

Statistica Sinica Preprint No: SS-2018-0028

Title	PETER GAVIN HALL
Manuscript ID	SS-2018-0028
URL	http://www.stat.sinica.edu.tw/statistica/
DOI	10.5705/ss.202018.0028
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PETER GAVIN HALL

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Abstract: This paper is about Peter Hall, documenting and commenting on how Peter's contemporaries, be they peers, colleagues, friends or students, or even the older generation of the statistical community, perceived Peter, in their own words. To some extent, I also do the same with Peter's own perceptions and thoughts.

Key words and phrases: Credo, gentle, kind, life, mind, passions, Peter Gavin Hall, soul.

1. Introduction

With Peter Hall's death the world statistics community lost one of its most remarkably accomplished, admired and loved members. Several obituaries for Peter have been published, at least three memorial websites have been set up for him, and two conversations with him have appeared: Delaigle and Wand (2016); Leong (2016). My intention is to avoid duplicating this material as far as possible, though it is impossible to do that completely, as I want this article to be reasonably self-contained. Also, in addition to using Peter's own words from other places, I plan to repeat some of his words from the two conversations. My other sources include recollections by his students, postdocs, collaborators, colleagues and friends, and Peter's wife Jeannie Hall. I will not be discussing technical aspects of Peter's research: that has been well covered by articles in a special issue of *The Annals of Statistics* (2016) and the memoir, Robinson and Welsh (2017). All the items mentioned above are listed in the References below.

My goal in this appreciation of Peter is to revisit some of the aspects of his life and work already discussed in print, to add a little previously unpublished material, and try to convey to readers just what an unusual and admirable human being he was. I will try to achieve the goal set for me by Peter's close friend Dr. Mark Westcott:

[to convey] the truth that, despite Peter's towering achievements, formidable intellect and workload, his most remarkable legacy is the gentleness, care and kindness within which his professional life was lived.

2. Résumé

Peter Gavin Hall was born on 20th November 1951 in Sydney, Australia, and he died on 9th January, 2016 in Melbourne, Australia. He is survived by his wife, Jeannie Jean Chien Hall (née Lo) and his sister, Fiona Hall. Peter had two remarkable parents: a brilliant, strong willed and at times combative mother, Ruby Payne-Scott, and a warm, gentle and calm father, William (Bill) Hall. They are well described in the books Goss and McGee (2010) and Goss (2013), and in Delaigle and Wand (2016). Peter grew up in the Sydney suburb of Oatley, attending Oatley West Public School (1957–1963), and Sydney Technical High School (1964–1969) located in the nearby suburb of Bexley. He attended the University of Sydney (1970–1973), graduating in 1974 with a BSc (Hons) majoring in mathematical statistics, with First Class Honours and a University Medal. He then went to the Australian National University (December 1973–September 1974), initially as a vacation scholar, and later as a postgraduate student. In September 1974 Peter took up a Senior Hulme (Overseas) Scholarship to Brasenose College at the University of Oxford, completing his D. Phil in August 1976 with a thesis entitled *Problems in Limit Theory*. In the same year he was awarded an MSc by the Australian National University (the ANU) for a thesis entitled *Martingale Limit Theory*.

Peter began his academic career as a Lecturer in Statistics at the University of Melbourne (1976–1978). This was followed by positions as Lecturer (1978–1982), Senior Lecturer (1983–1985), Reader (1986–1988) and Professor (1988–2006) in Statistics at the ANU. In 2006 he returned to the University of Melbourne as Professor of Statistics, and from 2012 was Laureate Fellow at that university. Also in 2005 he took up a 25% appointment as Distinguished Professor of Statistics at the University of California at Davis, and visited there annually until his death.

Peter described his research interests as probability and statistics, and within those fields, he worked in many subfields, see the word cloud made from the titles of his publications in Figure 1. He published over 600 papers with over 200 co-authors, and four research monographs. He supervised over thirty PhD students and advised nearly forty postdoctoral fellows. This incredible productivity is just one reason why Peter is so celebrated.

From 1982, Peter was a member of the editorial board, co-editor or editor of many of the world's leading journals in probability and statistics, including this one (member of the editorial board 1999–2011, co-editor 2008–2011). In

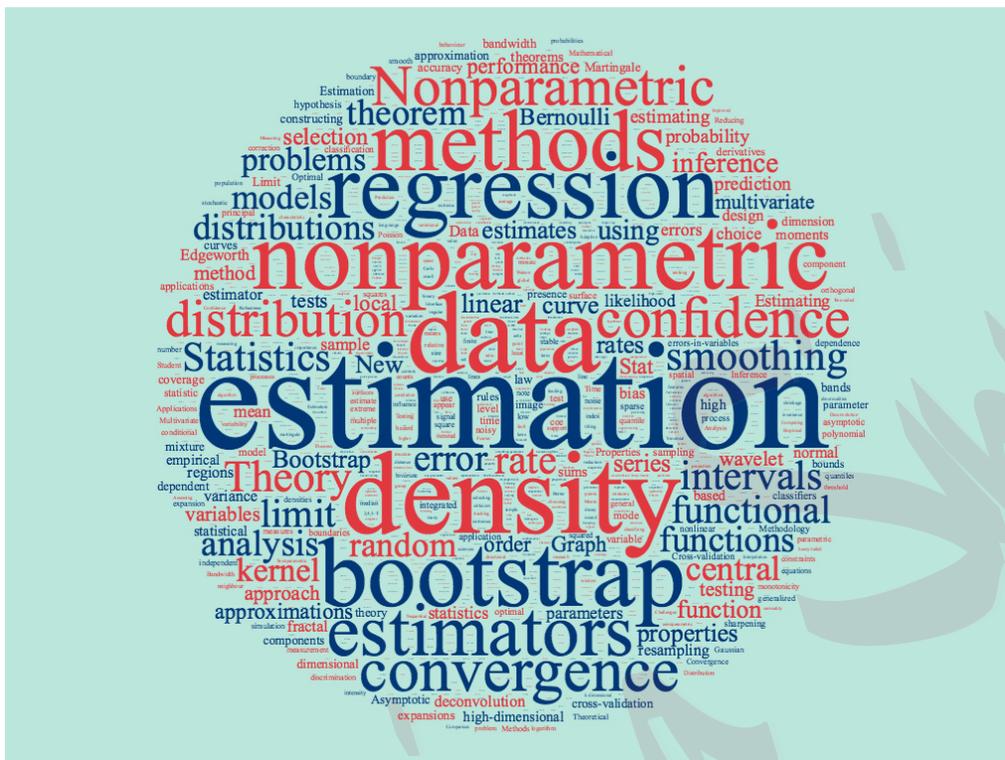


Figure 1. Word cloud from titles of Peter's publications.

addition to his phenomenal research output, and editorial work, Peter demonstrated exceptional leadership in, and gave outstanding service to, Probability and Statistics, the Mathematical Sciences more generally, and Science in general, both through membership of committees, and as an office bearer. See Figure 2. He was active both in Australia and internationally. Over his career, Peter received many prizes, awards and medals, he was invited to present honorific lectures all around the world, he was admitted to the world's most prestigious societies and academies, and he was awarded four honorary doctorate degrees.

For full details of all the items just mentioned, see the supplementary material to Robinson and Welsh (2017), where a complete bibliography and a curriculum vitae can be found.

3. Kind and Gentle Soul

The day after Peter died a memorial website was set up by Professor Song Xi Chen of the Center for Statistical Science of Peking University, on which scores

email, to answer questions and help on problems. This generosity included spit-balling new ideas together, editing, and advice on statistics generally.

Hugh Miller

We remember Peter as extremely conscientious, dedicated, focussed, highly motivated by students and others around him, but also incredibly sincere, gentle, thoughtful with a wry sense of humour. We enjoyed partaking in regular BBQ gatherings that Peter often organised out at the Cotter River (typically) to welcome/farewell new students and/or visitors, and to show them some genuine Australian hospitality and cuisine! We liked how Peter generally took time to stop for morning tea or lunch and would encourage his students along too.

Dave Matthews and Melissa Dobbie

Peter's combination of brilliance and modesty is very, very rare ... particularly in academia.

Ben Selinger

As mentioned above, Peter took on many administrative and leadership roles in statistics, mathematics and science, including terms as co-editor of the flagship journal *Annals of Statistics* (AOS) of the Institute of Mathematical Statistics (IMS) and President of the IMS. Here are tributes by two people who worked closely with him in these capacities, the first from the Executive Director of the IMS, and the second by another former editor and President of the IMS.

Peter was a truly exceptional man. He not only gave to every individual he met, but he also gave to the world as whole. When I would speak with him during his term as IMS President or AOS Editor, he would listen to my input thoughtfully. He would respond with grace and compassion no matter the issue. I can remember sitting in meetings with him, he would listen to what everyone had to say and somehow then fashion the perfect compromise and response. I truly have never known anyone who could do this with what appeared to be such ease and grace. Even more so, he made everyone feel like a dear friend in the process.

Elyse Gustafson

Always mature and always selfless, Peter was often the "adult" in the room.

J. Michael Steele

In 2004 Peter visited a university in the US. Circumstances led to him having to stay overnight at a seedy motel in a rough part of the town. As he was checking

out, the receptionist noted that his bill was to be paid by the mathematics department at the university, and asked him “*What sort of mathematics do you do?*” Peter replied “*I do statistics, and probability theory.*” The receptionist then asked him “*Do you know anything about martingales?*” Recounting this story later in an article in the Australian Mathematical Society Gazette, Peter said he almost fell over, but answered “*As it happens, I do know a little. I’m amazed that you ask. Why do you want to know?*” The receptionist wanted to understand how they were used to model the fluctuations of stock prices. An extraordinary discussion ensued. Peter ended this heart-warming story as follows:

When I finally departed for the airport I felt more uplifted and inspired than I had been for a long time. I had gained a far better impression of this little motel than I had believed was possible. And my impression of the receptionist had soared. Here, among the dust in the backblocks of this college town, I had found a diamond.

Hall (2004)

4. Peter’s Passions Outside Probability and Statistics

Peter had several passions unrelated to his work: for cats, railways, photography (photographing trains in particular), aviation, and for the Australian bush. He spoke in detail about some of these in Delaigle and Wand (2016).

His high school friend Dr Roger Renton wrote in the PKU tributes:

Peter had a small close knit group of friends at school, several of whom shared his passion in railways. Camping beside the railway line in the Newcastle area to photograph steam trains was a regular school holiday highlight for us both. An early mentor was Robert Booth, his Science teacher at high school for several years, who was also one of Australia’s foremost steam train photographers.

Peter’s passion for railways never diminished. He chased and photographed trains throughout his life. For more evidence, see Steve Marron’s memorial webpage, Marron (2016). He was a subscriber, since childhood, to the *Railway Digest* (and its companion *Australian Railway History*), a monthly magazine published by the Australian Railway Historical Society (NSW Division). He also subscribed to *Flight International*, which kept him up to date with the latest in world aviation. This helps make sense of an incident Professor Rudy Beran recalled in the PKU tributes:

Strolling in Davis, chatting about random topics, Peter and I heard

an aircraft high overhead. I looked up and saw a large airplane. Peter looked up and saw a military cargo plane, identified the model, its possible configurations and cargoes, and noted it was gliding to a landing at the airforce base some distance west of Davis. Then we returned to our previous topic.

Peter also had a keen interest in current affairs and politics. He was an avid reader of *The Economist*, reading it from cover to cover, especially when he was travelling, to keep himself abreast of the news, and he liked discussing politics.

Although it is hard to imagine, given his prodigious research output and commitment to many other aspects of statistics, mathematics and science, Peter was a ferocious reader (Jeannie Hall's term) of books unrelated to his work. He particularly liked historical and biographical works, especially ones related to the grand events and themes in human history (wars, battles, voyages, crusades, plagues, slavery, justice), but also science and engineering. Unsurprisingly, he also had hundreds of books on steam engines, railways, rail history, aviation and photography.

When he had visitors to the ANU, and later Melbourne, Peter would take them on trips into the countryside, frequently to the Tidbinbilla Nature Reserve and the Cotter River outside Canberra, or to the Puffing Billy Railway in the Dandenong Ranges outside Melbourne. Naturally this was greatly appreciated by his visitors. For Peter it was not only his being an attentive host, it was sharing his passions with others.

5. Citizen Hall

One of the reasons Peter gave for spending his career in Australia was that he had "*a strong interest in Australian history, government and politics.*" His interest was not in party politics but rather in being a good citizen. He said: "*I've always had a strong feeling that when things are not right you should try to fix them.*" The following three examples illustrate his efforts in this direction. His contributions to professional committees and reviews provide many further examples.

Peter's high school (1964–1969) and undergraduate (1970–1973) years overlapped almost perfectly with Australia's involvement in the Vietnam war (1962–1972). He was opposed to the war, and went to marches and demonstrations against it while at high school and university. He spoke about this at some length in Delaigle and Wand (2016). A few years after the war ended when Peter

was a lecturer at the ANU, he got involved in one of its legacies, Agent Orange. This was a herbicide and chemical defoliant widely used in the war to remove forest and crop cover for North Vietnamese and Viet Cong forces. The chemical caused major health problems for many individuals exposed to it. After the war ended, there was much controversy and many lawsuits over the extent to which it was responsible for the ill health of veterans on both sides, of civilians from Vietnam, and of other exposed individuals around the world. At the ANU Peter had become friendly with Professor Ben Selinger, a chemist a few years his senior, who had grown up in Sydney just a street away from him. Selinger wrote:

My father had insisted that I should study some statistics at Sydney Uni but I never really understood it till I met and worked with Peter. . . not only did we publish hybrid stats/chemistry academic papers but in the late 1970s went on a scientific crusade to help the Vietnam vets and Australian council workers with their fight to establish (statistically) the probable illness causing effects of Agent Orange. At the Bureau of Stats we uncovered that post use in Vietnam, a large surplus had been imported into Australia, destined for agricultural and council weed control use. Revealing this resulted in much local media exposure and a couple of papers in *Nature*. We chanced upon a sample held by a bureaucrat and connived to have it analysed by the government. Result? Very high levels of dioxins, a most dangerous impurity. I then left Peter in the lurch to face a probing Senate inquiry on that issue while I was happily ensconced on a sabbatical in Ottawa. But only a fax or twenty away!

In a 2005 Canberra Times opinion piece entitled *Lies, damned lies and the deft application of spin* about the Australian Federal Government's 2004–05 Innovation Report, Peter was scathing. The Report's executive summary, he said:

will make uplifting bedtime reading for the nation's scientists, mathematicians and engineers, who apparently have seldom had it so good. Despite accounts to the contrary, Australia seems to be fortunate that the state of its innovation in science and technology is so healthy.

He pointed out that the figures inside the Report told quite a different story from the summary, and the Report left unmentioned other important statistics. Peter went on:

. . . the fall [over the last decade] in the number of university teachers

of physics, chemistry and mathematics is alarming. . . (For example, in the mathematical sciences the figure is 38 percent.) Discussion of the implications of this decline is notable for its absence from the Innovation Report. . . You might conclude that the Innovation Report's executive summary puts a disingenuous, deceptive spin on data that the body of the Report correctly characterizes as giving cause for concern. Certainly Australia's performance in science, mathematics and engineering has its highlights, which we should celebrate. But more than a few of the trends are worryingly negative.

At the time Peter wrote this opinion piece, he was the Chair of the Scientific Advisory Committee of the Australian Mathematical Sciences Institute.

In 2006 he wrote a letter to the *Australian Financial Review*, contributing to public debate about the proposed Research Quality Framework (RQF), an initiative of the Australian government for formulating a framework for assessing research quality and impact. Drawing on UK's experience, Peter pointed out the very real threat posed by the RQF to diversity, as RQF assessments could lead to reduced funding for or closure of areas of research that were not immediately attractive or did not have a sufficient profile. He wrote:

In an era where the frontier fields of science are becoming highly multidisciplinary, reduced diversity is bound to have negative consequences. . . You can't have a stable, functioning forest comprised entirely of tigers: you need the rest of the ecosystem as well. The RQF aims to eliminate all but the tigers.

6. Powerful Mind

6.1. Early years

A recollection by Dr Roger Renton gives us a sense of Peter's high school mind.

He was a deep thinker, not a rote learner like most of us! He could derive algebraic theorems from first principles, and scared the life out of his friends when he advised us that this was required as part of the Maths curriculum – no doubt an interpretation conveyed to him by his mother, who at that time was a secondary school Maths and Science teacher¹. He often challenged commonly held beliefs, and had a low

¹Ruby Payne-Scott was a physicist and member of a pioneering group of radar scientists before she

tolerance for sweeping generalisations. . . He developed a tactful way of letting the Maths teacher know when a mistake on the blackboard had been made – a strategic low cough! The teacher took it in good heart and came up with the memorable line “*If I was as good at Maths as you are son, I wouldn’t be out here trying to teach you lot!*” Peter also gave credit where it was due, and if the teacher was “on a roll” solving an equation, Peter would be heard to say “*Look at him go!*”

From the University of Sydney where Peter did his bachelor’s degree (with honours), Professor John Robinson wrote:

It was clear that Peter was quite an extraordinary student. He was the only fourth year honours student in his year and Malcolm Quine and I decided that we should take the opportunity to learn some new material while giving Peter a couple of courses that would stretch him. We read with him Billingsley’s *Convergence of Probability Measures* and *Theory of Rank Tests* by Hajek and Sidak. I think these stretched us more than him but it was very useful.

Below we learn that Peter met Kai Lai Chung’s book in another reading course, and that firmly set the future direction of his research.

Peter’s trip to Oxford and his independence in research once there are well described in Delaigle and Wand (2016), and Robinson and Welsh (2017). Here we add an interesting recollection by Professor John Biggins, who at the time was one of his officemates in Oxford. It tells us a lot about Peter’s powers of concentration and his epsilontics.

I remember when he got the report on his MSc thesis [*Martingale Limit Theory*] which raised a question about one of the proofs. Those of us in the room at the time detected his anxiety. He went out for a walk and came back a few hours later and said “*it’s all right, I just have to take epsilon half what it was*”.

Around that time Peter visited the Statistical Laboratory in Cambridge to give a seminar. He was introduced to (now Professor) Andrew Barbour by Professor David Kendall as “Mr Martingale.” The name didn’t stick.

6.2. Where did Peter’s research inspiration come from?

Initially he was stimulated by probability books read during his undergrad-

 had Peter. She was the world’s first woman radio astronomer. See Chapter 6, Goss (2013).

duate degree, and soon afterwards, by direct interaction with Australian probabilists and statisticians. Around the time he became committed to theoretical statistics, the revolution of computer-intensive statistics was taking place, and Peter willingly joined that. Later still, he took on the role of consultant, and had many practical problems needing theoretical attention presented to him. And naturally, as his reputation grew, colleagues, collaborators and visitors brought problems to him.

In the two conversations and in Hall (2014), Peter recounted how much he loved Kai Lai Chung's book *A course in probability theory*, and how that book led him to want to do research in probability theory. Translating Chapter 8 entitled *Questions diverses relative sommes de variables enchainées* of Paul Levy's book *Théorie de l'addition des variables aléatoires* into English only strengthened this resolve. Upon arriving at the ANU, initially as a vacation scholar, and later as a postgraduate student, he was in turn inspired by Professor Pat Moran and Dr Roger Miles to work on questions of geometric probability, and by Professor Chris Heyde to work on martingale limit theory. That both of these exposures led to research monographs: *Martingale Limit Theory and its Applications* (with CC Heyde, 1980), and *Introduction to the Theory of Coverage Processes* (1988), is clear evidence of Peter's willingness to dive into a research area, and, once there, his ability to obtain definitive results in that area. He later remarked that yet another thread of his future research, kernel density estimation, was stimulated by a visit to Canberra of Professors Eve and Vic Bofinger. Eve had written a paper about kernel density estimation, and Peter saw that "*it was all just sums of independent random variables.*"

When he was working at the ANU, Peter was also very much influenced by Professor Ted Hannan. He was very close to Ted, and regarded him as a mentor and a father figure.

In the section entitled *Joining the revolution* in Hall (2014) Peter wrote:

I already had a strong interest in rates of convergence in the central limit theorem, and in distribution approximations. That gave me a way, in the 1980s, of accessing theory for the bootstrap, which I found absolutely fascinating.

All these methodologies – function estimation, particularly techniques for choosing tuning parameters empirically, and of course the bootstrap – were part of the “contemporary nonparametric” revolution in the 1970s and 1980s. It took off when it became possible to do the

computation. I was excited to be part of it, even if mainly on the theoretical side.

Later in his career, Peter became a consultant with Australia's CSIRO, and there he was challenged with many practical statistical problems. One of those concerned the fractal analysis of surface roughness. As he said in Delaigle and Wand (2016):

I am actually very interested in applications and very interested in solving mathematical problems.

This dovetails nicely with the impression Professor Daryl Daley gave about Peter:

Unquestionably, his great strength lay both in algebraic manipulation and in posing/phrasing problems in general settings.

6.3. Peter's work practices and impact on young researchers

In order to achieve what he did, Peter had to be incredibly well-organized and highly disciplined. He started off his career with a routine which was roughly this: devote Monday to Friday to research, Saturday to driving to a good spot to photograph a particular train in a particular location, and Sunday to editorial, refereeing and other administrative tasks. Over time, his Saturday respite from work progressively diminished to the point where in his later years he virtually worked non-stop throughout the week. The only concession he made was an hour or so at the gym up to three times a week – a routine that Jeannie enforced on him from the late 1990's. Even then, he temporised, much to Jeannie's disgust, by taking work to the gym to do in between exercises or while he was on the treadmill or exercise bike.

As well as being well-organised and disciplined, Peter was very fast: quick to respond, quick to solve what were for him straightforward problems, and quick to write them up. There was an innate impatience and an urgency to get things done immediately. Here are some recollections by his students, postdocs, collaborators and colleagues.

I sent Peter an enquiry about studying with him at 9:25AM, Friday Dec 1st 2006. His reply, sent at 9:28 [AM], Fri Dec 1st 2006, was encouraging. ... When I arrived [for our first meeting] he presented me with a sketch of what would become our first paper, and spent

an hour going through how the theory, discussion and numerical work would all fit together. Every time a task was completed he always had another up his sleeve, as if he constantly carried a list in his head of good ideas that had not been converted to a paper. Hugh Miller

I needed to find a referee for peer review. The contribution was closely related to one of Peter's work. . . I wasn't sure if Peter had time to take a look. . . I sent an email to Peter . . . if he could not provide a review. . . we would appreciate it if [he] could suggest an alternative reviewer. . . The email was sent out around 2 a.m. Pacific Time. I wasn't sure where exactly Peter was at the time. Then, within 10 minutes and to my total surprise, Peter replied, with a full-page referee report! Jiming Jiang

We were discussing the problem around 5pm one afternoon – we already had some preliminary results about the rate of convergence of the estimator we were considering, but the question was whether that was the optimal rate of convergence. Peter thought he knew how to do it and promised to look at it. I next saw him at 9am the next morning – in the few hours between our two meetings, he had not only got a result but had fully written it up, complete with regularity conditions and all details of the proof. After that, I was at a bit of a loss to know how I could make a contribution to the paper – in the end, I think I contributed enough to justify being listed as second author, but there was no doubt that the main impetus behind the paper was his. I suspect that many of his collaborations were like that, papers with students or more junior colleagues where Peter contributed at least his full share of the work if not the main ideas behind it. Richard L Smith

Eulogies will describe Peter's amazing contributions to science, and how he helped generations of young statisticians to launch their academic careers. I was one of them. I remember vividly the first time I saw Peter put together a paper – back then, in 1991, he wrote "Introduction" with his fountain pen onto the first page, and then proceeded to write out section after section, with only a few words crossed out here or there. Peter's legacy is that he brought civility to the competitive world of science. He was a star, but incredibly generous with his time, his advice; with kindness and patience. Birgit Grund

Other examples of Peter's quick responses can be found in the public tributes, and, most remarkably, the story of how his book on coverage processes came to the publisher, told in Robinson and Welsh (2017).

Insight into Peter's attitude to research can be gained from his talk Hall (2013), a talk aimed at imparting his own experience to young statisticians. On *Originality* he wrote:

Originality, novelty, innovation, creativity, nonconformity – call it what you will, originality is one of the main ingredients of excellent research. It is more important than technical correctness.

Try not just to find a research problem in your field that no-one else has tackled. Try to look in a genuinely new direction, one that nobody has considered before.

Of course, this can be very difficult, and you may not manage it more than a few times in your career. But it should be your aim, the main goal of your scientific work.

In particular, it should be your main goal when you look for a problem on which to work, even if you don't always manage to achieve it.

On *Locating the literature*, he wrote:

I remember discussing some of these issues with a colleague, G.S. Watson, many years ago. We agreed that there is an optimal time at which one should search the literature for related work.

Searching too early means that you might be too influenced by work of other authors, and that the originality of your work might therefore be less. Searching too late might mean that you discover relatively late that your proposed approach is too close to one that has been considered already, and that you have wasted time developing it.

On *Getting it all wrong*, he wrote:

Ben Selinger, a retired ANU chemist with whom I have worked, once confided to me that only when everything seems hopeless, and he has discovered that all his preconceptions and arguments are wrong, does he know that he is on the verge of discovering how everything works.

Those words also capture very well my own experience, on many occasions, of the process of research. The best research is far from a linear process.

Failure is an intrinsic part of the scientific process. It teaches us new things about our field, and that is always good. When everything we are doing is going wrong, and we have to understand why and fix the problems, we are learning more than when everything is working out as we expected.

You should remember these words when you discover that your ideas don't work as well as you had anticipated, or that someone else has already had the idea that you thought was yours, or when a journal rejects your work.

There is much more of interest in this talk, including *Reading the literature*, *Discovering the environments that are most conducive for difficult tasks*, and *Discovering good places to think*.

6.4. What drove Peter to work so hard, and to be so prolific?

This question was raised with him several times. Here is one example.

I asked Peter why he worked so hard and he told me that he could not help himself. He said that he had a devil on his shoulder continually pushing him to produce. One reason he gave was that he was stressed by the lack of security connected to his fixed-term appointment [1976–1978] at Melbourne.

Geoff Eagleson

He gave much the same answer to the same question in Delaigle and Wand (2016). But Peter found the security he sought in September 1978, when he took up his tenure-track appointment at the ANU. And just 10 years later, in September 1988, Peter received a letter from Professor Brad Efron, which said in part:

According to [the *Econometric Theory* article], you are the most productive statistician in the entire known universe. I am second, but my role in the article is mainly to show how far ahead of the rest of us you are!

Peter's productivity remained extremely high for almost thirty more years. I think we must search for another explanation of Peter's extraordinary industry. In fact, it predated his 1976–1978 Melbourne experience. Mathematics Professor James Oxley was a friend of Peter's from his short period as a postgrad at the ANU, and also went to Oxford for his DPhil, and so knew Peter there. He wrote:

Peter was a prodigiously hard worker and completed his doctorate in just two years.

However, Peter's astonishing capacity was evident even before Oxford. As revealed in Delaigle and Wand (2016) and Robinson and Welsh (2017), Peter's MSc thesis was completed in something like six months in 1974 before he left for Oxford in September that year. It was held over for submission until 1976 in order to comply with the university's enrolment requirement. This is why his MSc and DPhil were awarded in the same year, 1976.

I suspect we will never be able to understand fully why Peter was so incredibly driven, as if he was in a race against time. Professor Geoff Eagleson speculates as follows:

Another possible reason for Peter's focus on publishing could have been the fact that his mother died when relatively young after a fast onset of Alzheimer. Peter may well have been concerned that he did not have much time to prove himself.

Jeannie Hall offered this perspective:

Peter once told me that he was asked by a teacher at school what he would like to be when he grew up, and he said "a research scientist". His mother's influence was obvious. But Peter also inherited her single-mindedness, determination, and stubbornness. There was a thirst for knowledge and perfection, and an overwhelming, and impatient, need to master anything that he tackled, be it photography, understanding of aviation technology, or his first and foremost passion, research. This was what drove him. The motivation to strive relentlessly for new understanding and new knowledge came from within him. His life experiences might have spurred him on. But ultimately, the fire came from within him.

6.5. Peter's credo

In my view the clearest statement of Peter Hall's mature statistical credo came from the summary of a paper entitled *The Mathematics of Food Wrap and Stealth Aircraft* which he presented at the National Mathematical Sciences Symposium at the University of NSW on 23 February 1996, and I quote from there, Hall (1996).

I am a statistical scientist, working mainly on theoretical or “methodological” aspects of practical problems. Many real problems can be answered in a “one-off” way, solving the particular case that is of immediate interest and then passing to the next task. However, if related problems are going to be posed in the future then this “one-off” tactic is usually not the best way to proceed. We need to develop a general method – a strategy, or a *methodology* – for solving problems of the same type, and develop it to the point where we can apply it in a range of situations.

The specific, problem-focussed approach is sometimes referred to as *tactical research*, while the more generalist approach is an aspect of *strategic research*. I am going to discuss several examples of problems that are best solved through strategic research. In each, mathematical techniques are employed to obtain a broad understanding, and to suggest general methods of solution. The insights gained in this way are applied to produce problem-solving methodologies that have wide application.

6.6. A lasting concern

One theme that came up repeatedly in private discussions with Peter was his concern that institutional support for theory seemed to be declining. He spelled it out in Hall (2014) as follows:

I’m not troubled by them [changes in the nature of statistics as a discipline], except for the fact that they can make it more challenging to get funding for positions in statistics, and more generally for research and teaching in the field. Indeed, it is not just in Australia, but across the globe, that the funding pool that is notionally allocated to statistics is being challenged by many different multi-disciplinary pressures, to such an extent that financial support for core research and teaching in statistics has declined in many cases, at least relative to the increasing size of our community.

Funding is flowing increasingly to collaborative research-centre type activities, where mathematical scientists (including statisticians) are often not involved directly at all. If involved, they are often present as consultants, rather than as true collaborators sharing in the funding. This is the main danger that I see, for statisticians, in the diversifica-

tion of statistics.

6.7. Full circle

Peter started his career as someone whose scientific passion was for “mathematical things”, in particular, for limit theorems. In his two conversations and in Hall (2014), he described his transition from a probabilist to a theoretical statistician, suggesting that it was largely driven by his desire for secure employment. In a 1977 letter written to Professor CR Heathcote, then Head of the Department of Statistics at the School of General Studies of the ANU, in support of his application for a lectureship in applied statistics there, Peter said:

I believe that I have a very good background in probability theory and mathematical analysis, and that this could be most profitably used in the theory of statistics rather than in its applications.

Peter was appointed, and we all know the rest of the story. Around the same time, he wrote:

In the four years since I commenced my M.Sc. my research has shown a trend towards more applied probability theory.

This anticipates an ironic postscript. In Hall (2014), Peter made the following observation:

It is curious that the mathematical tools used [earlier in his career] to develop statistical theory were regarded firmly as parts of probability theory in the 1970s, 80s and even the 90s, whereas today they are seen as statistical. . . . Convergence rates in the central limit theorem are viewed in the same light. Indeed, most results associated with the central limit theorem seem today to be seen as statistical, rather than probabilistic. (So, I could have moved from probability to statistics simply by standing still, while time washed over me!)

6.8. Peter’s own conclusions

In the two conversations, Peter was asked what he regarded as his most important contributions, and which gave him the greatest sense of accomplishment. With over 600 papers and 4 monographs to choose from, his answers are interesting.

I still remember very fondly my work on the rates of convergence in the central limit theorem which I did in the late '70s and early '80s.

I think my work on continuum percolation has been a little more influential.

My work on martingales, at least through the book with Chris Heyde, has been influential, with my own personal results on martingales as really just bricks in the wall.

My work on the bootstrap is the work of which I'm most proud.

Probably my work on fractal properties of surface roughness has pleased me the most.

Acknowledgment

I would like to extend my thanks to Bin Yu, Karl Broman and the editor, Qiwei Yao, for their comments on a draft of this paper, to all the people I have named and quoted in it for their essential contributions, and most of all, to Jeannie Jean Chien Hall for her encouragement and assistance.

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(Received ; accepted)