PETER GAVIN HALL: 1951 – 2016

Hans-Georg Müller[1,2]

Peter Gavin Hall was born on November 20, 1951 in Sydney, Australia. He grew up in a suburban area of Sydney, where he went to high school and then completed a bachelor of science at the University of Sydney in 1974, after which he received a M.Sc. in Mathematics from the Australian National University in Canberra, and a DPhil from the University of Oxford in the U.K. in 1976.

Peter was an eminent scientist with a most distinguished career as a mathematical statistician. He received all major honors that statistics bestows, and more, including Foreign Associate of the National Academy of Sciences (USA), Officer of the Order of Australia, Fellow of the Royal Society of London, the Guy Medal in Silver, the Samuel S Wilks Memorial Medal, the Gottfried E Noether Senior Scholar Award for Nonparametric Statistics, and the COPSS award, among numerous other awards and fellowships in various academies. He received honorary doctorates from the Université Catholique de Louvain, Universidad de Cantabria, University of Glasgow, and University of Sydney. His service to the profession was equally distinguished and included terms as President of the Bernoulli Society, of the Institute of Mathematical Statistics, and of the Australian Mathematical Society, as well as Co-Editor of the Annals of Statistics and of Statistica Sinica, along with many other high profile appointments.

Peter's mother, Ruby Payne-Scott, was a distinguished radio astronomer (Goss and McGee, 2010), who published in *Nature*, while his father, Bill Hall, worked as a telephone technician. His mother was employed at the Australian research organization CSIRO and was politically left leaning. Discrimination against women at the workplace was openly practiced at the time, and when she was pregnant with Peter she had to leave CSIRO, as it was against the law for a married woman to be so employed. Peter is survived by his wife, Jeannie Hall, who worked in high profile positions for the Australian government for many years, and his sister, Fiona Hall, who is a famous artist in Australia and like Peter, received the honor of an Officer of the Order of Australia.

[1]Department of Statistics, University of California, Davis, One Shields Ave., Davis, CA 95616, USA

[2]This is a modified version of an obituary that has appeared in Bernoulli News in April 2016.



Peter Hall in his office at UC Davis, while visiting in the Fall of 2003, after which he joined the Department of Statistics as a part-time faculty member (Photo taken by Jane-Ling Wang).

Peter's entry into the field of Statistics followed a circuitous path. As an undergraduate, he was initially interested in physics, then mathematics and for his graduate research he chose to work in probability. An extended version of his master's thesis on martingale limit theory was published as a book (Hall and Heyde, 1980). He met his wife Jeannie in Oxford while he was working on his PhD thesis advised by John Kingman. Jeannie and Peter married in 1977, and subsequently Jeannie had various high-ranking positions in the Australian government. After completing his DPhil in 1976, Peter moved back to Australia and accepted an offer from the University of Melbourne. Peter did not receive tenure at Melbourne, undoubtedly one of the worst tenure decisions in the history of statistics! So in 1978, he moved to the Australian National University (ANU) in Canberra, where he stayed until 2006, when he moved back to the University of Melbourne. When he accepted the position at the ANU, he was told that he would have to move into statistics. This requirement may have been a major reason that Peter became a statistician.

In his later years, Peter had his positions funded by prestigious Australian fellowships, which allowed him to focus more on his research. After visiting in 2003-4, he accepted a 25% faculty position as Distinguished Professor at the Department of Statistics at UC Davis and joined the Davis faculty in 2005. Peter would reside in Davis every Spring quarter and would teach two courses every second Spring. The courses he taught were upper division undergraduate probability and a special topics graduate course on the bootstrap. He liked Davis for its character as a small university town,

climate, the department, and as a good basis for traveling within the U.S.

Peter's commitment to both his research and the profession was legendary. Many of those who had the privilege to know Peter realized that he was the hardest working scientist they would ever encounter. Upon discovering that statistics was the field he was most interested in, Peter devoted all of his inexhaustible energy to it. He would often create a complete and complex theory within days after learning about a problem that interested him. In the process, he would typically produce an almost final error-free write-up that did not require much further editing.

He has written more than 600 papers, most of which appeared in top journals, and thus has been the most productive scientist in the history of statistics. In his later career, he would increasingly write jointly with other researchers. Statisticians whom he met during his numerous and frequent travels would bring a problem to his attention and Peter would devise methodology and theory to address it and provide the core of the writing. Peter's typical approach was to take up those problems for which his sophisticated tool kit would be useful. He would often mold a given problem in a way that it became amenable to the formidable mathematical and probabilistic tools that he mastered; this enabled him to propose solutions to many pressing problems that had proven difficult.

Peter established his reputation in statistics with early work on the bootstrap in the 1980s, where he made seminal contributions and wrote several influential papers, for example on bootstrap confidence intervals, the block bootstrap for dependent data, and the double bootstrap, just to name a few. He also wrote an introductory textbook on the bootstrap (Hall, 1992) and when he joined UC Davis in 2005 as a part time faculty, he elected to teach a graduate topics course on the bootstrap every second year. He had an excellent rapport with the graduate students in Davis and his course was always well attended. His fondness for the bootstrap evolved in later years into work on empirical likelihood, where he employed the method of distribution tilting to many problems that came to his attention.

Another area of Peter's early work was nonparametric curve estimation in all its facets, notably density estimation and the estimation of conditional distributions and quantiles, where some of his most influential work dealt with various theoretical aspects of bandwidth choice, and also characterizing the stochastic behavior of deviation measures such as integrated squared error. His work in this area included influential papers on variance estimation in nonparametric regression and the treatment of boundary effects. Notable is also his early work on the estimation of ridges and modes, an area that recently has become fashionable.

Peter worked on an incredible number of problems in diverse areas that include point processes,

time series, extreme values, quantification of the roughness of surfaces and small area estimation, among others. In addition to bootstrap, empirical likelihood and curve estimation, another focus area of Peter was deconvolution and errors in variables. In this area he quickly became a leader. With his collaborators he investigated a multitude of models and schemes for this inherently difficult problem. More recently he devoted some of his efforts to high-dimensional data analysis, where in a seminal paper he studied the linearity of random projections and where he also investigated the selection of variables and interactions in high-dimensional regression problems.

In recent years, Peter developed a new research focus in functional data analysis, which he approached from a theoretical perspective. His work in this area was ground breaking, and he was able to introduce new perspectives and work out challenging expansions and arguments due to his mathematical and probabilistic background. His pioneering work includes a new approach for the theoretical analysis for functional principal component analysis in both the fully observed and sparsely sampled scenarios, theory of estimation and prediction in functional linear regression, the selection of optimal predictor points in functional regression, a functional version of partial least squares, a study of the density problem in function space, and various functional classification methods, where he introduced the concept of a perfect classifier in the context of functional data. His work in this area alone would have been sufficient for a distinguished career.

Peter was always inclined to travel and along the way encounter new problems to work on. He thrived on traveling and was uniquely able to not let exhaustion, jet lag or other inconveniences impede him in any way. He had the unique ability to hold many complex terms of a higher order expansion simultaneously in his working memory, juggle these terms in his mind and in real time obtain results that he wrote as they emerged. He seemingly could pause this process at will for a brief e-mail or office distraction, which would not throw him off his mental thread; he would simply pick up where he had left the argument, without apparent need to recollect his mind. Many ordinary statisticians working with pencil and paper would require undisturbed time to work out the argument term by term, would make mistakes along the way, and then would need extra time to reconcile the various terms and to recheck everything multiple times.

A characteristic of Peter was his humility and kindness to others. He was not just superficially friendly, but treated those around him gently and with genuine respect, be it staff, students, or colleagues, who liked and admired him. He was well known for mentoring young researchers and supporting their careers. He advised a large number of PhD students and always had several post-

docs working with him. Even while he was working hard, often simultaneously on various things demanding full concentration, he rarely if ever betrayed any outward sign of impatience or irritation, even when intrusions distracted him from his work. He regularly attended the faculty meetings in Davis when he was in residence, where his presence had a welcome calming effect and improved the quality of discussions and decisions.

Conversing with Peter was always a pleasure and usually illuminating, as he had wide ranging interests that included all aspects of statistics and also mathematics, politics, economics, and science, especially the hard sciences and engineering. But the topics most dear to him were trains, primarily non-electric trains and especially steam trains, as well as airplanes, aeronautic engineering and piloting. He knew everything about various plane models and their features, and whenever a plane crash happened somewhere, he would provide an insightful analysis. It is likely that he would have become an extremely successful aeronautic engineer if he would not have become a probabilist and statistician. It was most fortunate that his calling was statistics.

Peter's main hobby was photographing, for which he had great talent. His favorite motives were landscapes and trains. He knew everything about cameras and their optics and his photos were often impressive. Since the most convenient way to move around in Davis is bicycling, Peter bought an old, not particularly fancy used bike, which he used for shopping and commuting to the office. One day he came to my office and told me that he was (uncharacteristically for him) stuck in the middle of a difficult proof and that he needed to take some time off. He wanted me to help him find a good spot from where to photograph trains. So off we went with our bicycles over dirt roads in the agricultural fields surrounding Davis. Eventually we found a place right next to the tracks that was to Peter's liking. He then would spend hours at this strategic spot to wait for interesting locomotives and trains to zip by so he could photograph them. While he complained that the trains were (unsurprisingly for U.S. standards) not following the schedules he had found on the internet, this hunting for photo-worthy trains and locomotives nevertheless did help him break the impasse with his proof.

Peter passed away on January 9, 2016 in Melbourne, Australia. He will be missed as a great friend, caring mentor, good colleague and leader of modern statistics.

Acknowledgments

I am indebted to Aurore Delaigle and Matt Wand for making available a preprint of their informative article on a conversation with Peter Hall that is to appear in Statistical Science (Delaigle and

Wand, 2016), from which I have borrowed heavily. I also wish to thank Raymond Carroll for sharing a talk he gave in remembrance of Peter Hall, and Rudy Beran, Aurore Delaigle, Jeannie Hall and Jane-Ling Wang for sharing personal reminiscences.

References

Delaigle, A. and Wand, M. (2016) A conversation with Peter Hall. *Statistical Science*, **xxx**, xxx–xxx.

Goss, M. and McGee, R. (2010) *Under the radar: the first woman in radio astronomy: Ruby Payne-Scott*. Springer Verlag.

Hall, P. (2013) *The bootstrap and Edgeworth expansion*. Springer Series in Statistics.

Hall, P. and Heyde, C. C. (2014) *Martingale limit theory and its application*. Academic Press.