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Renfrey Burnard Potts 1925–2005

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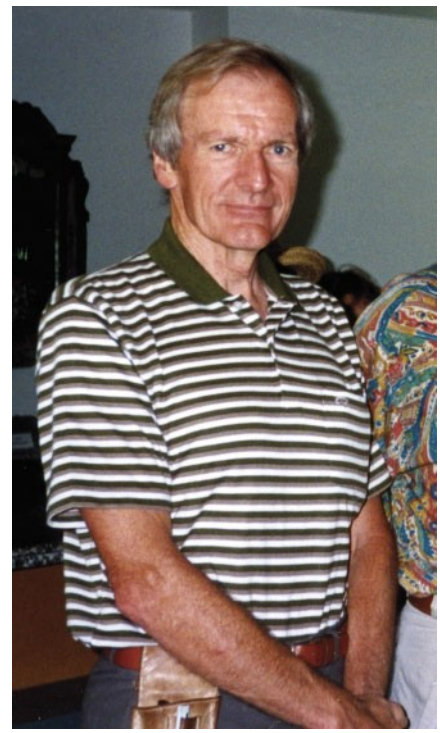
Ren Potts was an Australian applied mathematician whose early work in statistical mechanics later became influential: the 'Potts Model' became his most cited work. As Professor of Applied Mathematics at the University of Adelaide for thirty years, he built up an excellent Department of Mathematics and had a major influence on the development of Applied Mathematics in Australia. His work in transportation science and operations research is well known. Ren Potts was a gifted teacher and an inspiring research leader. He was an early advocate of close co-operation between academia and industry, was an early adopter of computing for research and teaching, and was a pioneer in forging new links between Australian universities and the South-East Asian region.

Introduction

Ren Potts was Professor of Applied Mathematics at the University of Adelaide for thirty years. He was an enthusiastic and inspirational teacher who encouraged several generations of students to pursue higher studies in applicable mathematics. He made research contributions in mathematical physics, transportation science (for which he was a joint winner of the Lanchester Prize for Operations Research in 1959), operations research and difference equations. He was appointed an Officer of the Order of Australia in 1991 after his retirement from the university. He was elected a Fellow of the Australian Academy of Science in 1975 and a Fellow of the Australian Academy of Technological Sciences and Engineering in 1983.

His early research was in statistical mechanics and produced the 'Potts Model', which later became his most cited work.



Early Life and Education

Renfrey Burnard Potts was born in Adelaide on 4 October 1925, the fourth of six children of Gilbert Macdonald Potts, a school teacher, and Lorna Emilie Potts (née West), a homemaker with a strong personality. The six children were alternately given the second names Macdonald and Burnard (names from each side of the family); Ren was named after a Dr Renfrey Burnard, one of his mother's favourite cousins.

Ren grew up in Rose Park, an inner Adelaide suburb. His mother came from the large West family (which included six University of Adelaide graduates), the social centre of which was a house belonging to his grandfather less than a kilometre away. Ren therefore grew up

surrounded by uncles, aunts and cousins, as well as his siblings. His was a Methodist family (his father was a lay preacher in the Methodist Church), with no alcohol and with church and Sunday school on Sundays, but he had a relaxed and happy childhood. His extended family and easy friendships meant that he had connections in many parts of South Australia and he was able to make several long trips by bicycle with school friends to various parts of the state.

At the age of five, Ren started at Rose Park Primary School, less than 100 metres from his home. He stayed there for four years and, in later life, remembered a grounding in learning and testing. For the last years of primary school, he transferred to Prince Alfred College's preparatory school, less than two kilometres from home. Here he encountered smaller classes but a more casual attitude to study and testing. His academic promise showed through early: he was dux of the preparatory school, twice in fact because the school was extended by a year after what would have been his final year.

At the age of 12, he entered the senior school of Prince Alfred College. The College, founded by the Methodist Church in 1869, is a prestigious independent school for boys and an Adelaide institution. Ren's father, nicknamed 'Gimpy' by the pupils, had been a teacher at the school since 1919; he stayed for 42 years, served as Second Master for many years, and became a well loved college institution. Ren was therefore very much at home at Prince Alfred College and took full advantage of what the school had to offer. He was encouraged in mathematics by a teacher, 'Spenny' Williams, who was gifted and enthusiastic and took advanced classes, but he found that the teaching of English did not inspire or prepare the pupils well for the public examinations.

As was common at the time, he repeated the final year of school leading up to the Leaving Honours public examinations, coming second in the college and winning the mathematics prize. In the public examinations, he did well in Mathematics and Physics and finished in the top twelve in South Australia, thereby gaining a scholarship to the University of Adelaide.

At the end of 1942, when Ren finished high school, the war situation for Australia was very serious. Ren had joined the Air Training Corps at college and was hoping to enlist in the Air Force. He had suffered for some time from osteomyelitis in the upper left arm, however, and was unfit to serve. The Manpower Authority then directed that he enter university to undertake a crash course in engineering before joining the army. He had originally nominated medicine as his field of study but only because it was the most expensive, and he had no intention of becoming a doctor. Engineering, though not appealing, at least permitted him to undertake second-year mathematics and physics courses in his first year. He did well in these subjects but found many of the other engineering courses uninspiring.

For his second year at the University of Adelaide, he was able to take several third-year mathematics and physics courses as well as compulsory engineering subjects. In Engineering Mathematics, he encountered the teaching of Professor Hans Schwerdtfeger, then a lecturer in mathematics, for the first time. Ren found Schwerdtfeger's lecturing style particularly appealing and claimed to have modelled his own later lecturing style on that of Schwerdtfeger. (Curiously, he later discovered that Schwerdtfeger had himself adopted the style of Professor Gustav Herglotz of the University of Göttingen—an example of mathematical teaching genealogy!)

With the war situation improving by the beginning of 1945, Ren was permitted to transfer out of Engineering and into Science for his third year. He continued with Schwerdtfeger's course and undertook fill-in science subjects, including Geology I, taught by Douglas Mawson. By the end of 1945, he had qualified for the BSc degree.

Ren could have taken honours in either Mathematics or Physics and, encouraged by Schwerdtfeger, chose Mathematics, even though it would take two years because of a requirement to make up for a perceived inadequate background. He completed the degree with first class honours by the end of 1947.

During his honours years, Ren became interested in pursuing a research degree overseas. His first choice had been Brown University, an Ivy League school on the east coast of the USA, where a strong department of applied mathematics had been founded in 1941. Unfortunately, it was hard for Australians at that time to obtain an appropriate visa for the USA, so Ren needed a back-up plan. He applied for the South Australian Rhodes Scholarship (which funded

students to study at Oxford University) and was somewhat surprised when he was awarded it. Oxford University was not known for its strength in mathematics at that time but Ren selected Queen's College as his first choice because Dr U. S. Haslam-Jones (who had been a student of G. H. Hardy) was a tutor there.

To fill in the time until the start of the Michaelmas Term at Oxford and to earn some money to help pay for his voyage to England, Ren became a temporary lecturer in mathematics at the University of Adelaide for the first two terms of 1948. This was his first formal appointment as a university teacher. Then, in September 1948, it was off to Oxford.

Oxford and the Potts Model

Having arrived in Oxford and enrolled for a BA, Ren found that the applied mathematics curriculum was very outdated. Indeed, it was about to be heavily revised for the following year. Instead of taking the applied mathematics on offer, he attended some lectures in mathematical physics and found particular interest in a course on quantum mechanics given by Jacobus Stephanus ('Jack') de Wet. Following advice from de Wet, Ren decided to try to change to a DPhil in Mathematical Physics. For a time, he was enrolled for a BA but was not studying for it; instead, he was strengthening his background in physics by working through some texts recommended by de Wet. He was able to transfer to the DPhil degree when a new lecturer, Dr Cyril Domb, arrived from Cambridge.

Ren's DPhil work was in the field of mathematical physics, specifically concerning models that have come to be known as Ising and Potts models. There is an extensive literature on these models, including several tutorials designed for lay readers (for example (Wu 1982)). Both the Ising and Potts models are models of interacting spins on a lattice, in one or more space dimensions. The spins on the lattice sites exist in two or more distinct states. In the Ising model there are just two states, up or down. In the Potts model there are q states, where q can take any integer value greater than 1. Interactions take place only between adjacent spins. The reason that the models are so interesting is that, in certain temperature regimes, all the spins are correlated, despite the very local nature of the interactions. That is to say, a spin at one site influences all other spins, no matter how far away, even though the direct interactions are just local. This feature is responsible for the widespread applicability of the model, not just to spin systems, but to the behaviour of crowds, the modelling of financial collapse, the properties of some biological molecules, and many other natural phenomena. In particular, the Potts model exhibits phase transitions (from an ordered to a disordered state, for example) and hence can be used to study systems with such transitions. The point at which a phase transition occurs is called a critical point.

Ren began his research as a DPhil student at Oxford in the Trinity term of 1949. His supervisor, Cyril Domb, was known for his work on the theory of phase transitions and critical phenomena of fluids, and on series solutions for models of co-operative phenomena. In 1944, Lars Onsager had found an exact solution for the Ising model on a two-dimensional lattice in the absence of an external field (Onsager 1944). Domb suggested that Ren should examine the problem of establishing a series solution for a similar model with an extended set of neighbours. Despite this, Ren's early efforts were on deriving exact solutions for related models. He attempted to extend the Onsager exact solution so that it applied to a two-dimensional Ising model in an external field, and also to a three-dimensional Ising model. Unfortunately, he was not able to achieve either of these goals—indeed, at the time of writing (2014), they are yet to be achieved. After eighteen months, Ren decided to return to the original problem that Domb had suggested, which ended up forming the basis of his DPhil thesis, and which was published in a joint paper with Domb (1).

Domb made another, much more significant suggestion to Ren near the end of his DPhil research. This was to look at a modified Ising model in which each element could exist in a greater number of configurations than just the two of the original Ising model. In the Potts model there are q possible states, where q is an integer greater than 1. The various forms of the model are distinguished by the nature of the energy function $J(y, z)$ that describes the interaction between spins of neighbouring points that are in states y and z, respectively, and in terms of the external field $H(y)$ that is imposed on the whole lattice. Ren followed Domb's suggestion

and, in the absence of an external field for the case where $J(y,z) = -k\cos(y-z)$, he was able to determine the exact critical point for the case where $q = 2$, 3 or 4. For a related model where $J(y) = k$ if y is equal to z, and k/q if y is not equal to z, Ren determined the exact critical point. Following Domb's advice, Ren published this paper as a single-author paper in the *Proceedings of the Cambridge Philosophical Society* (3). This model later became known as 'the Potts model' and it became the focus of a great deal of research from all around the world from the early 1970s. It is curious, however, that Ren did no further work on the Potts model, a situation that paralleled that of Ising himself, who wrote the first paper on the one-dimensional model in 1925 (Ising 1925). Ren did, however, continue to work on related mathematical physics models.

The terms of Ren's Rhodes Scholarship did not allow him to marry. Because of this, he did not apply for an extension to his scholarship at the end of his second year at Oxford. On 1 July 1950, Ren married Barbara Phyllis Kidman in St Giles' Church, Oxford, with a reception afterwards at Somerville College. Ren and Barbara had met when undergraduates in Adelaide through the Student Christian Movement, and had been engaged since 1948, but the wedding had had to be postponed because of the requirements of Ren's scholarship. Barbara came from a well established South Australian family and the wedding attracted prominent coverage in the Adelaide *Advertiser*'s social pages. Barbara Kidman's studies in Oxford were disrupted when the couple left for Adelaide, but she later graduated with a PhD in physics from the University of Adelaide. She subsequently played a prominent role in the establishment of Computer Science at the University.

Return to the University of Adelaide

At the completion of his DPhil, Ren hoped to stay in the UK, at least until Barbara had finished her DPhil. However, positions were hard to find in the austere conditions of Britain in 1951 and Ren ended up applying for a lecturer's position in the Department of Mathematical Physics at the University of Adelaide. The intention of this position was to support the newly-appointed Professor of Mathematical Physics, Herbert Sydney ('Bert') Green (Hurst 2001). As it happened, the advertised position went to Harry Messel but Ren was offered a lectureship in Mathematics, with the agreement that he could undertake research in mathematical physics.

Ren moved back to Australia in 1951, meeting Harry Messel on the ship at Gibraltar. They immediately hit it off and Harry asked Ren to look at his recent research on cosmic-ray theory. It was not long before they were collaborating on the development of models for the longitudinal evolution of cosmic-ray showers, while Harry and Bert Green worked together on the angular evolution. The collaboration between Ren and Harry produced a series of nine papers (5, 6, 7, 8, 9, 10, 11, 13, 14), eight jointly with Messel and one by Potts alone, which influenced the field greatly. Ren rated one of these papers (10), on the fluctuation problem in electron-photon shower theory, as one of his very best.

North America and the Beginnings of Transportation Science

The Vice-Chancellor of the University of Adelaide at that time, A. P. Rowe, had introduced several conditions that helped academic staff. One was graded staff levels, under which Ren was promoted to Senior Lecturer in 1954, and a second was study leave. Ren used the study leave scheme, as well as a Fulbright Scholarship, to visit the University of Maryland in 1955. There he collaborated with Elliott Montroll, one of the world's leaders in statistical mechanics, and several of his colleagues, on problems involving lattice vibrations. This collaboration produced another much cited paper (29)—eventually published in the 'Onsager celebration issue' of the *Journal of Mathematical Physics* in 1963—in which the authors described an elegant derivation using Pfaffians of spontaneous magnetization in the Ising model. Pfaffians had earlier been used by Angas Hurst and Bert Green (Hurst 2001) in Adelaide and Ren had probably been influenced by their work.

Ren returned to Adelaide at the end of 1955, having experienced a very fruitful year at the University of Maryland and convinced that he needed to maintain connections with the North American research community. In an effort to do this, he applied for an advertised Associate Professorship at the University of Toronto, which had a strong Pure Mathematics group headed

by Coxeter and Robinson, but which had no professor in Applied Mathematics. His application was successful, and he moved to Toronto in December 1957. There, he used the University of Toronto as a base to collaborate with colleagues in the USA and his research prospered.

While Ren was on study leave at the University of Maryland, he was introduced by Elliott Montroll to Robert Herman, who had moved to a senior position at the General Motors Research Laboratories in Detroit. When Ren subsequently took up his appointment at the University of Toronto, Bob Herman invited Ren to join his group as a consultant, and Ren visited Detroit once a month during his time in Canada. The group, which also included Denos Gazis and Richard Rothery, produced a body of acclaimed research on car following, and traffic dynamics more generally, that combined mathematical, numerical and experimental approaches. The 1959 Lanchester Prize for Operations Research was awarded to the group for three of its papers (Chandler 1958), (23) and (24).

Professor of Applied Mathematics

The Professor of Mathematics at the University of Adelaide, Harold Sanders, retired at the end of 1958, and the decision was made to replace him with two professors, one in Pure Mathematics and one in Applied Mathematics. Eric Barnes, whose biography Ren later co-authored (89), was appointed to the first of these positions and Ren, at the age of 32, to the second.

Ren started back at the University of Adelaide in May 1959. It was more difficult for him to maintain his joint work with his colleagues at General Motors but he continued to do so. He also struck up a collaboration with an engineering graduate from the University of Adelaide, Patrick Pak-Poy, who was working at the South Australian Highways Department. This collaboration gave Ren the opportunity to continue with the combination of experimental, numerical and mathematical approaches that he had used at General Motors. He supervised several graduate students who completed theses on various aspects of transportation science. The students worked on projects with other government instrumentalities such as the Australian Road Research Board, the Municipal Tramways Trust and the South Australian Railways. Ren in this regard was an early advocate of close co-operation between academia and industry on real problems. One student, Tony Tan Keng Yam, went on to be a member of the Singapore Parliament and, in 2011, President of Singapore.

While on study leave at Berkeley in 1967, Ren began a collaboration with Robert Oliver that led to the book *Flows in Transportation Networks* (53), published eventually in 1972. The aim was to provide a clear mathematical basis for many of the practices and computer codes that had been built up in transportation engineering and planning over the previous two decades. For example, it had become known to transportation planners, but not well understood by them, that the shortest (fastest) route between two points, A and C, say, in a road network in which there were turn penalties (where it cost something extra in time to turn at an intersection instead of continuing straight on) can include an intermediate point B but not be made up of the shortest path from A to B and the shortest path from B to C. This issue was studied in detail by Ron Kirby, one of Ren's PhD students (50).

Flows in Transportation Networks used a careful statement of basic network theory to develop the mathematics underlying traffic assignment and trip distribution procedures in transportation planning. In keeping with Ren's pedagogical approach, there was a consistent emphasis on diagrams and numerical examples to illustrate the mathematics. Each chapter included a section of carefully selected references with useful notes on their content. Each of the mathematical chapters had a 'Problems' section at the end through which readers could test their understanding of the material; the solutions to the problems were given in an appendix. What became known to generations of Ren's students as the 'Potts diagram', describing the relationship between the primal and dual formulations of a linear program, was published in another appendix. The book sold well for some years but did not become the established, widespread textbook that the authors may have hoped for.

Operations Research

After Eric Barnes' now fabled course on linear inequalities, given in 1962 (89), and while supervising John Tomlin's PhD studies (Tomlin 1967), Ren became interested in linear programming and the general application of the network

methods from transportation science to other problems. Subsequently, linear optimization and other methods from the relatively new field of Operations Research became a popular topic in Ren's teaching. Ren's research also turned in this direction.

Through a series of projects involving PhD and MSc students, Ren investigated applications as diverse as the travelling salesman problem, assembly-line planning, sand-dredging optimization, manpower planning and telecommunications network planning. The underlying theme in all these areas was that they involved network models. In sand dredging, for example, the path of the dredge could be seen as a network, while in manpower planning, staff could be seen as 'flowing' from one level to another. The power of network models was ably described by Ren in his contributions to Lighthill (Lighthill 1978): a chapter on 'Networks' (61) and a section on 'Manpower Planning' in the chapter on 'Planning'. In many cases, linear programming was used to generate optimal solutions. For example, the sand-dredging problem involved the solution of large-scale (for the time) linear programs. In all cases, the emphasis was on practical algorithms for creating good (or optimal) solutions to real-world problems.

The application area with the longest-lasting effect was telecommunications. Ren recruited L. T. M. Berry (later a Professor at Bond University on Queensland's Gold Coast and at RMIT University in Melbourne) as a research student. Berry wrote a thesis on telecommunications network planning (Berry 1971) and, with Ren's active support, went on to develop a telecommunications research group at the University of Adelaide and, in 1987, to found the Teletraffic Research Centre with support from Telecom Australia, OTC and their successor, Telstra. The Centre made significant contributions to teletraffic research, gained a substantial international reputation and, under the name TRC Mathematical Modelling, is still flourishing today (2014).

In addition to research and teaching, Ren encouraged the practice of operations research in South Australia by helping to found a local society for operations research. This brought together interested academics, trainers and a cross-section of industry practitioners in Adelaide for regular lectures and discussions. The local society became part of a national effort when the Australian Society for Operations Research (ASOR) was founded in 1972. In 1977, ASOR inaugurated the Ren Potts Medal to recognise individuals who have made outstanding contributions to the theory or practice of operations research in Australia. Ren did much to popularize the concepts of operations research and made sure that issues of *Operations Research* (the journal of the Operations Research Society of America published from the 1950s) were well circulated in Adelaide.

Robotics

Ren had become interested in robotics when visiting car factories and, near the end of his career, he had the opportunity to apply mathematics to various problems concerned with the control of robots. His main collaborators in this were a PhD student, Tan Hwee Huat, who came from Singapore, and a postdoctoral fellow, Xinghuo Yu, who had graduated as a control engineer in China. Together, Ren and these two colleagues used mathematical programming techniques to plan the trajectories of robotic arms.

Discrete Mathematics

A theme that can be traced through Ren's research right from the beginning is his dexterity with, and fondness for, discrete models. His early use of matrix algebra in applications is a good example. Another example is his interest in difference equations, which started when Ren was on study leave in Scotland in 1980. His research in this area involved the use of non-standard differencing in finite-difference models. Also related are nonlinear discrete equations leading to the construction of fractals and 'chaos'. Coincidentally, one of the early equations used for this purpose was based on the original Potts model.

Ren also promoted the use of discrete mathematics as a vehicle for teaching mathematics in schools. He made the case for discrete mathematics in his plenary address to the International Conference on Mathematical Education, held in Adelaide in August 1984 (Carss 1986). (He had been asked to chair the local organizing committee for the conference, a task he took on with his usual energy.) In his presentation (71), he took his audience on a journey through linear and non-linear difference equations, illustrating stable and non-stable equilibrium points, strange attractors, chaotic regions and periodic solutions.

It was Ren's pedagogy at its best, liberally using numerical examples and diagrams to take the audience by simple steps to an advanced and complex understanding of the subject. He used examples of networks to illustrate problems with polynomial time solutions and those without. ('Almost certainly the very best such lecture that he had ever heard in his whole life' reported one attendee.) One of his themes had been that 'discrete mathematics should play a more important role in mathematics education', while 'not advocating that … discrete mathematics replace continuous'. He concluded with an impassioned plea:

> My first example of difference equations … is suitable for a school curriculum. I recommend, challenge, insist that it be taught in secondary schools – next year!

Teaching and the Expansion of Mathematics

The decision by the university authorities to appoint two professors of mathematics in 1959 proved to be inspired. Eric Barnes and Ren Potts set about vigorously revitalizing the teaching of mathematics at the University of Adelaide and establishing a strong research culture. They worked together in tandem for the next fifteen years, through the foundation of a separate Faculty of Mathematical Sciences in 1973. Eric Barnes was appointed Elder Professor of Mathematics in 1959 ('Elder' not in the sense of age, although Eric was the elder by 21 months, but because the position had been founded through a bequest from Sir Thomas Elder, a colonial philanthropist). Ren in turn became Elder Professor of Applied Mathematics in 1976, after Barnes moved into the higher echelons of university administration, and held the post until he retired.

The emphasis in the 1950s had been largely on service teaching. The new professors set about changing that. The undergraduate curriculum in applied mathematics, in particular, was significantly revamped. A first-year applied mathematics subject was abolished, partly to remove overlaps with physics, and the second-year course was strengthened with the addition of elementary mechanics. Ren was particularly keen that there should be close co-operation with Engineering and that engineering mathematics should be taught by mathematicians. By the mid-1960s, a separate subject of engineering mathematics in first year had been abolished, leading to the greater integration of engineering and applied mathematics subjects, thereby easing the path to a double degree for the best engineering students. When computing had become established, Ren took the initiative to ensure that computing became a compulsory part of an engineering education.

The restructuring of the curriculum undoubtedly contributed to the rising numbers of undergraduate students during the 1960s but perhaps the most significant cause was the inspirational teaching of the new professors. Both Eric Barnes and Ren Potts were well organized and gifted teachers, but Ren perhaps had the advantage that, as a teacher of applied mathematics, he was able to introduce examples from the physical world or everyday life. (It was to Professor Barnes's disadvantage that his wartime exploits as an expert codebreaker (89) could not be similarly used due to security restrictions.) Ren, coming from a family of teachers, also had a strong appreciation of teaching technique. He would characteristically break his lectures up into ten-minute segments, for example, with short problem-solving or question times in between. His presentation of material was always a model of clarity.

In addition to the undergraduate curriculum, the fourth-year honours studies were also strengthened. Honours projects with individual staff supervisors were introduced: for the best students, these projects were a good induction into further research. Honours courses were of a high standard and often reflected the current research interests of the lecturers. The honours year became a signal success: from only one honours student in 1959, the numbers grew to 20 by 1964 and 10–20 honours graduates each year became the norm through the 1970s and 1980s.

In building the department, the new professors were lucky in being able to attract good students right from the beginning. In 1960, for example, Ren's first Honours student was, perhaps, his best, Ernie Tuck. Ernie was soon well on the road to a distinguished mathematical career, contributing greatly to the development of mathematics in Australia and, in his turn, becoming Elder Professor of Applied Mathematics after Ren retired. Ernie was elected to a fellowship of the Australian Academy of Science in 1988 (Grimshaw 2012).

The University of Adelaide became a major producer of mathematics graduates in Australia, eclipsing much larger universities. In the period 1973–89, the University awarded 339 honours degrees in mathematics and statistics, second only to Monash (442) and greater than both the Universities of Melbourne (248) and Sydney (192). In the same period, the University of Adelaide also produced 68 PhD mathematicians or statisticians, third after ANU (118) and Monash (95).

One reason for the strong output of graduates was the increasing profile of mathematics within the university. In 1963, Ren had encouraged Alan James to return from Yale to take the vacant professorship in statistics. The leadership of Professor James led to the formation of a Department of Mathematical Statistics in 1968. In 1970, the single mathematics department split again into Departments of Pure Mathematics and Applied Mathematics. This initiative, which was essentially due to Ren, was not universally welcomed, but it was amicable enough and close co-operation on undergraduate teaching continued: the two departments enabled a greater variety and depth of teaching in the later years. The two departments shared a common tea room, so that day-to-day interactions continued and were the norm.

By 1972, the mathematicians felt strong enough to strike out on their own and, from the beginning of 1973, a new Faculty of Mathematical Sciences was carved out of the Faculty of Science, with Eric Barnes becoming the new Dean. The new Faculty consisted of the Departments of Pure Mathematics, Applied Mathematics and Mathematical Statistics (all originally part of one department of Mathematics), Computer Science (formed on Ren's initiative in the 1960s) and Mathematical Physics (which retained one foot in the Faculty of Science). This provided a clear focus for students who wanted to pursue a career or interest in mathematics, but detailed co-operation with the Faculties of Arts, Science and Engineering was still required. For the staff it meant generally more streamlined decision-making.

The more efficient decision-making particularly appealed to Ren, who was a prime mover behind the formation of the new faculty. He was famously impatient with the discursive nature of much university politicking although meetings of the major university committees furnished him with a fund of amusing anecdotes. On one occasion—this was Alan James' version of the story—he was so incensed by a decision of a university committee that he stormed out of the meeting slamming the heavy meeting-room doors behind him and breaking the hinges. (The committee reversed its decision at its next meeting.) Eric Barnes, who was a talented university administrator, also found the new Faculty congenial, until he was snatched away to higher duties as a Deputy Vice-Chancellor.

Alas, the new Faculty did not long survive the retirement of the powerful professors who had formed it. In 1988, Mathematical Physics left and merged with Physics. In 1992, Computer Science began a drift towards Engineering with a move to be in both camps. A recombined School of Mathematical Sciences is now (2014) part of a Faculty of Engineering, Computer and Mathematical Sciences. However, the legacy of strong mathematics teaching and research continues.

Applied Mathematics Conferences and the Beginning of ANZIAM

The establishment of Applied Mathematics conferences in Australia has become the stuff of legend (Braddock 1984). Ren contributed to the mythology of the foundation (notably through several 'legendary' after-dinner speeches at later conferences) but, as one of the instigators, he had a unique view of the history and the personalities involved.

The first conference was held in August 1966 and established the principles on which most of the later conferences were run: the location should be away from universities so that the atmosphere could be relaxed and casual; there should be a principal guest; and students should play a significant part in the organization. Much of the credit should go to the co-founder with Ren, Professor Rainer Radok (then Professor of Oceanography at Flinders University), who provided the location, a remote research station on Kangaroo Island. Ren provided the guest speaker, Bob Herman from the General Motors Research Laboratories, who was visiting Adelaide at the time. Ren also undoubtedly contributed some of the fun, enthusiasm and informality that particularly characterized the early conferences.

After this first conference was declared a success, the second was held only four months later in December 1966, taking advantage of a visiting oceanographer and Professor Radok's new remote research station near the Coorong in south-eastern South Australia. The third was held at Flinders University (breaking one of the unwritten principles because, one might speculate, Professor Radok had run out of other 'remote locations') in June 1967. After that, the conferences became less of a South Australian affair, the fourth being held just over the border in Victoria, at Hall's Gap, in February 1968. From this beginning, the conferences have become a fixture on the Australian applied mathematics calendar in February each year and, in its current incarnation as the ANZIAM conference, the fiftieth event was held in Rotorua, New Zealand in February 2014.

Without perhaps quite realising it, Ren and the other enthusiasts for these conferences were creating a separate and recognizable identity for applied mathematics in Australia. This led to the formation of a new division of the Australian Mathematical Society called ANZIAM (Australia and New Zealand Industrial and Applied Mathematics), formally established at the conference in February 1975. The *Journal of the Australian Mathematical Society* also began publishing in two series: Series A for Pure Mathematics and Statistics; Series B for Applied Mathematics. Series B was renamed the *ANZIAM Journal* in 2001. Ren was chair of ANZIAM in 1978/79 and an assistant editor of the journal from its foundation. For his role in promoting applied mathematics and 'his splendid achievements that have done so much to shape Industrial and Applied Mathematics in Australia', Ren was awarded the first ANZIAM Medal in 1995.

Early Computing at the University of Adelaide

The beginnings of computing in Adelaide benefitted from the establishment of the Weapons Research Establishment (WRE) in nearby Salisbury. WRE had the dual benefits of an early digital computer, WREDAC, from September 1956 and an entrepreneurial computer enthusiast in Dr J. A. Ovenstone (later to become the first Professor of Computing Science—'Computing Science' being his preferred formulation—at the University of Adelaide). Encouraged by Ovenstone, Ren spent the summer of 1956–7, very soon after WREDAC had become operational, learning to program the computer in its native machine code (there being no high-level languages available). Ovenstone also organized a major conference at the WRE in June 1957, attended by many notable English pioneers in computing, including Maurice Wilkes from Cambridge, that stimulated further interest in computing at the University of Adelaide.

In February 1959, Ren and some of his students, along with others from the University, attended the first Fortran (actually Fortransit, a transitional version of Fortran available on the IBM 650 series) short course provided by IBM in Adelaide. From then on until the mid-1970s, Fortran became the high-level language of choice for university research, administration and teaching. From the mid-1960s, applied mathematics students were required to learn some Fortran for numerical analysis methods and further computing exercises were added to other mathematics courses progressively throughout the 1970s.

In 1960, Ren took the initiative to drive forward the formation of a university computer centre to satisfy all the University's computing requirements. The trigger was the need by the university administration to upgrade its punched card equipment used to keep track of student enrolments. As a result of Ren's lobbying, a Punch [*sic*] Card Equipment Users Committee was formed, bringing together potential users of computing from various departments and the university administration. With Ren's effective leadership skills to the fore, the committee acted swiftly during 1960 to recommend the formation of a 'computation centre' for the University and to specify the required equipment, including a computer and punched card peripherals, facilities and staff. By May 1962, the University's first computer, an IBM 1620, had been delivered. The university computing service had begun in 1961 with some punched card equipment and a share of time on WRE's new IBM 7090.

One complicating factor in the University's decision to obtain a commercial computer was that the Department of Electrical Engineering had embarked on designing and building an in-house computer called Cirrus. This was offered

as the basis for the University's computing service once it was operational. Ren's committee, while supporting the development of Cirrus, also promoted the urgent need for a research and teaching computer that was compatible with the WRE facility and commercial punched card equipment, and had Fortran. Cirrus could not satisfy these requirements in 1961 and was not operational, in fact, until 1963 and then only in prototype configuration. The installation of a commercial computer for university needs certainly diluted the emphasis on Cirrus and may have reduced its prospects for commercialization. Pearcey suggests that 'the failure to follow up the Cirrus design was probably one of the greatest mistakes in Australian computing' (Pearcey 1988). Ren's committee should not be perceived as at fault here: there was a general desire in the University to provide early access to computing facilities with a clear path to anticipated future growth.

As he would repeat later with operations research, Ren also saw the opportunity to harness the interest in computing within the general business community together with the enthusiasm within the University of Adelaide. Encouraged by the local IBM office, he circulated a notice proposing the formation of a computer society. The first two sentences read:

> Many achievements of modern science have quickly become an accepted part of everyday life. Few, however, are likely to have such a direct and revolutionary effect on so many different spheres of human activity as the electronic computer.

Even Ren probably could not have envisaged in 1960 just how true those words would become.

A formative meeting, attended by over 150 people, was held on 24 October 1960 and Ren was elected president of the new society. At the first meeting in November 1960, at which the name 'Computer Society of South Australia' was adopted, the speaker was David Elliott, then a Senior Lecturer at the University of Adelaide and one of Ren's PhD students. (David Elliott went on to become a long-serving Professor of Mathematics at the University of Tasmania.) The society held monthly talks at which many of the early pioneers of computing, including Trevor Pearcey, spoke. Later, in 2004, Ren's contribution to early computing in Australia was recognized when he was admitted to the Pearcey Hall of Fame. His citation reads:

> Emeritus Professor Ren Potts, Rhodes Scholar, Order of Australia, Ren was one of the first to learn to program and use the Weapons Research Establishment Digital Automatic Computer (WREDAC) in 1956, was responsible for establishing the University of Adelaide Computing Centre and was the inaugural President for the South Australian Computer Society in 1961.

The Computer Society of South Australia was the first of five State-based societies that came together to form the Australian Computer Society on 1 January 1966.

Not Just Mathematics

Ren had always been keen on sport from his school days. He did not shine at sport as a schoolboy, being of only moderate ability at cricket and football, and his senior years were restricted by a shoulder problem. At university, however, he took up hockey with enthusiasm and success, playing both in Adelaide and for Queen's College while in Oxford. In later life, as well as being a regular tennis player, he took up badminton and squash and would regularly play at lunchtime.

His biggest effect on others, however, was through long-distance running. In the mid-1970s, he joined a small band of runners from Mathematics on their lunchtime exercise and soon took to running with gusto. Under his leadership and enthusiasm, the lunchtime group began running further in the Adelaide parklands and soon expanded to a large band of Mathematics staff and students. Ren's running style—not being classical—was much remarked upon, but he found that he had great endurance and he would regularly compete in long-distance competitions and marathons. He made sure that Mathematics entered a competitive team for the annual Adelaide City-Bay 'fun runs' and he himself would always be placed in the top few for his age group. The high point of the lunchtime running group was in the period from the late 1970s to the late 1980s, when it contributed much to the obvious camaraderie and enthusiasm in the Mathematics departments.

Coming as he did from a family of teachers, Ren had always appreciated the need for the grounding of a good school education. He was a vocal and effective critic of the 'new

mathematics' when it became a fad in the early 1970s, showing that it lacked mathematical rigour (though it had a pseudo-rigorousness) and that the available textbook material was often of poor quality. The 'new maths' faded away. Ren was a major contributor to the success of the International Conference on Mathematics Education held in Adelaide in 1984 and the International Mathematics Olympiad in 1988.

Both his daughters attended Girton Girls' School in Adelaide and Ren joined the school board, becoming chairman in 1968 and serving until 1974. In that capacity, he helped guide the school through a merger with a nearby boys' school, King's College, to create a new co-educational institution, Pembroke School. Ren had proposed the name 'Pembroke' to continue the tradition of Cambridge college names. A lecture theatre at Pembroke is named after him to commemorate his contribution to the founding of the school.

Later Years

Ren retired from the University of Adelaide at the end of 1990, the year he turned 65, as then required by the University's regulations. In the Queen's Birthday Honours in 1991, he was appointed an Officer in the General Division of the Order of Australia. The citation read 'for service to education and in particular to Applied Mathematics'. In 2001, he received an Australian Centenary Medal 'for service to Australian society and science in operations research'.

From 1991 to 1993, Ren was a visiting professor at the National University of Singapore and travelled widely in the region. Ren and Barbara also travelled several times to New Zealand, where their two daughters, Linda Kidman Tame and Rebecca Anne Potts, were living.

While in Singapore, Ren was approached by a former student then working for the Hong Leong group (a diversified financial and industrial conglomerate in Malaysia) with a proposal for a 'twin' campus for the University of Adelaide in Malaysia. Ren was enthusiastic about the idea and took the proposal to the University of Adelaide. In this, as in so many other things, Ren was ahead of his time. Joint-venture campuses of Australian universities became a feature of the 1990s but Adelaide's was the first. (See the *New York Times* report (Richardson 1993).) When Ren returned to Adelaide, he held a part-time position from mid-1993 to early 1994 in the University of Adelaide administration to help establish the new institution. The campus, which became known as Sepang Institute of Technology, began operating in 1994 and continued as a joint venture until 2004.

Ren was plagued with serious health issues from 1995 on and was, from time to time, greatly restricted in his activities. He did, however, become a regular presenter of classical music on a local Adelaide radio station. He continued swimming as a means of keeping fit.

He remained to his last days a gifted teacher of applied mathematics. When he was in hospital shortly before he died—this is Ernie Tuck's story—the nurse was having trouble getting the right balance of blood ingredients for his blood transfusion and needed to divide a number by 2.5. She had no calculator and Ren suggested that, as she could divide by whole numbers, she could double the numerator and divide by 5. According to Ren, she was absolutely delighted—she thought it was terrifically clever—so delighted in fact that Ren felt unable to pass on the more sophisticated tip of multiplying by 4 and just moving the decimal point.

Ren Potts died in Adelaide on Tuesday 9 August 2005 at the age of 79. He was survived by his wife, Barbara (known professionally as Dr Barbara Kidman), and their two daughters.

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