young man, I asked Terry "What's the big topic at the moment in statistics? What's everybody working on?" And he said "Oh, the bootstrap." I'd heard of the bootstrap, because I had papers to referee and so on, but the way Terry made his remark really made me interested in it. Within a week or so of that, I got down journals and began to read them and this is where we go back to your comment about my being fortunate in coming in at the right time. At Oxford, as a D.Phil student, I'd become very interested in rates of convergence. In fact, this was one of the exciting things I found out about probability, and I remember looking at problems in probability in terms of the rate of convergence and the central limit theorem for either sums of random variables with different finite variances, or sums of distinct, identically distributed random variables. And I really enjoyed this for its own sake. I never anticipated that anybody would find any of it useful, but then when I poked around in Canberra in the early 1980s, I saw these rates of convergence arguments giving new expansions of approximations to probabilities. These were ideal, in some respects, for assessing the performance of the bootstrap. There was a German statistician, Pfanzagl, whose work I came across. I corresponded with him at least a couple of times, a very nice man. And it turned out—I discovered this after I did the work myself—he had discovered the same thing I was interested in. He was really a mathematical statistician; I was a probabilist trying to find my feet as a mathematical statistician at the time. We both looked at the mean of a sum of independent exponential random variables. As an exponential random variable has an asymmetrical distribution, we knew that the distribution of the sample mean would depend on the asymmetry. But we got quite different answers for the effect of the asymmetry, and only when we began to correspond did I realise that what my German colleague had done was look at the left-hand tail and I had looked at the right-hand tail. And I honestly hadn't expected at



FIG. 12. Cockatoos outside the window of Peter's Australian National University office. Fondness of the nature of Australia contributed to him basing his career there.

that point that we'd get such a big difference; I thought they'd be much the same. That led to my first paper in *The Annals of Statistics*, and then I became more and more immersed in these properties of the bootstrap, in terms of approximations of distributions. That led to several more papers in *The Annals of Statistics*. But the important thing here was that I was able to exploit my experience and love of probability theory and make a contribution to mathematical statistics for the first time.

Matt: Another early area of statistical research for you involved nonparametric function estimation and smoothing parameter selection.

Peter: While I was at the ANU, as a master's student back in 1973 and 1974, we had a visit from Vic and Eve Bofinger, who were at the University of New England. I got to like them a lot. Eve Bofinger had written a paper about kernel density estimation. I looked at this and I thought, "I can understand this." And I thought, "This new-fangled stuff called nonparametric function estimation—I don't need to have a pile of books beside the desk—this is all just mathematics. I can read it and understand it." I realised I could develop the theory in much more detail than they did. I also realised that it was all just sums of independent random variables, so it was all pretty straightforward. So I wrote a paper and sent it off somewhere—it might have been *Journal of the Royal Statistical Society, Series B*. And that was my starting off point for becoming a statistician: reading a paper and adding to it. The paper got rejected and I never bothered to do anything with it after that, but I was very pleased and that's how I sort of cobbled along, and I'd become interested, partly while at the University of Melbourne, in extreme value theory, because it's a very, very easy part of probability

theory to get into. So I began to look at statistical problems that were related to extremes. That's how I moved into statistics.

Aurore: So you started to work on smoothing and the bootstrap at the same time?

Peter: Yes, because they were both enabled by computational powers. The smoothing I grabbed onto, because it was all about sums of independent random variables, and by then I was quite expert at that topic, at least in the area that I needed to be, and the bootstrap, the bit that I latched onto there, was about rates of convergence and so on, and I'd already become familiar with that. So my conversion into a mathematical statistician began through those two channels. And that's really the story, and I kept along those lines with various, varying degrees of sophistication up until the late 1980s, early 1990s. At one point, I remember, in the early 1990s, looking back on what I'd done, I realised that I was competing with almost nobody there. Anybody else was doing simulations and things like that, and that's because I had the very good chance of having that background in rates of convergence, as well as an interest or a desire to do something in mathematical statistics. So, for example, when you look at what came out of Stanford in the 1980s—there's an exception here with work from Tom DiCiccio and Joe Romano—but there's almost nothing in the literature that competes directly with what I did. Because I was very lucky to fall to earth and came down in the parachute in the right place.

Matt: You also published a theoretical paper in the *Annals of Statistics* on the properties of least squares cross-validation for smoothing parameter selection.

Peter: That's right. Michael Woodroffe developed early methods for their empirical choice. And then in the 1980s I became interested in cross-validation. That had a lovely aspect to it. So I wrote this paper in the early 1980s on, which justified, under various conditions, the least squares cross-validation. It was a turgid mess, not least because I had to reduce the length, and in those days there was quite a lot of cutting and pasting, and I pasted things in the wrong place, and of course the printer printed everything. Anyway, I went to the University of North Carolina on sabbatical leave shortly after that, and I met Steve Marron. He was supervised by Chuck Stone partly at the University of California, Los Angeles, and partly at Berkeley because Chuck moved to Berkeley during Steve's PhD. And Steve said "Chuck would like to meet you." Now I knew Chuck's name; I knew him as a person working in stochastic processes. He'd been a bit like me in the

sense that he'd moved from stochastic processes into mathematical statistics, and I was enormously flattered that he wanted to meet me, and I said "Fine." So he was brought over to Chapel Hill to give a talk. It turned out he had a much nicer proof of the validity of cross-validation than I did. And I was very impressed by his proof and a little bit embarrassed that I hadn't a nice proof. But the reason he had got onto it and I hadn't was, as a theoretician, I felt that what assumptions you made about the kernel had to include the Gaussian kernel, whereas Chuck simply said let the kernel be a compactly supported symmetric function. When I first saw Chuck's proof, I thought "This guy's a genius—how come he's got such a simple elegant proof?" And then I realised that the Gaussian kernel did not satisfy his conditions so I felt a bit better after that. But what really gave me a boost as a young man was the fact that he was influenced by my work. I think it's true to say that it was my paper that made him interested in cross-validation. He had a method based on Poissonisation, I think he called it, for bounding probabilities on large deviation in the arguments needed to establish the validity of cross-validation. And I remember that T. W. Anderson was visiting us in Canberra at that time. I'd come back from Chapel Hill and T. W. Anderson asked me what I was working on. "Well, what I've got to do"—and this was with great trepidation—I said "I've got to take apart Chuck's proof of the validity of cross-validation, because I want to understand it so I can use it in regression and problems like that." I've always sweated blood to get a result to develop my own proof. I almost never borrow from someone else because I find it easier to do the work myself. And then when I realise somebody else has done it much better, it really is a big mountain to climb to understand what they did and then convert it to what I need it to be. And, so I kept to this point where this Poissonisation argument was used, and I realised this was a petty thing in a way, but it was a way for myself to get some credit from the whole business. It's actually much easier to use the martingale argument, which of course Chuck Stone wouldn't have been so familiar with because he hadn't spent his youth on martingales. So I did in the end modify his proof in that respect, and other people have since picked it up.

COLLABORATION AND TRAVEL

Matt: I know that you enjoy travel. For example, you are a regular visitor to Glasgow.

Peter: Ah, Glasgow, yes. Mike Titterington and I were working on nonparametric mixture problems,



FIG. 13. *Peter and Jeannie on a ferry to the outlying islands on their Christmas holiday in Hong Kong, circa 1990s.*

and that's an outgrowth of my desire to move somewhat into mathematical statistics. I managed to scrape together some money to bring Mike to Australia. So I wrote to him. We had "sort of" competing papers on this. Neither of them, and here I think Mike would agree with me, was particularly important, but anyway, we had fun doing the work. I brought him to Australia for the Statistical Society meeting, and then when I had sabbatical leave I wondered whether I could go to Glasgow and work with him. I just liked the physical environment around Glasgow; it appealed to me, although it rains heavily.

Matt: And you went up into the Scottish countryside a lot?

Peter: I went mainly to the west coast. I just found the atmosphere in Glasgow and the west islands very much to my liking. Occasionally, I would stay overnight there in a bed and breakfast, but usually I'd go up by train, first train in the morning and come back in the evening.

Matt: With your camera, I imagine?

Peter: With my camera, yes. And I really enjoyed it.

Aurore: So you got there after a visit by Titterington. I think you have a long history of an important visitor program. Do you like to have visitors because it creates some sort of an atmosphere, a dynamic environment?

Peter: Partly that. At the ANU, Neil Trudinger established in 1982 the Centre for Mathematical Analysis (CMA). We tried to get this renewed in the late 1980s, but were unsuccessful. However, the university put some money into it, which included money for visitors. I had been able to have visitors before that, but not on the scale that was permitted under the new CMA, which also included a fair bit of statistics. That led to a lot of opportunities for bringing people over, and I've always had this attitude, which is: bring over good people, as long as you have something in common. You might not do anything with them, but just have them around.

I was really pleased at how things worked out. We would have visitors come out and they'd often, but not always, work with me on at least one topic, but they'd usually work with other people as well. I'm a bit of a Type A personality in the sense that I like having people around to talk to, bounce ideas off, and we can decide to work together or not, as the case may be, but I had a lot of funding for visitors at that point, starting from the late 1980s, and I made use of it as much as I could.

I really liked problem solving—people would come with a problem. This reminds me of the time I spent in CSIRO. So from about, I think 1991, I was 50 percent employed at CSIRO, and the Chancellery told me that



FIG. 14. *Peter with his panoramic camera at Aberdeen harbour, Hong Kong, circa 1990s.*

because CSIRO wasn't ARC-eligible, I ran the risk of losing my ARC grant. So instead, at that point, I became a consultant with CSIRO, and that kept me going until about 1996 when CSIRO changed their structure. My role in CSIRO at that point was to really develop the strategic side of their work. I don't know whether other countries talk about it this way, but if you think of research in mathematical statistics, it's either strate-

gic or tactical research, where the latter means that it really solves a specific problem. And that's what they were doing. They were, in some cases, just walking the streets of Sydney, knocking on doors of big companies and getting problems that they could be paid to solve. However, the higher-ups in CSIRO wanted more strategic research; that is, they wanted research to be turned into something which is more globally



FIG. 15. *Peter taking photos in the Scottish highlands, circa 1990s.*

applicable than the particular problem that they got from industry. I used to show up in Sydney on Monday morning and leave on Friday, late Friday morning, and my friend at CSIRO used to say “You know Peter, it takes you only about a week to convert a real problem into a university problem.” He was commenting on the fact that the problems that I started off working with in CSIRO often turned out to be quite different from the ones that I was presented with initially. Among my CSIRO collaborators, I mention Nick Fisher and Steve Davies for particularly good taste in problems. Nick Fisher brought to me problems that were relevant to CSIRO but which they didn’t have the expertise to solve. My work on fractal dimension, and so on, was of that type.

Aurore: You just turned problems into something that you liked, which you still do these days when you have visitors.

Peter: That’s right. I turn them into something that motivates me and which is mathematically tractable. And when you talk about the problems that I work on with visitors, a fair number of those problems are of that type; they started off as something a bit different when the visitors showed up, and then got converted over time.

Matt: Isn’t Calcutta another place that you visited from time to time?

Peter: I never spent much time in Calcutta. My colleagues who go to India usually get out of there as soon as they can, and I thought I’d be like that when I went there the first time, but then I found India was just so interesting. They’re very patient, very organised, and there’s very little violence there, and of course, India has many other interesting features. It’s a paradise for a photographer. I find India very uplifting. I find time in India gives me confidence in humanity and the fact that it will survive all of these challenges in some form.

Matt: How about Davis, where you took a one-quarter appointment 10 years ago?

Peter: I visited there in the mid-1980s. This eventually led to a job offer there. But I didn’t want to leave Australia, so I said no. And then they said something like “How about half-time?” And it was still too much. It frightened me. I didn’t want to spend that much time away. So then they came up with this one-quarter, and I accepted it.

Matt: We talked about Mike Titterington earlier. Do you want to talk about any other big collaborators in your career, such as Ray Carroll?

Peter: I always liked working with Ray (Figure 16), because I felt I could contribute something from the

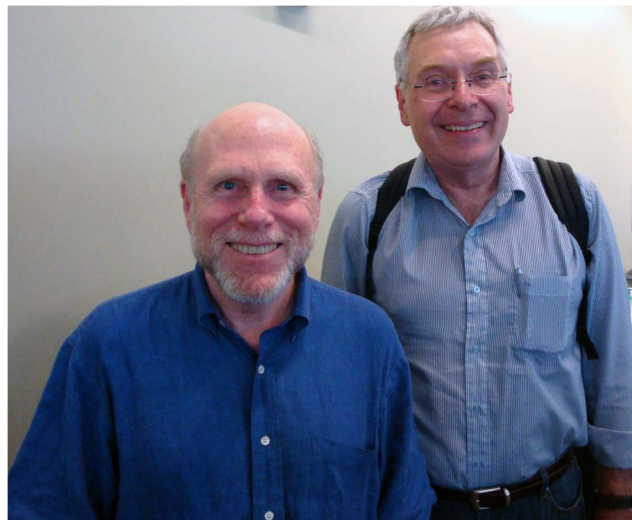


FIG. 16. With Ray Carroll in 2012. Ray, from Texas A&M University, has been a regular collaborator and visitor to Peter in Australia since the 1980s.

problem-solving side, the theoretical side, whereas he is more an applied person; he is also a professor of nutrition and toxicology.

Matt: A lot of his measurement error research has come out of his collaboration with nutritionists.

Peter: That’s right, yes. I think in working with Ray we bring to the table things that don’t overlap, and which complement each other very well, and I think that worked out very well for that reason.

Matt: You have also worked quite a bit with Steve Marron.

Peter: Yes, I think I could have collaborated with Steve almost until the cows came home, so to speak. We wrote two very good papers when I was on sabbatical in Chapel Hill, and then we’ve only met sporadically after that. I think if we had been in the same place we would have collaborated intensively and for a long period.

CONTRIBUTIONS TO AUSTRALIAN MATHEMATICS

Matt: Do you want to talk about Australian mathematics? I know that, as a statistician, you haven’t just focused on your branch of mathematics; you’ve actually done a lot for mathematics in general.

Peter: Yes, I’ve got tied up in these things. I’ve been happy to do it. I think the key point here is that I was really trained as a mathematician, not as a statistician, and my love has always been for aspects of mathematics. As an undergraduate, I learned that there are limits to how much enthusiasm I can feel for some areas of mathematics, like pure mathematics, but overall



FIG. 17. *Peter admitted as a Fellow of the Royal Society of London, 2000.*

my passion has been for mathematical things, and I got kind of moved in the direction of mathematical statistics while looking for work, and I was very pleased that that happened, because it helped my career and made it much more interesting for me. But nevertheless, at the end of the day, I still have this strong mathematical enthusiasm for things.

Matt: Do you want to just say a little bit about your advocacy for Australian mathematics with respect to government panels and the like? The Australian Mathematical Sciences Institute was established in Melbourne about 12 or 13 years ago. Were you part of that?

Peter: Yes, I was the first chair of the Scientific Advisory Committee. Then when I became involved in the Academy of Science, I realised fairly quickly that a lot of people in the Academy didn't think of mathematics as really being science, so one of the things you had to do was to impress upon colleagues in the Academy that a lot of what they were doing wouldn't be possible without mathematics. And I have to say that the strongest scientists in the Academy didn't need any convincing. Two people here I'd mention especially, were Jim Peacock and Suzanne Cory, and they're both former Australian Scientists of the Year. Both of them really appreciate how important the mathematical sciences are to their work. Jim, because he's a geneticist, sees mathematics in the background.

I remember we had a review at the end of 2006, and early 2007. Hyam Rubenstein, Jan Thomas and I took the findings to Canberra. Jim was Chief Scientist by

then, and we wanted Jim's support with the review to convince the government that mathematics courses in universities should be paid by the government at the same rate they paid computer science courses. They had been paid at a lower rate before. We went to see Jim and told him we wanted his support and he said, "Well, you'll get my support if you can convince me that mathematics is important to science, to the nation's economy and things like that." I remembered from my time at CSIRO that he had benefited a lot from help of a statistician, Emlyn Williams, and I said to Jim, "Look, when you were in CSIRO, Emlyn did an enormous amount of mathematics for you. It's just that when he presented you with the results, he didn't put all the technical arguments in. You couldn't have done the work you did without the help of Emlyn." And Jim looked at me and he said "Yes, you're right." And that was it. We knew we had Jim on board. And that's the only resolution, the only recommendation, from that early review that ever saw the light of day. I remember being in Davis in May the following year, at the time that the federal budget was brought down, and I was very pleased to see that provision was made in the budget of 2007 for increasing the funding for universities so that they could increase funding for maths and stats courses. Thanks, Jim.

Then there was Suzanne Cory. I found that it was very easy to convince her of the importance of mathematics to science. Of course, in this context you have to remember that it was Suzanne who brought Terry

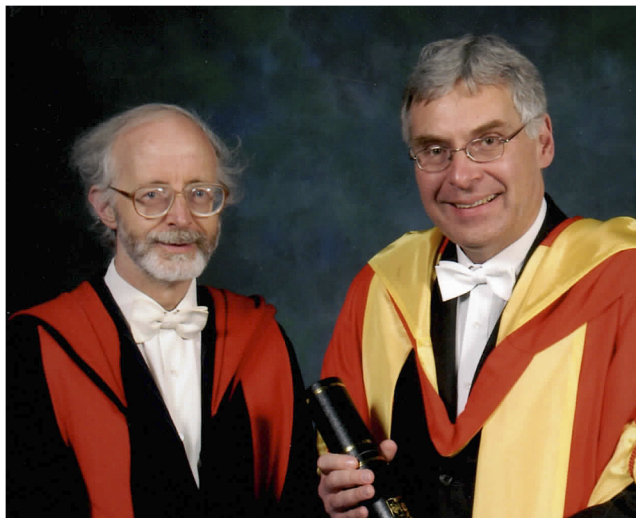


FIG. 18. Peter with Mike Titterington, after receiving his Honorary D.Sc from the University of Glasgow, 2005.

Speed back to Australia. At some point, I think she became aware that they had to have a vital forward-looking innovative bioinformatics group. I think she asked various people, “Who should we have to lead it?” And people said “Terry Speed.” And I think they offered Terry Speed a job, and he said no. And eventually it was a bit like the arguments that Davis had with me; they offered him a half-position. So Suzanne and Jim have been aware of the importance of statistics and mathematics to bioinformatics and to medical research more generally, but I want to say that my time in the Academy has led me to believe that many of Australia’s top scientists really appreciate the importance of mathematics and statistics.

I remember years ago, at the Australian Academy of Science, there was a push to introduce a sectional committee in a sort of information technology and engineering and I supported it. At that time, I was Chair of the Mathematical Sciences Sectional Committee. Council concluded that they would introduce a new sectional committee but they didn’t want to increase the total number of sectional committees, so they decided to merge Physics and Mathematical Sciences. Somebody on Council made me aware of this. I went to see a physicist from the Physics Sectional Committee at the University of Sydney, and he felt like me that this was outrageous.

We decided that we were going to write a letter to *Nature*, just a correspondence letter, not a science letter. And so we did this, and we had lot of signatures on this letter because both the physicists and the mathematicians saw quite rightly that it would result in reduced numbers of physicists and mathematicians being

elected. Don’t forget that I have a strong love of physics as well as mathematics. Just about every physicist or mathematician who was in the Academy signed it. And we had the letter drafted and re-drafted and so on, and I e-mailed it to the editor of *Nature* in London. I alerted the AAS Secretary, Science Policy and the President of the Academy, and copied the letter to the President of the Academy and to the Scientific Secretary. This was just before the sectional committees met on the special Sectional Committee Day. And I received an e-mail message overnight from *Nature* in London, which said “We have decided to publish your letter with all the signatures on it.” I thought, “Well, this is going to put the cat amongst the pigeons; I expect to be thrown out of the Academy for this.” This e-mail message arrived one night, and the next morning as chair of the Mathematical Sciences Sectional Committee, I sat in the front row of the Dome in Canberra. The President always gives his pep talk about how we have to maintain standards, etc., and this time he said as well, right at the end of his talk “By the way, some of you will have heard of a plan to combine the Mathematical Sciences and Physics Sectional Committees. That plan has been abandoned.”

Aurore: So the letter wasn’t published?

Peter: The letter was not published. As soon as there was a gap in the proceedings of my sectional committee, I ran to my computer across the other side of the campus, and sent a message to *Nature* telling them what had happened, thanking them. A message came back overnight saying: “We’re always happy to help.”

Matt: Approximately what year are we talking about?

Peter: Probably the late 1990s, or early 2000s. But I remember discussing this with the physicist from Sydney, who said we could get ourselves into a lot of trouble if this failed. And I said, “I don’t mind having a fight with people, as long as I win.” And he looked at me rather strangely. Whenever we meet, we always shake each other’s hands and pat each other on the back. Very few people know about the episode, although, of course, everybody who was on the Australian Academy of Science Council at that time would know about it. That was an exciting time.

This streak that I have in me was obviously also in my mother, and so it’s not something that was out of character for me. I know my mother would have done the same thing. Red Ruby, indeed.



FIG. 19. *Officer of the Order of Australia, 2013.*

CLOSING REFLECTIONS

Aurore: Can we talk a bit more about your research? What led you to do the most amazing work you've done?

Peter: I always think that with my collaboration and with my work by myself, I've benefited enormously from having a past in probability theory which my colleagues didn't. So I really felt advantaged by the fact that I was told to move from probability to statistics. I went with a bag of tools that most of my statistics colleagues didn't enjoy. I am actually very interested in applications and very interested in solving mathematical problems. And my interest in applications really goes back to my mother, and you know, my mother would have been extremely pleased to see me having got so far, but at the same time she would have smiled and said, "You've really become a mathematician, not a scientist." And I think there are both sides to my work.

Matt: But you worked with strong applied people, and your skills as a strong mathematician have been used to progress science, so that could be explained to your mother.

Peter: It's true—we go back to what I said earlier about that discussion with Jim Peacock. Jim had worked with Emlyn Williams, and without this work with Emlyn, he may not have received the accolades he's got. Emlyn has a degree in mathematics or mathematical statistics from the University of Adelaide.

Aurore: Some people think that you don't care about applications, but this is very unfair, quite wrong actually. To be interested in something, you really need the motivation from the real problem, rather than work that is purely theoretical, like theoretical probability work, for example.

Peter: Well, it depends a bit on how elegant it is. I'm still knocked off my feet sometimes by some work in probability. The nature of my research has, since the early 1980s, been shaped by the fact that I have a past as a probabilist and a future as a mathematical statistician. And it's been combining these two directions that has dictated what I've done. And I've found it very, very enjoyable. I must also mention that, as I've gotten older, I've found that probability was too fixed, too unexciting, because it didn't change very much. It's like the conventional mathematics problem—the thing's been unsolved for 250 years. The young man who solves this problem makes his reputation. Well, there's nothing like that in statistics. If it hasn't been solved for 2.5 years, people basically aren't interested in it. And it's the way in which statistics has been changed by the advent of computing and that's not just change in one point in time, but it's changed continuously over time.

Matt: It's a technology-driven area of research.

Peter: Yes. And it's not just the computing, it's not just the IT that's used to do the calculation. What you have to appreciate is that the changes in technology that



FIG. 20. Peter with the Rector, Professor Jose Carlos Gomez Sal, after receiving his Doctor Honoris Causa from the Universidad de Cantabria, Spain, 2014.

we're seeing, that motivate all the scientists with whom we work, are where the excitement lies. When you look at probability theory, you don't find this same excitement; the field is more slowly evolving. So that's one of the things I've benefited from, from being asked to move into statistics from probability. That phone call that Chip Heathcote made to me really helped my career in many ways.

Matt: And it helped the field of statistics.

Peter: Otherwise, I'd still be fussing around with martingales and things like that.

Matt: What drove you to work so hard—I don't know if it was partly the fact that you didn't get tenure at Melbourne?

Peter: I didn't get tenure; that was the major thing.

Aurore: But then you continued. Why?

Peter: It's a mixture of two things. First of all, I was really surprised that I didn't get tenure. And I really wanted to lay a foundation as a young man with a future so that this sort of thing wouldn't happen again. But the other thing, of course, was that I was moving into this new field.

Aurore: You had to learn a lot.

Peter: I had to learn a lot, or at least I had to do a lot of stuff there. As you probably know from what I've said, I didn't have to learn a lot in the sense that I didn't ever sit down with statistics textbooks and work through them from cover to cover. I had to learn

about the ideas, but basically the ideas were those of subset-independent random variables. These are the two reasons why I kept on going.

Aurore: Something we haven't talked about is maybe what you regard as the work that you prefer or your most important contributions.

Peter: My work on the bootstrap is the work of which I'm most proud. I made my reputation there, and as I said, it all goes back to that question I asked Terry Speed when he came back from the Joint Statistical Meetings in about 1981. And I'm most proud of the way in which I was able, fortuitously, to bring together my interests and skills in probability theory with my desire to move into mathematical statistics. In the Committee of Presidents of Statistical Societies (COPSS) paper I wrote (Hall, 2014), I said that I feel very privileged to have been able to be active at the time of the development of these computer-intensive methods.

The bringing together of my interests and work in probability theory and the desire to move into mathematical statistics underlie my successes. Into all that, you have to mix my fondness for problem solving. I became interested in functional data analysis, really because it was a different class of problems from before. There wasn't really any practical issue that motivated my work there.



FIG. 21. Peter's last official function, at the launch of the Australian Research Council Centre of Excellence for Mathematical and Statistical Frontiers, September 2014.

I still find the theory side really interests me. And I have a feeling that Brad Efron appreciates that. I wrote that COPSS article, and it should have been clear from that article that I really was turned on by theory. The applications are interesting; they provide a fascinating motivation, but I was really there because of the theory.

Aurore: You said that you prefer to live in Australia, but at the same time you feel the need to spend a significant amount of time in the U.S.

Peter: Oh yes. You need to be abroad and you should attend the big conferences. As you know, I asked Terry a key question about the bootstrap. I had come back to Australia in 1976, and I hadn't left again, so I relied on Terry to tell me what was going on. In those days, it was very difficult to get money for travel. Travel is probably the most important thing for statisticians and probabilists.

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