Chapter 8

National Organisations and Mathematics

The growth of ANZAAS was documented in Chapter 3 and in that spirit this chapter now continues the stories of nationwide ventures that concern mathematics. Three organisations are considered in detail here: the Australian Bureau of Statistics, CSIRO, and the Australian Academy of Science. The origins of the Australian Mathematical Sciences Institute are included in this chapter but most national organisations that are specifically dedicated to mathematics, such as the Australian Mathematical Society and the Australian Association of Mathematics Teachers, are dealt with elsewhere.

One aspect of the work of the Academy of Science is its involvement in discipline reviews. The final section of the chapter details one of those reviews in particular, conducted during 1995, and also describes other surveys into the state of mathematics in Australia that have been conducted over the past ninety years.

The Australian Bureau of Statistics

Many of the state responsibilities in data gathering were subsumed by the new Australian federation when it established the Commonwealth Bureau of Census and Statistics in 1905, with George Handley Knibbs as the first Commonwealth Statistician.

Knibbs was born in Redfern, an inner suburb of Sydney, on 13 June 1858. In an astonishingly varied career, he became a licensed surveyor with the New South Wales Trigonometrical and General Survey Department in 1878 and lecturer in surveying in the University of Sydney in 1890, where his teaching ranged over geodesy, astronomy and hydraulics. For two academic terms in 1904 he was acting professor of physics in the University during a period of leave of James Pollock[1] and in the following year he served as Director of Technical Education in New South Wales. In June 1906 he was appointed to the post of Commonwealth Statistician, a position he held until 1921 and for which he had had no formal training. His final post was as director of the Commonwealth Institute of Science and Industry, a job he saw through until the establishment of the CSIR, which replaced the Institute in 1926. Knibbs was knighted in 1923 and was a fellow of both the Royal Statistical Society and the Royal Astronomical Society. He died on 30 March 1929 in Melbourne.[2]

He was very closely associated with the Royal Society of New South Wales, joining it in 1881, editing its *Journal and Proceedings* for nine years and serving in various capacities on its council, including as president in 1898–1899. Most of all, he was a prolific contributor with

Sir George Handley Knibbs, 1858–1929. (Australian Bureau of Statistics)

28 papers over the period 1885 to 1927 in its journal, out of his total of almost 100 publications. These included papers in prominent overseas journals as well, such as the *Journal of the Royal Statistical Society* and the *Journal of the American Statistical Association*.

A comprehensive annotated bibliography of Knibbs' published work, as well as an account of his life and work for the new Commonwealth Bureau of Census and Statistics, was given by Chris Heyde in the bicentennial history issue of *The Australian Journal of Statistics*. Heyde commented that "Knibbs' early papers give the impression of competence as a mathematician",[3] with contributions in such diverse fields as fluid mechanics, theory of probable errors, astronomy and non-Euclidean geometry. The breadth of his knowledge of mathematics was evident in the extensive account of the history of the subject that he gave to the Royal Society of New South Wales as his presidential address in 1899.[4]

Timothy Coghlan and Robert Johnston, the government statisticians of New South Wales and Tasmania, had declined the new position of Commonwealth Statistician and Knibbs' subsequent appointment was generally well received despite the fact that he "had hitherto had little direct involvement in the kind of official statistical work for which he was to be responsible." Coghlan was the government's principle adviser on the establishment of the Bureau and held lingering doubts about Knibbs' capabilities, as was evident in a letter he wrote to the prime minister, Alfred Deakin:

> Mr. Knibbs has high mathematical attainments, he is earnest, hardworking and scrupulously honest but he must be given experienced assistants, a knowledge of the technique of statistics is absolutely essential to even moderately good work.[5]

Two of the "experienced assistants" that Knibbs was pleased to appoint, Charles Henry Wickens and Edward Tannoch McPhee, would follow him as Commonwealth Statisticians.

Knibbs' early responsibilities to the federal bureau included the production of the first commonwealth *Year Book* in 1908 and the conduct of the first commonwealth census in 1911. The *Year Book*, based on the principles previously adopted by Henry Hayter in Victoria and Coghlan in New South Wales, included statistics for the entire period of federation, 1901 to 1907, and was designed to be the authoritative source for such information. In this it succeeded well, being described by *The Times* as the "most wonderful book of its kind in the world". The three-volume report of the 1911 census included, as Appendix A of Volume 1, a 466-page treatise titled *The Mathematical Theory of Population, of its Character and Fluctuations and of the Factors which Influence Them*, which was later printed separately. It was considered by one reviewer that this book would "stand as one of the leading works on mathematical statistics of the twentieth century", but Heyde, in quoting others such as Ronald Fisher, was a little more circumspect in his praise.[6]

There is a telling passage in Forster and Hazlehurst's account of the 1911 census:

> Confronted by the fact that their 1911 figures showed that 80 per cent of all reported cases of deaf mutism were aged 10 to 14 . . . Knibbs and Wickens sought the explanation in understatement

> by parents hoping that their children would recover or anxious about losing them to educational institutions . . . Ten years later the discovery that the age group 20 to 24 had the most deaf mutes made it clear that an epidemic of some sort must have affected this particular cohort.[7]

As mentioned in Chapter 6, it was Oliver Lancaster's subsequent research that confirmed this by establishing the link between rubella and natal deafness.

Wickens was Knibbs' assistant throughout his term as Commonwealth Statistician, first as "compiler" and from 1913 as the supervisor of census, and was the one to succeed him in August 1922. Born near Bendigo, on 16 October 1872, Wickens by 1896 had qualified as an associate of the Institute of Actuaries through private study. He travelled to Western Australia in 1897, obtained employment in the statistical office there and within ten years came to be regarded as Australia's foremost actuary and statistician as a result of his compiling of the first life tables in Western Australia. Lancaster,[8] in an account of Wickens' career that included a complete and annotated bibliography, discussed Wickens' approach to the construction of life tables along with a survey of other such tables for New South Wales and Victoria, produced on various earlier occasions by Morris Pell, Timothy Coghlan and Elphinstone Moors.

Wickens gained a fellowship of the Institute of Actuaries in 1920 and in 1925, with others including his temporary successor Lyndhurst Giblin, was instrumental in establishing the Economic Society of Australia and New Zealand. He was Commonwealth Statistician, and Commonwealth Statistician and Actuary from 1924, at a time of increased demand for statistics on domestic finance and international trends in trade, and he became an influential adviser to successive governments of the day. Forced to withdraw from the public service in 1932 after suffering a stroke the previous year, Wickens died in Melbourne on 30 July 1939.

Regarding the work of Australia's first two government statisticians, Heyde was moved to write:

> Australia was fortunate indeed to have had men of the calibre of Knibbs and Wickens as its early Commonwealth Statisticians. They saw their role in the widest possible terms and they were methodologists and interpreters of statistics of considerable distinction as well as collectors and disseminators of high international standing.[9]

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Until 1928, the Commonwealth Bureau of Census and Statistics was situated in Melbourne. It moved to Canberra in that year, and at the time of Wickens' retirement was transferred from the Department of Home Affairs to the Treasury portfolio. This began a period in which Tasmanians dominated the position of Commonwealth Statistician and took on a pioneering role in establishing the economics profession in Australia.

First was Lyndhurst Falkiner Giblin (1872–1951), who, after studying at the University of Tasmania and University College, London, had entered King's College, Cambridge, from which he graduated in 1896 as senior optime in mathematics and science. After more than 20 years as an adventurer, mathematics teacher, representative in the Tasmanian parliament and war hero, Giblin was appointed as the Tasmanian government statistician in 1919. Ten years later, he took up the Ritchie Chair of Economic Research in the University of Melbourne, although he had no formal training in economics. Nonetheless, "his intellect, varied experience and mathematical background ensured him prominence in a local profession which had yet to mature."[10] Giblin was acting Commonwealth Statistician from April 1931 to December 1932 and was also designated Chief Economic Adviser to Treasury. Another Tasmanian, Edward McPhee (1869–1952), who, with Wickens, had joined Knibbs as a principal professional

officer in 1906, became Commonwealth Statistician in 1933. He was succeeded in the post by the eminent Tasmanian, Roland Wilson.

Born in Devonport on 7 April 1904 and with doctorates in economics from both Oxford and Chicago, Wilson was Commonwealth Statistician and Economic Adviser to the Treasury for three periods, 1936–1940, 1946–1948 and 1949–1951. He had been brought to Canberra by Giblin and groomed by McPhee to undertake a "basic rethinking" of the Bureau's purpose that would enable it to participate more fully in economic policy making. From 1951 to 1966, Wilson served as the country's longest serving secretary to the Treasury. He was knighted in 1955 and died on 25 October 1996 in Canberra.

In the periods between Wilson's terms as Commonwealth Statistician, while he headed the wartime Department of Labour and National Service, the position was given to Stanley Roy Carver (1897–1967), from Goulburn, New South Wales. Carver then succeeded Wilson as acting Commonwealth Statistician from 1951 to 1957, while concurrently serving as New South Wales Statistician, and was subsequently Commonwealth Statistician in his own right until 1961. In the early 1950s he was responsible for directing the expansion of the statistical service to meet the demands of post-war Australia. Carver's deputy from 1958 was Frank Benson Horner, born in 1917. When Horner retired after 43 years service to the New South Wales and federal governments, he became noted for his research into early Australian history.[11] He was a major figure in the early days of the Statistical Society of New South Wales.[12]

Keith McRae Archer (1905–1999), another Tasmanian, was Commonwealth Statistician from 1962 to 1970 after an involvement with federal census and statistics going back to 1933. Archer is credited with introducing computerisation to the bureau and with enhancing the collection of economic statistics. Among many international posts, he was elected chair of the United Nations Statistical Commission in 1968.

Archer was followed in office, until 1975, by yet another Tasmanian, John Patrick (Jack) O'Neill (1910–1998). Resident in Canberra from 1938, O'Neill was head of the newly formed Development Branch in the Bureau in the 1950s and showed great support for research and development into new statistical methods, later promoting the introduction of seasonal adjustment techniques in Australian official statistics during the 1960s.

In 1974 the Commonwealth Bureau of Census and Statistics was abolished, to be replaced by the Australian Bureau of Statistics as a new statutory authority, and O'Neill's title, and that of his successors, was changed to Australian Statistician. Those successors were Robert William (Bill) Cole, born in Melbourne in 1926, who held office from May to December 1976; Roy James Cameron, born in 1923 in Port Pirie, South Australia, and in office as Australian Statistician from 1977 to 1985; Ian Castles, born in 1935 in Kyneton, Victoria, in office from 1986 to 1994 and now in the National Centre for Development Studies at ANU; William Patrick (Bill) McLennan, born in 1942 in Grafton, New South Wales, from 1995 to 2000; and Dennis John Trewin since July 2000.

Trewin was born in Melbourne in 1946 and is a graduate of the University of Melbourne and the London School of Economics. He had previously been deputy to Bill McLennan and before that held a similar deputy's position in New Zealand. McLennan retired to become director of the Office of National Statistics in the United Kingdom, the same position that he held before being appointed Australian Statistician. He was also the chair of the UN Statistical Commission from 1994 to 1995. While the commonwealth or Australian Statisticians from McPhee

to Castles had a background more in economics, the most recent two, McLennan and Trewin, were trained in mathematical statistics.[13]

CSIR and CSIRO

The origins of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) have been documented by its former executives, the agricultural scientist George Alexander Currie and the senior administrator John Graham in their book of that title.[14] The beginnings date back to the months before the federal parliament was established in 1901 when several authoritative figures such as Alfred Deakin and Isaac Isaacs were advocating the formation of a federal Department of Agriculture. There was at that time already evidence of successful research in agriculture, such as William Farrer's wheat breeding experiments, but doubts persisted regarding the legality of the commonwealth legislating for a bureau that in many respects may have duplicated existing state agriculture departments, and the matter languished.

In 1913 a report instigated by the South Australian branch of the British Science Guild, in which the Adelaide physicist Kerr Grant played a leading part, recommended the formation of an Australian institute for scientific research. It suggested seven scientific departments, none of which had specific reference to biometrics, for example, or any other area of direct mathematical or statistical application. The impending war and the knowledge that Great Britain recognised its own technological tardiness in comparison with Germany, in particular, highlighted the need for a national body of scientific research in Australia. Strongly pressed by the Victorian government and a group at the University of Melbourne that included the recently retired Thomas Ranken Lyle, his successor as professor of natural philosophy, Thomas Howell Laby, and the mathematician Thomas Cherry's father, who was professor of agriculture there, Prime Minister William Morris Hughes founded the Commonwealth Advisory Council of Science and Industry in 1916. Almost five years of investigation and negotiation by the Council would follow before the Commonwealth Institute of Science and Industry was founded with George Handley Knibbs, then aged 62, as director. The position had been declined by Sir John Monash.[15]

The Advisory Council had undertaken a number of tasks of its own, with progress on the problems of prickly pear and paper pulp, but Knibbs' new scientific institute was "almost devoid of money, scientific staff and research facilities".[16] There were four research divisions—agriculture, industries, information and standards—with no explicit mention by Currie and Graham of associated statistical investigations or even the accumulation of data, despite Knibbs' obvious knowledge of the possibilities. Financial and staffing difficulties were to counteract all of Knibbs' plans. Allocation of projects to universities on an honorary basis was not successful, and the Institute did not even gain a laboratory of its own until 1923.

Public support for fuller government involvement was evident in pronouncements by the press and university departments, and Monash, in his presidential address at the 1924 meeting of the Australasian Association for the Advancement of Science, was outspoken on the "short-sighted neglect" shown by the government. The effect was an announcement in April 1925 of a conference to discuss the reorganisation of the Institute and "how best it could be made useful to the industries of the Commonwealth."[17] It took place the following month with Prime Minister Stanley Bruce in the chair and Alexander Ross, professor of mathematics and physics in the University of Western Australia, as one of 33 distinguished university scientists, industrialists, politicians and public servants who attended. Ross and Knibbs were the only ones present who, in their official capacities, had at least a passing interest in mathematics.

By June of the following year, a refreshing enthusiasm on the part of the federal parliament saw the easy passage of a bill that brought into existence the Council for Scientific and Industrial Research (CSIR) to replace Knibbs' Institute. Before that, appointments had already been made to an executive committee to direct the Council. Its chair for the next 20 years would be the Sydney engineer and inventor of the automatic totalisator, George Alfred Julius, and its chief executive officer for the same period was A. C. D. (David) Rivett, previously professor of chemistry in the University of Melbourne. Unlike its predecessor, the CSIR was to be led by scientists rather than bureaucrats and Julius and Rivett typified this approach; it would be resoundingly successful.[18]

Five areas of research, concerned with animal and plant pests and diseases, food preservation, forest products, and fuel, were identified for immediate examination. The benefits of applying statistical methods in agricultural investigations were brought home to Rivett during a visit to Australia by Sir Edward John Russell, director of Britain's famous Rothamsted Experimental Station, and in July 1928 a studentship to obtain familiarity with the methods of Ronald Fisher at Rothamsted was advertised. It was won by Betty Allan of the University of Melbourne.

This may well have been the first of Fisher's many personal contacts with Australia and Australians. He had been at Rothamsted since 1919 and held the chair of eugenics at University College, London, from 1933 until appointed Balfour Professor of Genetics at Cambridge University. He spent the final three years of his life in Adelaide as a research fellow in CSIRO. Fisher was knighted in 1952 and awarded an honorary doctorate by the University of Adelaide in 1959, one of seven such awards that he received. He died on 29 July 1962 and his ashes lie in St Peter's Cathedral in Adelaide.

Some details of Betty Allan's studentship have been given already in connection with her teaching at the Canberra University College. After spending her first year at Cambridge studying mathematics, statistics, applied biology and general agriculture, then working with Fisher at Rothamsted and fitting in visits to Europe to see applications of agricultural statistics, she returned to Australia and on 29 September 1930 took up duty in the CSIR Division of Plant Industry in Canberra, one of several divisions formed by then.

She consulted and collaborated in a broad range of research programs, listed in a survey in the *Australian Journal of Statistics* as:

> work on plant diseases, genetics, seepage in the Murrumbidgee Irrigation Area, and problems of noxious weeds (Division of Plant Industry); control of blowflies and peach moths (Division of Economic Entomology); effects of various supplements on sheep (Division of Animal Nutrition); strengths of different types of packing cases (Division of Forest Products) to name very few. [19]

Furthermore, from the same article:

> Many of these investigations involved the use of statistical techniques which now appear routine, such as randomised block and latin square designs and their consequent analyses of variance, regression and correlation. However . . . the subject was a rapidly developing one at the time, and these techniques were both novel and, in terms of their impact on research programmes, powerful.

In 1936 Allan gave a series of 16 lectures on statistical techniques to colleagues in the Canberra-based divisions of the CSIR and wrote a series of four papers on those techniques.[20] Besides her teaching at the Canberra University College, she also taught biometrics part time at the Australian Forestry School in Canberra each year from 1938 until her sudden death in August 1952, aged just 47. Allan had married Joseph Calvert, a noted botanist and plant physiologist

in the CSIR and later CSIRO, and was obliged to resign from the CSIR in 1940 as government regulations did not allow women to continue working after marriage. She is acknowledged as Australia's first professional biometrician.

From the time Allan travelled to Rothamsted to study with Fisher, her work was strongly encouraged by Rivett, who continued to be impressed by the relevance of statistical techniques in agricultural and other scientific investigations. When Mildred Barnard sought employment that would use her demonstrated talent in mathematics and physics along with her interest in agriculture, he strongly recommended that she first follow Allan's path to London.

Florence Elizabeth (Betty) Allan, 1905–1952. (CSIRO)

Mildred Macfarlan Barnard, born in 1908, was the younger daughter of R. J. A. Barnard. She had known Betty Allan when both were at the Melbourne Church of England Girls Grammar School and had also attended Melbourne University where she graduated with a BSc in 1931 and an MA in 1932. Encouraged by Belz and Allan, and with the suggestion of future employment from Rivett, she successfully undertook a PhD with Fisher at University College, London, and returned to Australia in late 1936. As anticipated, she was employed in the CSIR as a biometrician, but located in Melbourne in the Division of Forest Products rather than Canberra. She married Sydney Arthur Prentice in 1939 and as a wartime measure was able to remain with the CSIR until 1941. Mildred Prentice did some part-time lecturing in Melbourne and then in Brisbane when her husband was appointed professor of electrical engineering in the University of Queensland in 1950. She was appointed lecturer in mathematical statistics there in 1970, retiring finally in 1977. In 1972 Prentice was the first president of the Queensland branch of the Statistical Society of Australia.[21] She died in 2000.

Along with Betty Allan and Mildred Barnard, Helen Alma Newton Turner is remembered as one of the first three biometricians in the CSIR, all women and all in the 1930s.

Helen Turner was born in Sydney in 1908 and became the first woman to graduate in architecture from the University of Sydney, but the difficult economic conditions at the time obliged her to take a typing course and she found employment in 1931 as secretary to Ian Clunies Ross in the McMaster Laboratory of the CSIR Division of Animal Health and Production. Ross would later be the first chair of CSIRO following the CSIR's reorganisation in 1949. In Turner's words: "There was a statistician on the staff, and in typing his papers I got interested in the new discipline of statistics applied to agricultural experiments."[22] She was prompted to complete courses in mathematics and statistics at Sydney University and by 1934, with the help of Allan and Rivett she was appointed permanently to the laboratory as "Secretary and Statistician". A year later, Rivett wrote to her regarding Allan: "She is a stimulating person and it will be all to the good if you can maintain a close association with her work. If later we can add Miss Barnard to the biometric team, we should get ourselves reasonably equipped on that side." [23]

Turner's interests were in statistics for veterinarians and in 1938–1939 she was able to take leave in Britain where she spent time at Rothamsted and several other research centres in England and Scotland, with ten weeks visiting sheep research stations in the USA on the return

journey. Back in Australia, she was soon appointed full time to the newly created Biometrics Section of CSIR.

By this time, the Aeronautics Division had been established within CSIR and the Radiophysics Division and Lubricants and Bearings Section would soon follow, along with a number of other divisions. World War 2 necessitated the urgent expansion of scientific and industrial research and the involvement of numerous mathematicians in these activities has been recounted in Chapters 4 and 5. The government's responsibilities for the testing and standardisation of scientific apparatus and instruments were also acknowledged with the new National Standards Laboratory established in the grounds of the University of Sydney in 1938. Its three sections, metrology, physics and electrotechnology, were to become divisions of CSIR in 1945.[24]

The new Biometrics Section was to be headed by Edmund Alfred Cornish. Alf Cornish, as he was known, was born on 7 January 1909 in Perth, where he completed his early schooling. He then attended Wesley College in Melbourne and the University of Melbourne, graduating in 1931 with first-class honours in agricultural biochemistry and in agricultural engineering and surveying. He was appointed as an agrostologist, studying grasses, at the Waite Agricultural Research Institute attached to the University of Adelaide and became interested in statistical problems associated with his research. With the encouragement of John Wilton, the professor of mathematics there, Cornish took further courses in mathematics and in 1937 travelled to England to study at University College, London, with Fisher.

Within a few years of his return to Australia, he was appointed to the post in CSIR. Following their marriages and enforced resignations from the public service, Betty Calvert née Allan was replaced by George McIntyre and Mildred Prentice née Barnard by Evan Williams, of whom details have been given in Chapter 6. The Biometrics Section, centred in Melbourne, had Cornish as officer in charge, McIntyre with the Division of Plant Industry in Canberra, Williams with the Division of Forest Products in Melbourne and Helen Turner at the McMaster Laboratory in Sydney.[25]

The section was expanded and renamed the Section of Mathematical Statistics, headquartered in Adelaide, in 1944 and ten years later it became the Division of Mathematical Statistics (DMS), still with Cornish as chief. He was appointed foundation professor of mathematical statistics in the University of Adelaide for a five year term in 1960, while simultaneously retaining his position in CSIRO, and was still there as chief of DMS, but contemplating retirement, when he died suddenly on 31 January 1973.[26] His collected papers were published in a single volume in the following year.[27] Cornish remained productive as a research statistician until the end. His early work on climatology and his later studies in multivariate analysis were key contributions to the field and constituted a major inducement to his former teacher and mentor, Sir Ronald Fisher, to spend his retirement in Adelaide.

George Archibald McIntyre was with Cornish for almost the entire period, retiring as senior principal research scientist in 1971. McIntyre was born in Western Australia on 28 August 1909 and obtained first-class honours in mathematics there, under Charles Weatherburn. Before joining CSIR, he worked for the Australian Council for Educational Research in Melbourne and was largely responsible for the standardisation of intelligence tests in Australia. He spent the year 1948–1949 visiting the Rothamsted Experimental Station and the School of Agriculture, Cambridge, and in 1952, following Betty Calvert's death, gave lectures in statistics at the Australian Forestry School. McIntyre was highly regarded by Cornish but had little concern for

publishing his work and resisted attempts to be promoted beyond the level of senior principal research scientist. He died on 14 June 1974.[28]

Helen Turner remained with the McMaster Laboratory until 1956. Her interest in sheep breeding had grown and at that time she became a senior principal research scientist and leader of the Animal Breeding Section of the Division of Animal Genetics, achieving national and international renown. With a DSc awarded by the University of Sydney in 1970 for her published work on sheep breeding, she retired in 1973 and died on 26 November 1995. Turner was one of the founders, along with Cornish, of the Australasian Region of the Biometric Society in 1948 and was foundation president of the Statistical Society of New South Wales.[29]

Of a number of statisticians that Cornish recruited to Adelaide and elsewhere around the country, mention may be made of Alan James, later professor of statistics in the University of Adelaide, and Graham Wilkinson, both of whom were recipients of the Pitman Medal. James' career is described elsewhere. Wilkinson was a student of Pitman's, graduating BSc from the University of Tasmania in 1947. He worked with Cornish in Adelaide from 1950 to 1970, gaining an honours BSc in 1953 and an MSc in 1958, and then held a number of overseas appointments including four years at Rothamsted Experimental Station before returning in 1978 to a position in the University of Adelaide. He was awarded a DSc from that university in 1980 and in 1986 resigned from there to take an appointment again with CSIRO in Adelaide.

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The change from CSIR to CSIRO took place in 1949. In the late 1940s political pressure called for a separation of the military research, which the CSIR had taken on over the preceding ten years, from the civil scientific and industrial research for which it was founded. David Rivett, who by then was Sir David and chair of CSIR, saw nuclear physics, for example, as an instance of the second category but "Cold War paranoia"[30] dictated otherwise and Rivett was to be an eventual casualty of the establishment in May 1949 of the Commonwealth Scientific and Industrial Research Organization in place of CSIR. ("Organization" was changed to "Organisation" in 1986.)

Helen Newton Turner and Sir Ronald Fisher sailing on Sydney Harbour in 1960. (CSIRO)

The CSIR's Division of Aeronautics at Fishermans Bend was transferred to the Commonwealth Department of Supply and Development and renamed the Aeronautical Research Laboratories. This, along with Melbourne's Munitions Supply Laboratories, the Weapons Research Establishment which incorporated several laboratories in Salisbury, South Australia, and numerous other laboratories around the country, was incorporated into the Defence Science and Technology Organisation (DSTO), within the Department of Defence, in 1974. The late 1940s was also the time of the discovery of a uranium deposit in the Northern Territory and the establishment of the Industrial Atomic Energy Policy Committee, the direct antecedent of the Australian Atomic Energy Commission. This was reorganised in 1987 as the Australian Nuclear Science and Technology Organisation, conducting most of its activities from Lucas Heights, southwest of Sydney.

Meanwhile, with the passing of Alf Cornish in 1973 a search was instigated for a successor in the DMS. Joe Gani, then at Sheffield, was not altogether pleased with his Australian experiences to that date and resisted an invitation to return. The job was offered to the distinguished theoretical physicist, John Adair Barker, who was originally from Western Australia but at that time was with the IBM Research Laboratory in San Jose, California. He declined the position and the request again went out to Gani who agreed at least to undertake a review of the division.

Gani reported that DMS was too oriented to agricultural and biological statistics whereas more emphasis was required in a modern setting on other areas of mathematical application such as operations research and computational mathematics. Several months after submitting his report, Gani was told that it had been accepted in full by the executive of CSIRO and that only he could implement the recommendations. In consequence, towards the end of 1974 Gani returned to Australia as chief with the brief to steer the division away from being essentially an agricultural consulting service and to develop it into an integrated research and consulting bureau.[31]

The acting chief of DMS for the 20 months from January 1973 until Gani took over was Geoffrey W. Hill. He had first joined CSIRO's Division of Radiophysics as a part time technical assistant in 1949 and he remained with CSIRO, moving through a number of divisions, until his death in 1982, aged 57. Hill was one of Australia's first workers in electronic computing, being involved with Trevor Pearcey in the design and construction of the CSIRO computer, CSIRAC, in Sydney. With an MSc from the University of Sydney, he transferred to DMS in Adelaide in 1955 and two years later was seconded to the CSIRAC Computation Laboratory, by then situated in the University of Melbourne and under the general supervision of Tom Cherry. Hill enrolled for a PhD under Cherry and the degree was awarded in 1961 for a thesis entitled *Advanced Programming of Digital Computers*. In this, he began his major work on algorithms and optimisation techniques for use in statistical computations, later applied to mineral research. Hill was promoted to senior principal research scientist in 1971 and spent his final years in the Division of Mineral Chemistry in Melbourne.[32]

With the results of his review in mind, shortly after Joe Gani took up office in the Division of Mathematical Statistics he moved its headquarters from Adelaide to Canberra and he made a subtle change to its name: it became the Division of Mathematics and Statistics, still DMS. Gani was chief of the division for seven years, recruiting to it Chris Heyde as assistant chief and Richard Tweedie who became senior regional officer in Victoria, and many others.

A review in 1981 by a committee chaired by John Philip, as head of the Institute of Physical Sciences in which DMS was located, was complimentary on the quality of its work yet critical

in that this did not accord with the government's requirements. With the indication of a coming cut in resources, Gani resigned his post and took a chair in statistics at the University of Kentucky. Four and a half years later, he was invited to create a Department of Statistics at the University of California, Santa Barbara, and he spent the final ten years of his formal working life there, retiring in 1994. That meant returning to Australia to a visiting fellowship at ANU, where he remains active in research.[33]

When Gani departed, Heyde took over as acting chief of DMS until the appointment in early 1983 of Terry Speed to the post. Terence Paul Speed, born on 14 March 1943 in Victor Harbour, South Australia, had been educated in Melbourne. He obtained a BSc with honours from the University of Melbourne in 1964 and a PhD from Monash in 1969. His interests turned to statistics, though oddly enough his PhD was in algebra and supervised by Peter Finch, a statistician. In a career that tended to follow Joe Gani around the world, Speed went then to Sheffield University and in 1974 was appointed to the chair of statistics in UWA. His term of three and a half years with CSIRO followed, after which Speed took the chair of statistics at the University of California, Berkeley. Ten years later, he combined that with a joint position in the Division of Genetics and Bioinformatics at the Walter and Eliza Hall Institute of Medical Research in Melbourne and today still divides his time between the two institutions.

Speed's period with CSIRO was highlighted by the recognition, as for universities around the country, that there was to be a growing need for external earnings leading in CSIRO's case to an increased concentration on assistance to Australian industry. The recommendations of the McKinsey review of CSIRO at that time almost led to the closing of DMS. That was forestalled but nonetheless the changing circumstances meant the time that Speed and previous chiefs had allowed the scientists there for personal research had to be curtailed.[34]

Born and educated in England, Peter J. Diggle succeeded Speed as chief of DMS for the period July 1987 to June 1988. He had been a senior research scientist and then principal research scientist in DMS from 1985. Diggle, now professor of statistics in the University of Lancaster, England, was succeeded by Ron Sandland, who first joined DMS in 1969 and currently holds a senior executive position in CSIRO. Sandland was educated at the University of Sydney and UNSW (PhD in statistics, 1980) and was chief of DMS from 1988 to 1999. The transformation from Terry Speed's time as chief was completed in spectacular fashion by Sandland:

> His leadership of that Division was characterised by his driving a complete culture change that took it from an internally focused group to one that was strongly externally focused and customer oriented. The Division's external revenues increased fourteen-fold over the period 1988 to 1996.[35]

In 1997 restructuring within CSIRO brought together the Division of Mathematics and Statistics, the Division of Information Technology and certain Biometrics Units to form the Division of Mathematical and Information Sciences, referred to as CMIS (where C stands for CSIRO), headquartered now in North Ryde, a northern suburb of Sydney. The current chief is Murray Cameron, a graduate of the University of Sydney with a PhD in time series analysis from ANU. There are about one hundred mathematicians and statisticians employed in CMIS's offices around the country.

Some have been there almost 30 years. Frank Robert de Hoog, for example, joined DMS in July 1977 as a research scientist. Born in 1948 in Leyden, Holland, de Hoog took his first degree from the University of Western Australia. In 1973 he received a PhD from ANU for work on the numerical solution of integral equations. He became a chief research scientist in

1997 and is now director of research at CMIS. De Hoog had been a research fellow with Bob Anderssen in the ANU Computer Centre from 1975 to 1977 and talked him into joining DMS in 1979. Anderssen is still there, now as chief research scientist. The Australian Mathematical Society Medal was awarded to de Hoog in 1988 and the Society's George Szekeres Medal to Anderssen in 2004.

Noel Barton is another Australian mathematician identified with CSIRO. He was educated at the University of Western Australia, where he graduated with a PhD in applied mathematics in 1973. He followed that with a CSIRO postdoctoral scholarship for study at Cambridge. After six months at the University of Queensland and then six years at UNSW, Barton began with CSIRO in 1981 and resigned in December 2003 to set up a private business venture. He was honoured that year by the award of an honorary doctorate from the Queensland University of Technology (QUT).

Barton was leader of CSIRO's applied mathematicians from 1987 to 1999. During that time, the group grew to contain more than 30 staff members, with sub-groups concerned with the mathematical modelling of industrial processes, computational fluid dynamics, and operations research.

De Hoog led the mathematical modelling group. One of its successes was the work by the Queenslander Tony Miller, who has been with CSIRO in Adelaide since 1986. His mathematical modelling of spectacle lenses culminated in the winning of the Sir Ian McLennan Achievement for Industry Award, given annually in memory of a former chair of BHP, in 2000. Nick Stokes, with a PhD from ANU, led the computational fluid dynamics group for 15 years and Graham Mills, who had previously worked at the University of South Australia and is now retired, led the operations research group.

Barton was the director of the Mathematics-in-Industry Study Group (MISG) on seven occasions from 1985 to 1993. The MISG was first brought to CSIRO and Australia by Terry Speed in 1984 when he was chief of DMS. It followed the format of a successful and long-running initiative championed by John and Hilary Ockendon of Oxford University's Centre for Industrial and Applied Mathematics. The Ockendons were invited to Australia to run the first MISG, held at the University of Melbourne, and were helped by Kerry Landman, who was at that stage an applied mathematician employed by Siromath, the commercial arm of DMS established in 1981. Landman has a BSc and PhD from the University of Melbourne and is now associate professor of applied mathematics there. The MISG helped DMS build up a portfolio of commercial clients and provided valuable marketing knowledge on the mathematical requirements of Australian industry. In 1993, it was released to the wider mathematical community in Australia, first to the University of Melbourne, with Landman as director, from 1994 to 1997; then to QUT with Sean McElwain as director, 1998–1999; then the University of South Australia with Phil Howlett and David Panton as directors, 2000–2003; and most recently to New Zealand under the directorship of Massey University's Graeme Wake. In the mid-1990s, the MISG was made into a special interest group of ANZIAM, the revamped Division of Applied Mathematics of the Australian Mathematical Society.

De Hoog, Anderssen, Barton and others just mentioned are applied mathematicians, but the large majority of CMIS's mathematical scientists are statisticians. Nicholas Irving (Nick) Fisher, for example, took honours in mathematical statistics from the University of Sydney in 1968 and joined DMS the following year. He resigned from there as chief research scientist in 2001 to go into private consultancy. He has been a vice-president of the International Statistical

Institute and president of the Statistical Society of Australia, and, with a DSc from the University of Sydney awarded in 1994, is currently a visiting professor of statistics there. Fisher is also a visiting professor of geology at Macquarie University, indicating the breadth of his interests. In the manner that Keith Bullen and Barry Ninham viewed modern applied mathematics as not occupying a special relationship with traditional mathematics, so Fisher holds an embracing view of statistics as the science of managing uncertainty, within which mathematical statistics need not play a major role.[36]

There are mathematical scientists in other divisions of CSIRO as well, such as Forestry and Forest Products, and Atmospheric Research.[37] Jorgen Frederiksen, for example, a graduate in mathematical physics from the University of Adelaide and since 1996 chief research scientist in the Division of Atmospheric Research, was recently elected to a fellowship of the Australian Academy of Science.

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The final paragraphs of this section are not intended for those weak of heart.

The Division of Atmospheric Research was called the Division of Atmospheric Physics when the notorious Rory Jack Thompson joined it in 1976. Thompson was born in Seattle in 1942, excelled in his undergraduate mathematics at San Diego State College and took a PhD in meteorology at the Massachusetts Institute of Technology in 1968. He had a number of lecturing positions in mathematics around Australia before joining CSIRO and he held a chair in oceanography for a short time at Florida State University. With more than 50 journal articles in his name and after 15 years as a professional scientist, he moved with his wife and two young children to Hobart in January 1983 as principal research scientist in the newly formed Division of Oceanography. That September he strangled his wife, cut up her body, flushed much of it down the toilet and buried the rest. Thompson was arrested within a week and the following February was found not guilty of murder by reason of insanity. There were subsequent recommendations for his release from incarceration, with none acceded to, and in September 1999 he hanged himself in his cell in Risdon Prison Hospital.

By deed poll in August 1994 Thompson had changed his name legally to Jack Newman.[38]

The Academy of Science

The Australian Academy of Science was founded in 1954 on the initiative of Australian fellows of the Royal Society of London. It was granted a royal charter, which established the Academy as an independent body, but with government endorsement allowing it to supersede the Australian National Research Council that was formed in 1919. That council had been established following World War 1 to permit Australia's participation in the scientific work of the International Research Council and to act itself as a national academy of science, but it was never able to win the high prestige, particularly from government, that was gained by similar bodies in other parts of the world.[39]

Mark Oliphant and David Forbes Martyn are considered to be the founding fathers of the Academy. In November 1951 they wrote to all fellows of the Royal Society who were resident in Australia with their suggestion for a new national scientific society. Including themselves, there were just twelve such fellows, the only mathematicians among them being Keith Bullen and Thomas Gerald Room. George Michell, the engineer and inventor who was the brother of the Melbourne mathematician John Michell, by then deceased, was another of the twelve and he alone was not in favour of the move. Eleven additional eminent local scientists, includ-

HRH Prince Philip, left, with the Academy president, T. M. Cherry, at a special general meeting in September 1962. (Australian Academy of Science)

ing Tom Cherry who gained his FRS shortly after, joined the original group in an approach to Prime Minister Robert Menzies at the end of 1953 and, with the prompt attainment of the royal charter, government support for the new academy and acquiescence to its independence were ensured.[40]

Bullen, Cherry and Room were among the foundation fellows of the Academy. The first elected fellows, in 1954, included Eric Barnes, Alf Cornish, Bert Green, John Jaeger, Edwin Pitman and Charles Henry Brian Priestley (always known as Bill Priestley; his connection with mathematics and Monash University is described in the following chapter). Oliphant was the president and Cherry one of the ordinary members of its first council. Cherry was vice-president in 1955, secretary (physical sciences) from 1955 to 1959 and president from 1961 to 1965. Other past and present office holders among mathematical scientists on the council of the Australian Academy of Science are listed in Appendix 3.

The Academy operates with a varying number of National Committees designed to foster the branch of science in Australia that each individually represents. The chair of the National Committee for the Mathematical Sciences, since July 2004, is Hyam Rubinstein from the University of Melbourne, succeeding Peter Hall from ANU. The committee was outspoken in its call in mid-2002 for a national mathematics institute, for example, and conducts a website with copies of numerous reports, documents and submissions to support its view that "Aus-

tralian mathematics has been languishing for more than a decade, first edging downhill and now declining at an accelerating pace."[41] The Australian Subcommission of the International Commission on Mathematical Instruction is a direct responsibility of the National Committee for the Mathematical Sciences. The Academy also has a less active National Committee for Theoretical and Applied Mechanics.

During the mid-1980s, the Academy was instrumental in seeking to coordinate the work of Australia's larger scientific societies in lobbying government after an attack on science and technology funding in the preceding federal budget. It was therefore very supportive of the formation of an umbrella organisation, the Federation of Australian Scientific and Technological Societies (FASTS), in 1985. The Australian Mathematical Society was one of its founding members.[42] By 1989, smaller mathematical organisations were represented within FASTS by the Australian Mathematical Sciences Council (AMSC).

Key people involved in the formation of AMSC included Garth Gaudry, who was its first president, Bob Anderssen, Pat Costello and David Widdup. At the time, Gaudry was also president of the Australian Mathematical Society, Anderssen was treasurer of FASTS, Costello was president of AAMT, and Widdup was executive director of FASTS. The original member societies of AMSC were the Australian Mathematical Society; the Statistical Society of Australia; the Mathematics Education Research Group of Australasia (MERGA); the Mathematics Education Lecturers' Association (MELA); and AAMT, which withdrew from the organisation at the start of 1996. MERGA and MELA were both formed around 1976 and amalgamated under the banner of MERGA in 2000. The Australian Society for Operations Research is also now a member of AMSC.[43]

There are presently around 400 fellows of the Academy, with 16 new fellows elected each year. Election to fellowship acknowledges a career that has significantly advanced scientific knowledge. Current fellows (in June 2006) who are now or have been involved in the mathematical sciences in Australia are listed in Appendix 3 along with lists of corresponding members of the Academy and of deceased fellows who were associated with the mathematical sciences. Corresponding members are persons who are eminent in respect of scientific discoveries and attainments but are not normally resident in Australia; no more than two corresponding members can be elected in any one year.

The story of Richard Meyer's election to fellowship makes interesting reading.[44] Richard Ernst Meyer was born in Berlin on 23 March 1919 and had a very classical school education that included no science or mathematics, but studies at the Swiss Federal Institute of Technology in Zurich from 1937 to 1945 led to a doctorate on aerodynamic effects in future aircraft jet engines. "Primarily, however," he wrote, "I studied mountaineering." From 1946 to 1952, Meyer was in the mathematics department at the University of Manchester, where he supervised the PhD theses of Harry Levey and John Mahony, and from there he obtained a senior lectureship in aeronautical engineering at the University of Sydney. He was resident in Australia for only five years:

> The biggest surprise came in mid-1956 with a telegram that I had been elected to the Australian Academy of Science. I had not had the slightest hint of being a candidate and never found out who may have proposed or seconded me. My department head turned out to be a knowing and unsuccessful candidate, he left promptly for a chair in Belfast; half the committee selecting his successor had also been unsuccessful candidates and rejected me. That saved my research career, but I did mind that nobody gave a sign of wanting me to stay. A couple of months later, I got a prestigious offer from the US . . . and left Sydney at the start of 1957.

Meyer's new post was at Brown University, where he befriended Walter Freiberger, and then from 1964 to 1994 he was professor of mathematical physics at the University of Wisconsin. He became a foundation member of the Australian Mathematical Society in 1956 and returned to Australia for a semester at the University of Queensland in 1975, at the invitation of Fenton Pillow. During a lecture tour of the country at that time, Meyer particularly remembered meeting Rainer Radok:

> [It] turned out that a few wave-gauges which he had installed on an uninhabited, storm-tossed island in the Southern Ocean, created records which sparked one of the major pioneering advances in mathematical fluid dynamics of the last half-century, in which even I got involved much later.

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The Academy of Science makes numerous awards, many of which are specifically directed at the mathematical sciences. The oldest of these is the Lyle Medal, in recognition of Sir Thomas Ranken Lyle FRS, first awarded in 1935 by the Australian National Research Council and subsequently taken over by the Academy. J. R. Wilton, professor of mathematics in the University of Adelaide, won the medal at its initial presentation. There was no award then until 1941, when it was won jointly by T. G. Room of the University of Sydney and the physicist George Henry Briggs. Again it was six years until the next award but the Lyle Medal has since then been awarded every two or three years and its recipients are a large subset of those fellows listed in Appendix 3.

The Hannan Medal commemorates Ted Hannan's achievements in time series analysis as well as mathematics generally and is awarded in turn in one of three areas—pure mathematics, applied and computational mathematics, and statistical science—at two-yearly intervals. It was first awarded in 1994, jointly to Peter Hall and Chris Heyde.

The Matthew Flinders Medal and Lecture recognises "scientific research of the highest standing in the physical sciences". First awarded in 1957, the winners in 1969, 1976, 1984, 1986 and 2006 were, respectively, Keith Bullen, Bill Priestley, Bernhard Neumann, Jacob Israelachvili and Peter Hall.

The Moran Medal, partly endowed by the Australian Mathematical Society,[45] commemorates Pat Moran's contributions with an award for outstanding research by scientists, usually under 40 years of age, in one or more of the fields of applied probability, biometrics, mathematical genetics, psychometrics and statistics. It was first awarded in 1990, the winner being Alan Welsh who is now a professor of statistics at ANU. The Pawsey Medal recognises the contributions

The Hannan Medal, the Moran Medal and the Jaeger Medal. (Australian Academy of Science)

to science in Australia by the late physicist Joseph Lade Pawsey; its purpose is to recognise outstanding research in physics, again by scientists under 40. Winners have included Barry Ninham in 1971 and Rodney Baxter in 1975.

There is also the Jaeger Medal, named for John Conrad Jaeger "for contributions to the Science of the Earth and its Oceans".

"Adding to Australia"

As one of its reviews of the major academic disciplines in Australia, in 1993 the Australian Research Council (ARC), which was the government's primary advisory body on national research priorities, initiated a strategic review of research activities in the mathematical sciences and an investigation of the provision of high level mathematical services across the country.[46] What was then called the National Committee for Mathematics of the Australian Academy of Science was the overall coordinating body for the review and it appointed a working party that would implement the terms of reference determined by an advisory council.

The working party consisted of Alf van der Poorten from Macquarie University as chair with Noel Barton from CSIRO as executive officer; Michael Barber, at that time a pro-vice-chancellor at UWA; Tim Brown, then head of the Department of Statistics in the University of Melbourne; Derek Robinson, emeritus professor at ANU; and Edwin van Leeuwen, who is now the manager of exploration technologies with BHP Billiton. The advisory council was chaired by Cheryl Praeger from UWA. Praeger had just stood down as president of the Australian Mathematical Society, Robinson was the current president and van der Poorten was to succeed him, and Barton was chair of ANZIAM, so the Society could hardly have been better represented.

The term "mathematical sciences" was to be interpreted broadly to include mathematics in its own right, the various branches of applied mathematics, statistics, operations research, actuarial science and computational mathematics. After some two years of effort, the 120 page report of the working party, under the title *Mathematical Sciences: Adding to Australia* and dated January 1996, was submitted to the ARC. There were 20 recommendations, directed across the field to such parties as individual department heads, the Australian Vice-Chancellors' Committee, the Australian Taxation Office and the Australian Mathematical Society.

The scope of the review was unprecedented in Australia. It conducted hearings in eight cities across the country during which it received submissions from over 40 academic departments and "well over 50 non-academic enterprises and organisations".[47] It directed its attention to the future conduct of the mathematical sciences profession over the 15 year period 1995–2010 and among its principal findings observed a number of "major" challenges which are sufficiently current to be worth repeating here in full:

- improving the image of the profession to match its importance and effectiveness
- balancing an age distribution which is currently skewed by the growth in the profession in the late 1960s and 1970s
- redressing the gender imbalance at senior levels
- attracting good undergraduate students into mathematical sciences courses
- increasing opportunities for postdoctoral level researchers
- broadening the funding base for research
- educating potential users to the value of the mathematical sciences
- improving technology transfer programs and associated educational programs, particularly for [small to medium enterprises][48]

Beyond the research that was carried out in the universities, typically categorised as "basic", the review identified those government laboratories that conduct "applied research and experimental development". Largest among these were the DMS at CSIRO, as it existed then; the Australian Bureau of Statistics; and DSTO. However: "Many other government laboratories in Australia, both federal and state, employ mathematical sciences PhDs. Examples include other CSIRO divisions, the Bureau of Meteorology, and various primary industry departments that employ biometricians."[49] As regards the private sector, the working party concluded unsurprisingly that "industrial application of the mathematical sciences in Australia is neither broad nor deep by the standards of best international practice," but it did identify a few large companies that employ "many" mathematicians—companies like BHP, Telstra and various banks and investment houses. There was also a "handful" of businesses conducting consultancies in statistics and operations research.

Chapter 2 of the report of the working party gave a summary of the historical development of basic research in the mathematical sciences in Australia, almost all conducted in the universities and almost all dating only from the early 1960s apart from the work of a few exceptional individuals. Lamb, Cherry and Pitman were mentioned in that category. There was also a "snapshot of current activity" which led to the following conclusion:

> [We] find that current basic research . . . is varied, vibrant and involved in many of the most modern developments. There is widespread activity in universities, and the significance of the mathematical sciences has been acknowledged in the planning of government institutions such as CSIRO and DSTO. Financial support of the mathematical sciences by the Australian Research Council has increased substantially over recent years. . ., some individual researchers are recognised as world leaders, and Australian groups have had significant impact in a variety of areas. Australian publications in the mathematical sciences remain at respectable international levels, particularly when the citation impact of these papers is considered.[50]

The situation away from basic research was less happy. The term "Advanced Mathematical Services" was used by the working party "to denote work based on mathematical principles and carried out by people with at least graduate level experience in the mathematical sciences". Examples given included: the use of optimisation methods to develop more efficient crew rosters or timetables; the analysis of large and complex sets of data; the design and analysis of clinical trials; the use of mathematical or computational models to improve the design of industrial equipment or processes; financial applications of mathematics such as optimisation of investment portfolios or pricing of options; economic forecasting; simulation of mining or mineral processing operations; the use of mathematical techniques for layout of facilities such as warehouses and factories; and statistics applied to public health and epidemiology.[51]

Such a varied range of activities enabled the working party to conclude "that the total number of people providing advanced mathematical services to the Australian economy is substantially larger than the number of academic mathematical scientists." Furthermore:

> This large body of people carries out work which is vital to the nation, but the pivotal and critical role of the mathematical skills they use is largely unappreciated because of their diverse range of activities and mode of employment.[52]

This was a serious call for recognition to administrators in government and industry, which, in the way of these things, had little impact on the subsequent conduct of the mathematical sciences in Australia, with possibly one exception. The working party called strongly for a national mathematical sciences research centre along the lines of the Mathematical Sciences Research Institute in Berkeley, the Fields Institute for Research in Mathematical Sciences in Toronto and

the Isaac Newton Institute for Mathematical Sciences in Cambridge. The New Zealand government was behind the establishment in June 2002 of the New Zealand Institute of Mathematics and its Applications,[53] but Australia continued to lag behind.

Finally, in November 2002, the Australian Mathematical Sciences Institute (AMSI) was established, not through the ARC or with federal government funding, as recommended by van der Poorten's group, but with initial funding of $1,000,000 from the Victorian government and matching funds from a consortium of Australian universities and other mathematical organisations. Premises for AMSI were provided by the University of Melbourne nearby in Barry Street, Carlton, and commonwealth funding was later received for summer schools conducted by AMSI since January 2003.

Much of the credit for the formation of AMSI, and a great deal of the hard work behind it, was due to Jan Thomas who was then a senior lecturer in mathematics education at the Victoria University of Technology. In 2001 she saw the opportunity for such an institute that was provided by the Victorian government's Science, Technology and Innovation program and she and Tony Guttmann wrote the grant application.[54] Now employed full-time by the Australian Mathematical Society and AMSI as executive officer to both organisations, Thomas is a former president of AMSC and in 2000 was vice-president of FASTS. Guttmann, a professor of mathematics in the University of Melbourne and at the time a vice-president of the Australian Mathematical Society, subsequently became acting director of AMSI, pending a formal appointment to that post.

AMSI has a mission to "become a nationally and internationally recognised centre for the mathematical sciences, providing service to its member institutions, improving the international competitiveness of Australian industry and commerce and enhancing the national level of school mathematics, by the provision and support of mathematical and statistical expertise." Garth Gaudry succeeded Guttmann as full-time director until mid-2005 at which time Philip Broadbridge was appointed. Peter Hall, who as chair of the National Committee for the Mathematical Sciences had also called for the formation of an institute such as AMSI, is chair of AMSI's Scientific Advisory Committee.

As far as Australian mathematics is concerned, perhaps more than any other action since the founding of ANU, AMSI is indeed "Adding to Australia". It is not coincidental that, since the founding of AMSI, two further centres of excellence were established with federal funds. The ARC supported funding of approximately $2,400,000 a year for the five years 2003 to 2007 for MASCOS, the Centre of Excellence for Mathematics and Statistics of Complex Systems. Guttmann is director of the Centre. Research carried out for MASCOS by investigators around Australia has applications in traffic control, understanding catastrophic failure, modelling financial systems, risk modelling, meteorology and oceanography, among others. The University of Melbourne administers the Centre with premises almost next door to those of AMSI and the two have a close working relationship.

Then, in January 2004, the federal government awarded to AMSI the International Centre of Excellence for Education in Mathematics, known as ICE-EM. With funding of $7,800,000 over four years, its concern is the development of mathematics and statistics education at all levels, from kindergarten to advanced research and technology transfer in collaboration with industry. Gaudry left his position at AMSI to become director of ICE-EM. A typical report of AMSI and ICE-EM was its account of major disparities in final year school mathematics syllabuses and assessment methods across Australia. Authored by Frank Barrington from the University of Melbourne and Peter Brown from UNSW, the report made front-page news in October 2005.[55]

Another ARC centre of excellence with a mathematical connection was also established in 2003. CUDOS, the Centre for Ultrahigh-bandwidth Devices for Optical Systems, received total funding of $3,500,000 per year for five years, including a contribution from the New South Wales government. CUDOS undertakes theoretical and experimental research into the development of all-optical signal processing devices that will lead to the development of the photonic chip, an integral component of the next generation of optical communication systems. A key element is based in the Department of Mathematical Sciences at UTS, where Tasmanian-born Lindsay Charles Botten, professor of applied mathematics there since 1998, leads CUDOS's computational modelling program. Botten's honours BSc and PhD (awarded in 1979), both from the University of Tasmania, were in theoretical physics.

To return finally to the working party's report, its later chapters concerned issues of human resources, education and funding, as well as the predictions for the 15 years to come. It remains as the most impressive and comprehensive survey of mathematics in Australia and the only one to concentrate in such depth on the applications of mathematics.

Other surveys

In 1914, as Australian representative to the International Commission on the Teaching of Mathematics, Horatio Carslaw presented a report[56] that surveyed all aspects of mathematics as it was then taught across the country, in secondary schools and to a lesser extent primary schools, in the technical colleges and the teachers colleges, in the Royal Military College of Australia and the Royal Australian Naval College, and in the universities. The report also provided a useful review of the totality of work done in technical and teachers colleges, not just in mathematics. Because of the insight it gives into the mathematics taught across the country almost a century ago, the complete document has been summarised in Appendix 1.

Many years passed before there were any further reviews of mathematics in Australia. Though his authorship was not explicit, Joe Gani in 1961 wrote an essay on mathematics in Australia for the *Current Affairs Bulletin* published by the University of Sydney.[57] Half of the article was on the nature of mathematics generally, with the second half concentrating on the Australian scene in contrast to other countries' achievements. Overall, it was not an encouraging scene:

> In spite of the research record of Australian mathematicians, graduate students have been scarce at the universities; yet there is a serious need for mathematicians both in the universities and in our society at large if mathematics in Australia is to progress in a balanced manner. For a variety of reasons, among them public apathy, the inadequate value set on research, the difficulty of justifying an abstract intellectual pursuit, the lack of funds to improve mathematical training in Australia, a critical situation has developed where a severe shortage of skilled mathematicians exists.

Gani wrote other reports on mathematics in Australia including a series of studies that made use of the *Research Register* produced by the Australian Mathematical Society as well as detailed statistics on staff and student numbers gathered from all the universities that existed at the time. The first of the three studies was written jointly with Larry Blakers in 1959.[58] For the final report in the series[59] there were eleven universities, counting the Newcastle University College. Gani, who would come to be acknowledged and appreciated, along with Blakers and Neumann, as one of the earlier visionaries of Australian mathematics, was again not entirely pleased with what he saw. A sympathetic view of the problems faced by Australian mathematics at the time was given in the 1964 report of the commonwealth government's Martin Committee in its chapter headed *The Need for Mathematicians*; some background to this is given in Chapter 10.

Ian Macdonald, who spent less than five years in the country, was also not pleased with what he saw. In 1968 he reviewed the state of pure mathematics in Australia based on publication rates.[60] In the 14 universities at the time, he found just 42 "experts", some of whom were expert in two fields but only George Szekeres in three. Three universities had no experts. Seven years later, using Macdonald's approach, the number of experts among pure mathematicians in the country was found to have more than doubled.[61]

Martin Bunder in 1982 used numbers of postgraduate and honours students, relative to staff numbers, to obtain "an interesting measure of the 'vigour' of Mathematics" in all 19 Australian universities. His top three in order were Monash University, the University of Adelaide and the University of Wollongong.[62]

The Australian Academy of Science, through the National Committee for Mathematics or its variants, has initiated other reviews besides its involvement in *Adding to Australia* in 1996. There was, for example, a review in 1981 conducted on its behalf by Ren Potts. Its report[63] included chapters on pure mathematics (by G. E. Wall), applied mathematics (R. S. Anderssen), Statistics (J. Gani and C. Heyde), mathematical physics (C. A. Hurst), computer science (A. H. J. Sale of the University of Tasmania) and operations research (R. B. Potts).

In 1994 an extensive review[64] of organised mathematics in Australia, with an emphasis on mathematics education and teaching across the country, was published by Nerida Ellerton, professor of mathematics education at Edith Cowan University in Perth, and Ken Clements, professor of education in the University of Newcastle. (Both are now at Illinois State University.) The title of their book, *The National Curriculum Debacle*, described their attitude to the document *Mathematics—A Curriculum Statement for Australian Schools* that was developed between 1990 and 1993 by the Australian Education Council as a national system for monitoring and reporting student achievement. An extract summarises their views:

> Most mathematicians are . . . opposed to reductionist behaviourist approaches to teaching and learning mathematics which, they believe, give rise to atomistic approaches to curriculum development and encourage methods of teaching and learning that fail to assist the development of holistic views of mathematics.
>
> However, the mathematicians' major objection to the national mathematics curriculum documents has been concerned with the quality of the mathematical thinking evident in the national documents themselves. From the mathematicians' perspective, if the documents do not faithfully reflect the history of mathematics, and do not represent quality contemporary mathematical thinking, then the school mathematics programs engendered by these documents will inevitably be less than satisfactory.[65]

Ellerton and Clements' book described the sustained "crescendo of protest" that was led by Garth Gaudry, president of the recently formed Australian Mathematical Sciences Council, and Clements himself, who at the time was president of MERGA. By the end of 1993, the Australian Education Council had decided not to endorse a national curriculum framework and Ellerton and Clements had made their point "that education bureaucrats and politicians *do not* own the curricula of Australia's schools, and should not behave as if they do."[66]

A few years earlier, Ellerton and Clements, together with Lindsay Grimison who was a senior lecturer in mathematics education at the University of Sydney when he retired in 2002, discussed the history of Australian school mathematics, and university mathematics to a lesser extent, largely from the point of view of their dependence until recently on developments in England. Constituting one chapter of a more general book on school mathematics, their work includes reviews of the use of Cuisenaire rods in the 1960s and the "new mathematics"

of the 1960s and 1970s, and, with over 100 references cited, is a valuable resource.[67]

The most recent review of the totality of mathematical sciences in Australia (excepting another by the Academy of Science that commenced in September 2005[68]) was carried out in 2000 by Jan Thomas on behalf of FASTS.[69] In her review, she documented the "brain drain" from Australian universities to overseas posts, since then corrected in small part by the government's introduction of Federation Fellowships, and she emphasised the effect on mathematics research and teaching, even at the school level, by a "decline of some 25% in staff since 1995, . . . marginalised or restructured departments, fewer applications for research grants, few if any new appointments, difficulties in making appointments in key areas such as financial mathematics and statistics, and some universities no longer offering a three year degree majoring in mathematics or statistics." An update by Thomas in 2002 included lists of young Australian mathematicians who had left for positions overseas.[70]

In 2004–2005 there was a review of statistics at Australian universities conducted by the Statistical Society of Australia. In its draft report, there was an acknowledgment of "the growth of related, but increasingly separate, disciplines—such as econometrics, actuarial science, financial mathematics, data mining, biostatistics and bioinformatics—which are substantially founded on the applications of statistical models and techniques". The effect on the core discipline of statistics, however, was an "increasing inability of the university system to continue to supply sufficient numbers of high quality PhD graduates to provide the next generation key leadership capability to maintain and develop innovative research within the Universities and other key Australian research organizations and agencies."[71]

The issues highlighted by Jan Thomas in her review in 2000 are evident in the stories of the long-established universities considered in Chapter 6 and much more so with regard to the University of Canberra in Chapter 7. The following chapter looks at Australia's remaining universities, mainly those established in the preceding 30 years, and shows that the grave situation for mathematics that is evident in the University of Canberra is mirrored in a number of other universities as well.

Chapter 9

Mathematics and the Later Universities

A brief account of the role of government in policy making and funding Australian universities and colleges since World War 2 will assist in an understanding of how mathematics has fared in the universities, new and old. One, the University of Canberra, which was established as the Canberra College of Advanced Education in 1967 and accredited as a university in 1990, has been considered at the end of Chapter 7. The report of how the mathematics discipline has been treated there will be seen to be typical of the situation in a number of the universities that arose from the college sector around that time.

Towards the end of the 1950s, there were nine universities in the country with an average enrolment of just over 4000 students. Fifteen years later there were twice as many universities and numerous colleges of advanced education catering for four times the number of students. The extraordinary growth was due to an expanding economy and the increase in secondary school enrolments following World War 2. There had been a consequent demand for university-educated graduates and university-educated teachers, and the pending crisis was acknowledged by the commonwealth government with its establishment in 1957 of a committee led by Sir Keith Murray to investigate the state of Australian universities.

The wartime measure of transferring the collection of income taxes from the states to the commonwealth necessitated also the transfer of the responsibility for university funding. The Commonwealth Reconstruction Training Scheme in the second half of the 1940s and the Colombo Plan of the 1950s and 1960s, which assisted students from under-developed nations to study in Australia, were the first instances of commonwealth funded aid for the universities. But, with the acceptance of the recommendations of the Murray Committee,[1] the commonwealth government began to make a more substantial and permanent intervention into higher education policy and its funding.

Monash University in Melbourne was the first university to be established as a direct consequence of the committee's report. Macquarie University and La Trobe University followed in 1964, then the University of Newcastle in 1965 and Flinders University in 1966, all attributable to capital grants made to the states for an expansion in higher education.

By the mid-1970s, with 18 universities and over 70 colleges of advanced education in Australia, and following the abolition of student fees under Prime Minister Gough Whitlam, the proportion of government expenditure that went to higher education was around 2.8 per cent, compared with 0.83 per cent in 1957. The colleges of advanced education, as a sector,

constituted the other half of the binary system of higher education introduced in 1965 in an effort to restrain this expansion in cost. They included former teachers' colleges, agricultural colleges and specialist institutions for paramedical studies and fine arts (generally renamed as or amalgamated into Colleges of Advanced Education or Institutes of Higher Education) and those sections of technical colleges that concentrated on tertiary diploma courses (the future Institutes of Technology). All were intended to offer courses of university standard but without the disproportionate expense of a commitment to research and postgraduate training. The binary system was the result of the commonwealth government's acceptance of the main recommendations of its Martin Committee, established under Sir Leslie Martin in 1964.[2] Its recommendations with regard to mathematics are described in Chapter 10.

Many institutions that were classified as colleges of advanced education, more than 100 altogether in 1977, each catered for less than 2000 students and were relatively expensive to operate. By 1981 the commonwealth government was insisting on amalgamations between smaller institutions if they were to continue to be funded. In those years also, college diploma courses were being upgraded to degree courses and postgraduate courses were becoming commonplace, leading to an overlap with university practice. Among the metropolitan institutes of technology in particular, there was pressure to be converted to university status.

The end of the binary system was announced in a commonwealth government green paper in December 1987; it was to be replaced by the Unified National System. Shortly after, the Higher Education Contribution Scheme was introduced whereby students became liable for a contribution to tuition costs. The colleges of advanced education were encouraged to merge into larger institutions, either existing universities or newly created ones, and by 1999 there were 37 public universities across the country with an average enrolment of 18,500. Many were multi-campus institutions, not necessarily cost efficient, but the proportion of government expenditure spent on the universities had fallen by then to less than 2.2 per cent. The student to academic staff ratio in the ten universities in 1964 was 7.0 and in the 37 in 1999 it was 18.4.[3]

An aspect of the Unified National System was increased competition between universities for research funds and one consequence of the overall decline in funding was a quest for overseas full-fee-paying students. The perception of mathematics compared to other disciplines ensured that it was relatively less able to compete for research funds and less able to attract overseas students. Its staple of service teaching to other disciplines was in many cases subsumed by the disciplines themselves and there was in any case a decrease of mathematical content in the syllabuses of many of those disciplines. The effect is apparent in a number of the stories that follow.

Not all of the universities established since the 1950s can be treated here in equal detail (to keep the size of the book down, if for no other reason), but the stories of mathematics in those universities that are discussed at some length, whether large metropolitan universities or small and perhaps struggling regional universities, are indicative of the rest.

The University of Newcastle and the University of Wollongong

It was always the New South Wales state government's intention that the expansion of tertiary technological education in Sydney through the establishment of the New South Wales University of Technology in 1949 would be accompanied by similar facilities throughout the state. Within two years, divisions of the University were operating in Newcastle and Wollongong. Whereas the northern campus was quickly instituted as the Newcastle University College, with connections also to the University of New England (UNE), south of Sydney it was to be the Wollongong

Division of the parent university for ten years. Only then did it gain some independence of name and function as the Wollongong University College but it was still ten years after the University of Newcastle was enacted that on 1 January 1975 the University of Wollongong was similarly incorporated as a self-governing body.

From the late 1950s to the mid-1980s there was also a Broken Hill Division of the New South Wales University of Technology and later of UNSW. The university *Calendars* for many years listed the staff of its School of Mathematics in the Division of Science at Broken Hill as the senior lecturer B. S. Ray, MSc (Calc), PhD (Gött), and the lecturer P. S. Ray, MSc (Calc). They were father and son, respectively.

The University of Newcastle

Prominent citizens of the Newcastle region, north of Sydney, had been campaigning throughout much of the first half of the 20th century for some form of university representation in their city. An approach to the University of Sydney to establish a college in Newcastle, although considered a *fait accompli* there in October 1942, had fallen through by December when the university senate in the end gave little more than an expression of sympathy for the project. It was nine years later, on 3 December 1951, when the Newcastle University College, affiliated with the New South Wales University of Technology which had been founded just three years before, opened on the site of the Newcastle Technical College.[4]

The College began teaching in March 1952 with 18 teaching staff from the technical college organised into seven schools, of which one was the School of Mathematics servicing courses in engineering, metallurgy, physics and chemistry. The head of school was Ivan L. Rose and its only other staff member was Mort Temple. Rose was with the college, and later the University of Newcastle, until late 1974, by which time he had been promoted to associate professor. He obtained a PhD from UNSW in 1960, supervised by Austin Keane in its Wollongong Division, and he is remembered in the area for his work in helping to start the Newcastle Mathematical Association. He died in November 1985. One claim to fame of his associate, Mort Temple, was that at Trinity College, Dublin, he had been a mathematics tutor for James Johnston Auchmuty, a historian and founding vice-chancellor of the University of Newcastle. Temple died in 1968.[5]

In an unusual arrangement, in 1954 the College taught subjects towards a BA from UNE, with an enrolment of five students in Mathematics I. The arrangement did not last long: by 1958 Newcastle's students were graduating with a BSc or a BA from UNSW, although for some years to come the better graduates were encouraged to undertake an honours year at New England. By that time the mathematics staff had been increased with the addition of John Alexander Lambert, Roman Frantisek Matlak and Warren Brisley. John Robilliard Giles arrived a year later. All four had completed mathematics honours degrees in the University of Sydney in the early 1950s.

Lambert gained a senior lectureship in mathematics and in 1969 was appointed the foundation director of computing sciences in the University of Newcastle; he remained with the University throughout his working life and died in May 2001. Brisley and Giles had parallel careers. Brisley was born in Newcastle in 1932 and Giles in Sydney in 1933, they taught in schools for about three years before joining the Newcastle University College, they obtained their PhDs in 1969 (Brisley from the University of Newcastle and Giles from UNSW), and they retired as associate professors in December 1993 but both still maintain a relationship with the University. Giles had a more extensive research career, predominantly in functional analysis.

Matlak was born in southern Poland on 3 October 1912 and had just taken a university teaching position after completing his studies in mathematics at the University of Cracow when war broke out. He spent six years as a prisoner of war in Germany and came to Australia in 1949. Obliged to renew his studies, Matlak's honours degree at Sydney University was obtained in 1955 while he was teaching at St Stanislaus College, Bathurst, and the job in Newcastle followed one year later. He moved to Sydney in 1960, first to UNSW and nine years later to Macquarie University. A PhD from UNSW, supervised by George Szekeres, was awarded in 1970. Matlak retired from Macquarie University as a senior lecturer in 1977 and took on a new career as an interpreter and translator for the state government's Department of Ethnic Affairs. One of the earliest members of the Australian Mathematical Society, he died in Sydney on 19 June 1992 after several years of illness.[6]

Preparations for autonomy from UNSW began in 1962. In December 1964 legislation was passed creating the University of Newcastle as the second provincial university in New South Wales, UNE being the first, and autonomy was granted soon after. By 1966, coinciding with the move of the university to its current site at Shortland (now Callaghan) and with a professor of mathematics having been appointed two years before, the Department of Mathematics was able to offer its first fourth-year honours course.

Ian David Macdonald was appointed as the first professor of mathematics in 1964 but he held the chair only for two years before taking a readership in the University of Queensland. He was succeeded in the chair by Reyn Keats after more than a year in which the position remained vacant. Other appointments in the 1960s and early 1970s included Ivor Vivian, who moved to the Canberra College of Advanced Education in 1969; W. T. F. (Bill) Lau, who joined the department in 1965 and retired as senior lecturer in 1996; and Paul Smrz and Warren Wood, both of whom arrived in 1971 and who, like Brisley, would later be head of department. Smrz, promoted to associate professor, retired in 1996 and Wood in 2003.

The honours class in the year that Keats arrived, 1968, included John Wylie Lloyd who went on to complete a PhD at ANU in functional analysis, supervised by Sadyuki Yamamuro, and then lectured in mathematics at the University of Melbourne for four years. He completed a diploma in computing in that time and subsequently gained the chair in computer science at the University of Bristol in the UK. Lloyd returned to Australia in December 1998, succeeding Richard Brent in the Computer Sciences Laboratory at ANU. Brailey Sims was in the same year as Lloyd and gained first-class honours and a university medal. His PhD from Newcastle in 1972 was supervised by Giles and in that year he was appointed lecturer at the University of New England. He returned to the University of Newcastle in 1989 and is now an associate professor with his son Aidan, appointed lecturer in mathematics in 2004, as one of his colleagues.

It took three years, but Keats was able to argue successfully for a Faculty of Mathematics based on the quantity of teaching carried out on a service basis to other disciplines—an argument that no one else in the country had been able to mount as convincingly (although the University of Adelaide gained its Faculty of Mathematical Sciences two years later and the University of Wollongong had a Faculty of Mathematics from 1974). The faculty consisted of a single department, the Department of Mathematics, and Keats was its dean until 1976 and again from 1980 to 1983, when he retired and was given an emeritus professorship. The new faculty offered the degrees of Bachelor of Mathematics and Master of Mathematics (BMath and MMath), rarities in Australia, and was soon able to obtain the services of a second professor, an American, Herbert Melvin (Mel) Lieberstein.

There were over 20 members of staff by then, including Wal and Jennie Wallis, both appointed in 1970. Walter Denis Wallis, born in Sydney in 1941, had done a PhD in representation algebras under Sam Conlon at the University of Sydney in 1968 and lectured for four years at La Trobe University before taking the Newcastle appointment. He was promoted to senior lecturer and then associate professor in his 16 years there and is now a prominent graph theorist and combinatorialist, situated at Southern Illinois University, Carbondale, with some 20 books or edited conference proceedings and about 250 papers to his credit.

Jennifer Roma Seberry, born in 1944 and married to Wallis from 1964 to 1973, graduated from UNSW in 1966 and obtained a PhD in computational mathematics from La Trobe University in 1971. After six months with the Canberra College of Advanced Education, four years in Newcastle and two years with the Institute for Advanced Studies at ANU, in August 1976 she gained a lectureship in applied mathematics in the University of Sydney, rising to the position of reader, and in 1984 transferred to a readership in computer science there. Seberry subsequently became professor of computer science at ADFA in Canberra (the first woman in Australia to hold such a chair), moved briefly to a chair at the University of Nebraska–Lincoln, and in July 1992 was appointed professor of computer science at the University of Wollongong. She is there still and for much of the time has also been adjunct professor of electrical engineering at Nebraska. Seberry is noted for her work in cryptography, secure access and privacy. She has supervised more than 30 PhD students in these fields and in combinatorial designs, her original field of research.

Lieberstein's tragically brief tenure as professor of mathematics and his role in getting the Division of Applied Mathematics of the Australian Mathematical Society started are described in Chapter 10. He was replaced by Robert W. Robinson, an American combinatorialist with a PhD from Cornell University, Ithaca. Robinson resigned in 1982 to take a chair at Southern Illinois University, Carbondale, and is presently professor of computer science in the University of Georgia, USA. A third professor, John A. Campbell, with master's degrees from Adelaide, the Massachusetts Institute of Technology and Cambridge and a DPhil from Oxford, was appointed to join Keats and Robinson, but he stayed in Newcastle for just two years.

Roger Benjamin Eggleton took up a lectureship in mathematics at about the same time as Campbell gained his chair, but Eggleton remained on staff much longer. Promoted to associate professor in 1987, he resigned the following year to take the foundation chair of mathematics at the Universiti Brunei Darussalam. Eggleton, born on 6 January 1941 in Renmark, South Australia, studied first in the University of Melbourne and has a PhD from the University of Calgary in Canada, gained in 1973. Since 1993 he has been professor of mathematics at Illinois State University and is currently also conjoint professor, an honorary appointment, in the University of Newcastle. His publications are mainly in graph theory, combinatorics and number theory.

In 1982 the Newcastle department's name was changed to the Department of Mathematics, Statistics and Computer Science. Keats retired soon after and Tony Guttmann arrived as professor of mathematics. Then Les Keedy was appointed as the first professor of computer science, in 1985, and Annette Dobson as the first professor of biostatistics, in 1986. But at the beginning of 1987 the department was split into three, giving new departments for mathematics, statistics and computer science, and two years later these were dispersed with the formation of a new Faculty of Science and Mathematics. Only the Department of Mathematics remained in that faculty, with statistics moving into the Faculty of Economics and Commerce and computer science into the Faculty of Engineering.

Annette Jane Dobson was born in 1945 in London, England, and received her school education in Salisbury, Rhodesia (now Harare, Zimbabwe). She obtained a BSc from the University of Adelaide in 1966 and then an MSc (in 1970) and a PhD (1974) in mathematics and population health, both from the James Cook University of North Queensland. After three years lecturing mathematics at Griffith University in Brisbane, Dobson was appointed senior lecturer in statistics at the University of Newcastle where she remained until 1999. She is currently professor of biostatistics in the Schools of Population Health and Physical Sciences, University of Queensland, where she is noted for her research into neurodegenerative disorders.

As part of the amalgamations of colleges of higher education with universities taking place across the country in the late 1980s and early 1990s, the Hunter Institute of Higher Education (the former Newcastle College of Advanced Education) joined with the University of Newcastle in 1989 and its Department of Quantitative Methods became part of the university's Department of Mathematics in January 1991. Among the five staff members that came with it, complementing the 20 or so in the department at that time, was William Patrick (Bill) Galvin, a principal lecturer in the Hunter Institute. Galvin was born in 1938 and began his teaching career in 1957. He completed a BA at Sydney University as an evening student in 1962, majoring in pure mathematics and education, and was seconded to the Newcastle Teachers College, forerunner of the Newcastle College of Advanced Education, in 1970. Between 1974 and 1982 he completed three research masters degrees in the neighbouring university, gaining expertise in operations research in particular, and was able then to embark on a research career of some merit. He remained heavily involved with the Newcastle Mathematical Association and other school-based enterprises but died of cancer in December 2003.[7]

In January 2000 the Department of Mathematics ceased to exist. Its staff, along with those from the former Department of Statistics, joined the School of Mathematical and Physical Sciences within the Faculty of Science and Information Technology. Brailey Sims was the outgoing head of mathematics and became the first head of the new school, which still offers the degrees of BMath and MMath as well as a Master of Statistics.

Kerrie Mengersen was professor of statistics in the revamped school from April 2001 to March 2004 when she returned to the Queensland University of Technology (QUT) to a chair in the Centre for Complex Dynamic Systems and Control; she had been a lecturer and then senior lecturer at QUT since 1994 and for three years before that was at Central Queensland University. Her BA with first-class honours and PhD in mathematical statistics are from UNE.

The current professor of mathematics is Iain Raeburn, appointed in January 1991. Raeburn was born in Edinburgh, Scotland, on 10 July 1949 and obtained first-class honours in mathematics from the University of Edinburgh in 1971. After completing his studies for part 3 of the mathematical tripos at Cambridge in 1972, he travelled to the University of Utah where he was awarded a PhD in mathematics in 1976. Raeburn taught for 14 years at UNSW as lecturer, senior lecturer and then associate professor before winning the chair in Newcastle. His interests are in operator algebra, functional analysis and representation theory.

Clive Anthony Croxton, born in 1945 and with a BSc from the University of Leicester and a PhD from Cambridge, was first appointed lecturer in mathematics at Newcastle in 1974 and was awarded a personal chair in mathematical chemistry six months after Raeburn gained his appointment there. A world leader in his field, Croxton died a little more than two years after gaining the chair.[8]

Among the distinguished mathematics honours graduates from the University of Newcas-

tle, besides those already mentioned, are Joan Cooper (1971), Peter Cummings and Katherine Heinrich (both 1975), Eileen Doyle (1976) and David Balding (1983).

Joan Cooper became the country's first female professor of information technology when she was appointed to that post in the University of Wollongong in 1997 and she is now pro-vice-chancellor (academic) at Flinders University; her PhD in 1974 was the first to be supervised by Jennifer Seberry. Peter Cummings gained a PhD in mathematics from the University of Melbourne in 1980 and taught at the University of Virginia from 1983 to 1991, reaching the position of professor of chemical engineering; he is now Distinguished Professor of Chemical Engineering, Chemistry and Computer Science at the University of Tennessee–Knoxville. Eileen Doyle followed her BMath with an MMath in 1981 and a PhD in applied statistics from the University of Newcastle in 1985. She holds a number of board directorships in the Newcastle region and is conjoint professor in the University's Graduate School of Business.

Katherine Heinrich was born in Murwillumbah in northern New South Wales and completed a PhD at the University of Newcastle in 1979 under the supervision of Wal Wallis. In 1981 she joined the Department of Mathematics and Statistics at Simon Fraser University, Vancouver, and was promoted to full professor six years later. In 1999 she moved to a senior executive position in the University of Regina and now concurrently holds a chair in the Department of Mathematics and Statistics there, where she continues her research in graph factoring problems and designs. Heinrich was president of the Canadian Mathematical Society from 1996 to 1998.

Finally among these, with his first-class honours and university medal from the University of Newcastle, Balding proceeded to the University of Oxford and gained a DPhil in mathematics in 1988. He was lecturer and then senior lecturer in probability and statistics at Queen Mary and Westfield College, University of London, from 1989 to 1996 when he won the chair of applied statistics at the University of Reading. In 2001 Balding was appointed professor of statistical genetics at Imperial College, London.

The University of Wollongong

The Wollongong Division of the New South Wales University of Technology was housed until 1962 in the buildings of Wollongong Technical College and Austin Keane, who was in charge of mathematics and physics diploma courses in the college, taught the first university mathematics classes as well. That was from 1951 to 1954, until Brian Edward Clancy was appointed the first full-time lecturer in mathematics at Wollongong. Clancy was born at The Rock in southern New South Wales on 6 February 1930 and was a graduate of Sydney University. He took out a PhD in 1970 from what was by then the Wollongong University College.

Austin Keane was born on 27 August 1927 in Sydney. He attended the University of Sydney and in 1949 was awarded a BSc with first-class honours in mathematics and a university medal, shared with John Sandiford, but shortly afterwards he contracted tuberculosis and completed his studies for an MSc in 1951 in a sanatorium. Leaving his job with the Wollongong Technical College, in 1955 he joined the University of Technology in Sydney and rose to the position of associate professor. In his first years there he completed a PhD, with a thesis entitled *Finite Elastic Strain with Geophysical Applications*. This was probably the second PhD to be awarded in the mathematical sciences in Australia, Oliver Lancaster's being the first. In 1959, following a year's leave spent at the Atomic Energy Research Establishment, Harwell, England, Keane was appointed executive officer of the Institute of Nuclear Engineering at UNSW and consultant to the Australian Atomic Energy Commission (AAEC) at Lucas Heights. Disappointed at not

Austin Keane, 1927–1979.

being given the chair of nuclear engineering, he left the university in 1961 to become principal research scientist and head of the theoretical physics section at AAEC. Clancy resigned his Wollongong lectureship in 1962 to join Keane there, and subsequently became head of its theoretical physics section, but in October 1964 Keane returned to Wollongong as foundation professor of mathematics. He was at the same time offered the foundation chair in Newcastle.[9]

Keane's return to Wollongong signalled the beginning of separate undergraduate courses in pure and applied mathematics and of the first postgraduate work in mathematics. Around that time the Department of Mathematics was incorporated into a Division of Physical Science, along with physics and geology, and that general structure remained until 1974 when, in preparation for an autonomous university the following year, faculties were introduced. This included the establishment of a Faculty of Mathematics, the only one of the five original faculties that consisted of a single department. From 1979, students in the University of Wollongong were able to enrol for the degree of Bachelor of Mathematics.

Ill health that had been advancing for some six years brought about Keane's early retirement in August 1978—he had by then been deputy vice-chancellor for a year—and he died the following March. Awarded an emeritus chair, in 1980 he was also given a DSc posthumously and in 1983 the building in which mathematics had been taught since 1970 was renamed the Austin Keane Building.

Thomas Sumner (Tom) Horner was the second full-time appointment, in 1961. He had gained a BSc with honours in mathematics from the University of Sydney in 1952 and a PhD from the University of Wollongong in 1978. Horner retired as a senior lecturer in 1992 so he saw the university through all its incarnations. So did Desmond John (Des) Clarke, from Western Australia, who was appointed lecturer in 1966. He also gained a PhD from Wollongong University (in 1971) and retired as associate professor in 1998. Other early but long-lasting appointments were those of Keith Phillip Tognetti and Martin Bunder, both appointed in 1969. Tognetti, whose interests include operations research, statistics and number theory and who is also an acclaimed environmentalist, was a reader when he retired in 1993. Chandra Gulati, a statistician, was appointed in 1971 and he and Bunder are still there, part-time in Bunder's case.

Born in 1942 in The Hague, Maarten Wicher Bunder, as he was then, came to Australia in 1951, completed a BSc in pure and applied mathematics at Newcastle University College in 1961 and was one of those who transferred to UNE to complete an honours year. Peter Dodds,

Alan McIntosh and Neil Trudinger were the locals in that class and constituted very formidable competition. As the University decreed that Bunder and two colleagues from Newcastle were ineligible to receive an honours degree, they had to be content instead with a "Certificate of Equivalent Honours".[10] Appointed to a tutorship in Armidale, Bunder's interests settled in the area of logic and after completing an MA in formal logic with the philosophy department he enrolled for a PhD in the University of Amsterdam. The thesis, *Set Theory Based on Combinatorial Logic*, was successfully completed early in 1969 and his first appointment at Wollongong was as professional officer to Keane in applied mathematics. Subsequently, most of Bunder's 100-odd publications were in logic and some in number theory. He was promoted through the ranks to become professor in 2002.

The move towards autonomy in the mid-1970s saw a number of other appointments made, including those of Philip Laird and Rodney Nillsen, both appointed in 1974 and both there still as associate professors although Laird, like Bunder, is no longer full time. Laird, with a PhD from the University of Calgary in Canada, is a pure mathematician involved also in land freight transport research. Nillsen is a Tasmanian with a PhD from Flinders University, another of the many harmonic analysts to come out of that university; he was recently awarded a DSc by the University of Tasmania.

James Murray (Jim) Hill was appointed to a lectureship in 1975. Born in England, Hill began studies at the University of Durham that were completed at the University of Queensland with first-class honours in mathematics in 1968. He gained a PhD there in 1972 for his work

Mathematicians in the Faculty of Informatics, University of Wollongong, around 1992. From left: Graham Williams, Phil Broadbridge, Joanna Gourd, Sid Morris, Peter Nickolas, Rod Nillsen (standing), Martin Bunder, Philip Laird.

in finite elasticity and in early 1988 was awarded a DSc by that university. Later in the same year, he gained a five-year appointment to a University Chair of Mathematics in the University of Wollongong and in 1997 was promoted to be professor of theoretical mechanics.

In 1979 the Faculty of Mathematics gained a second department, the Department of Computer Science, headed by Juris Reinfelds, who in 1975 had been appointed professor of computing science within the Department of Mathematics. He has a PhD in mathematical physics from the University of Adelaide and is currently professor of computer engineering at New Mexico State University. The Faculty of Mathematics was renamed the Faculty of Mathematical Sciences in 1984 and the Faculty of Informatics in 1990, the latter incorporating also an electrical engineering department and an information technology unit. Three years later the Department of Mathematics was split into departments of mathematics and applied statistics and the final administrative change to date was made in 1998 when those two departments were recombined as the School of Mathematics and Applied Statistics.

The other professors of mathematics in that time have been John Robert Blake, a graduate of the University of Adelaide and of Cambridge University, who was at Wollongong from 1980 to 1989 and is now professor of applied mathematics in the University of Birmingham; Philip Broadbridge, in Wollongong from 1990 to 2002 and until recently, like Blake, in an overseas chair (see Chapter 10); and Sid Morris who was in Wollongong from 1992 to 1997 and was the foundation dean of the Faculty of Informatics. Morris's career is described elsewhere in this book.

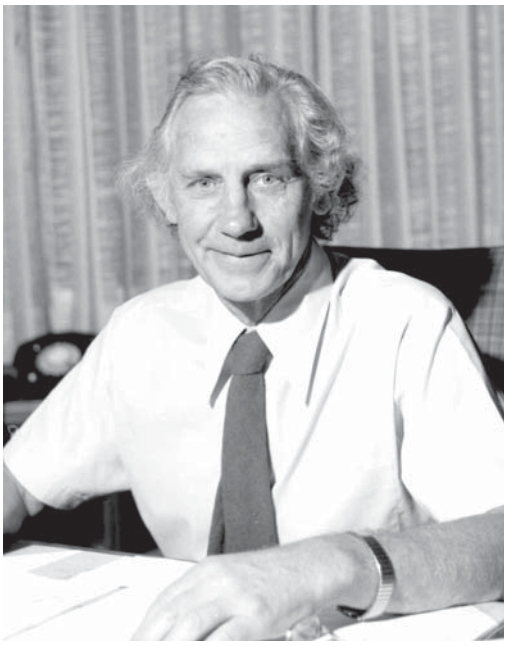
The foundation professor of statistics in the University of Wollongong, with research interests that include biostatistics and epidemiology, was David Atherton Griffiths, appointed in 1987 and there still. Griffiths was born in Sydney in 1946, gained a BSc with first-class honours and a university medal from UNSW and, on a Rhodes scholarship, completed a DPhil at Oxford. He has been chair of the academic senate at the University of Wollongong since July 2001. The only other professor of statistics there, originally appointed as a senior lecturer in 1992, is David Steel. His PhD was gained in the University of Southampton in 1985 and his current interests include survey methodology and analysis methods for complex social and economic data.

A number of honours graduates in mathematics or statistics from the University of Wollongong have gone on to chairs in Australian universities. Matt Wand (honours, 1986) is a recent appointment to a chair of statistics at UNSW. Peter Eklund (honours, 1985) was foundation professor of information technology at Griffith University in Brisbane, then moved to the University of Queensland as professor of computer science and is now back at Wollongong as professor of information systems. Alex Zelinsky (honours, 1983) gained the chair of systems engineering at ANU and established its Robotic Systems Laboratory; since December 2004 he has been director of CSIRO's Information and Communication Technology Centre.

Tony Jakeman and W. L. (Bill) Hogarth might be added to this list but officially they are graduates of UNSW, having both obtained their first-class honours degrees in 1973 from Wollongong University College. Jakeman obtained a PhD in applied numerical analysis from ANU in 1976, moved towards environmental modelling and now holds a chair in the School of Resources, Environment and Society at ANU. Hogarth went to Griffith University as a mathematics tutor in 1976 and his story is given in connection with that university.

The third vice-chancellor of the University of Wollongong, appointed in 1995 after five years as its deputy vice-chancellor, was Gerard Roger Sutton. He had joined the New South Wales Institute of Technology in 1976 as senior lecturer in mathematics and was in the School of

Mathematical Sciences there for twelve years. Before that he was a senior research scientist with the Royal Australian Navy. Born in Sydney in 1942, Sutton has an undergraduate engineering degree and a Master of Engineering Science from UNSW and a PhD from the Catholic University of America.



Kevin Charles Westfold, 1921–2001. (Monash University Archives)

Monash University

Monash, the second university to be founded in Victoria, was established by an act of parliament in 1958 and took in its first students in 1961. Its original campus at Clayton remains its largest but numerous amalgamations and a policy of expansion have resulted in two international campuses and six campuses throughout Melbourne and eastern Victoria.

The Caulfield campus, for example, began as the Caulfield Technical School in 1922. That became the Caulfield Institute of Technology in the 1970s. "Where blacksmith, carpentry, farriery and wheelwright courses had once stood were diplomas and degrees in disciplines such as computing, business, applied science, engineering, mathematics and psychology," according to the University's website. The Caulfield Institute of Technology amalgamated with the State College of Victoria at Frankston to form the Chisholm Institute of Technology in the early 1980s, and this merged with Monash University in 1990. Another campus was known for some years as Monash University College, Gippsland. It incorporated the former Gippsland Institute of Advanced Education, founded in 1972, and became part of the "Monash University family" in 1991.[11]

With over 50,000 students in 2004, Monash University is the largest in the country.

Kevin Charles Westfold was one of the first to be appointed to a chair there when he became professor of applied mathematics on 1 January 1961. Some details concerning Westfold have been given in Chapter 6 with regard to his previous position at Sydney University. He held the chair at Monash only until the end of 1964 but was dean of the Faculty of Science from 1962 to 1975 and was then pro-vice-chancellor for a year. During the latter period he was also appointed professor of astronomy and held that post in the Department of Mathematics until 1982 when he became deputy vice-chancellor. He retired as professor emeritus at the end of 1986 and died on 3 October 2001.

The first appointments in mathematics, along with Westfold, were Gordon Charles Smith and Geoffrey Anton Watterson as senior lecturers and Betty Lovell Cumming and Herbert Laszlo as lecturers. Watterson was one of the first PhDs in mathematical statistics from ANU, supervised by Pat Moran and Herbert David and graduating in 1960. He was a reader when he retired in 1994, at which time he also resigned the fellowship of the Australian Academy of Science that he had achieved in 1991. After Robert Edwards and John Blatt, he thus became the third Australian mathematician to return his FAA. Ravindra Madhav (Ravi) Phatarfod was another

of the earliest appointments in mathematics at Monash: he joined as a senior lecturer in 1964 and was a reader when he retired more than 30 years later.

After Westfold, Gordon Bamford Preston was selected as foundation professor of pure mathematics. He was born on 28 April 1925 and attended the Carlisle Grammar School and then Magdalen College, Oxford. With an MA and a DPhil from there, Preston joined the Royal Military College of Science (RMCS) at Shrivenham as a lecturer in 1950 and was in fact a member of its staff until 1989 because for 26 of the 27 years while professor at Monash he was on secondment from RMCS. The appointment at Monash began on 13 June 1963. A noted algebraist who specialised in the theory of semigroups, Preston retired as emeritus professor at the end of 1990 and for six months of each year returns still to Oxford. He founded the school-focused magazine *Function* in 1977 when the Mathematical Association of Victoria determined that its magazine *Vinculum*, with which Preston was also associated, would concentrate only on the teaching of mathematics.

During his long involvement with the Australian Mathematical Society he took over as editor of the Society's fledgling *Journal* from the foundation editor T. G. Room in 1964 and in four years saw submissions increase from a few dozen to some 300 papers a year; he was president of the Society in 1982–1984. The second of his 13 PhD students, Thomas Eric (Tom) Hall, joined the staff of Monash as a senior teaching fellow in 1969 and is now a reader there. Hall was editor of the *Journal of the Australian Mathematical Society (Series A)*, as Preston had been earlier in effect, from 1983 to 1991, longer than any other holder of that office.

By the late 1960s there were six professors of mathematics and statistics at Monash, more than in any other Australian university at that time—the result of an unusual but discerning decision by the newest and then smallest university in the country. Peter Finch was appointed to the chair of mathematical statistics in 1964, and in the following year Zvonimir Janko and John Boris Miller were appointed to chairs of pure mathematics and René François Edouard Van der Borght to a chair of applied mathematics. Van der Borght, previously mentioned in Chapter 7, retired from the University as emeritus professor at the end of 1986.

Finch, an Englishman born on 7 December 1929, had a BA from the University of Durham and was a senior research officer in the London School of Economics before coming to Australia, to a senior lectureship in Melbourne, in 1959. After four years there and then three years as a research fellow with Pat Moran at ANU, he gained the Monash chair from which he retired, emeritus, on 31 December 1994 after more than 30 years.

Other professors of mathematical statistics at Monash have been Stephan Maritz from 1973 to 1975; Warren Ewens from early 1977 until mid-1996; and Fima Chaim Klebaner who was appointed in 2002 after a career at the University of Melbourne that began with a lectureship there in 1988. Klebaner's interests are in stochastic modelling, particularly in its applications to finance. A Sydney University graduate, Robert Charles Griffiths, whose PhD was supervised by Geoff Eagleson and awarded in 1970, was appointed to a lectureship at Monash in 1973 and was a reader there when he joined the Department of Statistics at Oxford in 1998. Two years later Griffiths was designated Professor of Mathematical Genetics at Oxford.

The Department of Econometrics and Business Statistics in the Faculty of Business and Economics at Monash also has a professor of statistics, Robin J. (Rob) Hyndman, appointed in 2003. His BSc and PhD are from the University of Melbourne and he was previously in the statistics departments of Melbourne and Monash Universities.

Zvonimir Janko, born and educated in Croatia, was at Monash for just four years but in

that time became noted for his work on sporadic simple groups, an essential component of the epic worldwide study on the classification of the finite simple groups. He went later to ANU, then to Ohio State University and is now at the University of Heidelberg.

John Miller was born in Sydney on 24 March 1928. In 1949 he and his fellow student, the tragically short-lived Roger Thorne, gained first-class honours at the University of Sydney and both proceeded to Cambridge. Within a few months of his return to Sydney, Miller gained a teaching position at St Peter's College, Adelaide, and two years later was appointed to a lectureship at UNE. There he undertook a PhD on integral transforms, supervised by Andy Guinand, the first PhD to be awarded by UNE. After three years, Miller went to Canberra University College and saw it become ANU's School of General Studies. Miller was a reader at ANU when he moved to the chair at Monash, from which he retired with an emeritus chair at the end of 1989, although he continued to maintain the research output that had characterised his working life.

There were two long-standing appointments made in 1967: Bruce Morton to a chair of applied mathematics and Carl Moppert.

Bruce Rutherfurd Morton was born in New Zealand on 11 April 1926. His first degrees are from the University of New Zealand and he then took out a BA and a PhD from Cambridge where he worked in George Batchelor's Department of Applied Mathematics and Theoretical

Carl Moppert and his analemnic sundial, 1980. (Monash University Archives)

Physics, establishing a reputation in geophysical fluid dynamics. Morton was a lecturer and then senior lecturer for over ten years at the University of Manchester before winning the chair at Monash. He retired as emeritus professor at the end of 1991.

Moppert's early career has been described in Chapter 6. He came from the University of Melbourne, where he had been for nine years, to a senior lectureship at Monash. His publications over his lifetime, although not numerous, covered a wide range—Riemann surfaces, Brownian motion, Euclidean and non-Euclidean geometry, linear algebra—and he tended to move between pure and applied mathematics, labels that he disapproved of, as his interest took him. He had a flair for invention and has two enduring monuments at Monash, a "vertical analemnic sundial" and a driven Foucault pendulum. Moppert died on 16 September 1984, aged 63.[12]

John Newsome Crossley was appointed professor of pure mathematics in 1969. He had a DPhil from Oxford (1963) and was lecturing in mathematical logic there prior to the appointment in Melbourne. His chair in pure mathematics was converted into a chair in logic in 1994. Crossley had also gained a reputation for his work in the history of mathematics, influenced by his association with Gordon Smith, who was mentioned above. He retired in 2003.

Crossley's chair of pure mathematics was taken by Klaus Ecker in 1995 and held by him until 2002. Robert Bartnik, formerly at the University of Canberra, was appointed professor of pure mathematics in 2005.

When Crossley moved to Monash in 1969, a DPhil student of his, Christopher John Ash, followed him from Oxford to a senior teaching fellowship. Encouraged by Preston and Hall, Ash shifted his interests from mathematical logic to semigroup theory and universal algebra. He was promoted to lecturer in 1973, senior lecturer in 1981 and reader in 1986. Extraordinarily gifted as a mathematician and almost as gifted as a musician, Ash was nonetheless incapable of halting the depression that overtook him. He was elected a fellow of the Australian Academy of Science in 1994 but in February of the following year died from acute toxicity due to a deliberate overdose of the drugs he was taking. He was aged 50.[13]

In applied mathematics, Colin Bertram Grant McIntosh was appointed to a lectureship in 1970; he had a PhD in cosmology from UNE, supervised by Wes Taylor. Two years younger than his brother Alan, whose career at Macquarie University is yet to be recounted, Colin McIntosh served briefly as head of the Department of Mathematics at Monash and retired in 1997, aged 52, as an associate professor. Alan and Colin's youngest brother Robert is also a very capable mathematician, with a PhD from ANU studying under Leon Simon. There are four other siblings between Colin and Robert, all of whom graduated from UNE.

Roger Grimshaw was professor of applied mathematics from 1994 to 1999 and as head of department in 1996 had the task of compulsorily reducing its size. One effect of the amalgamations earlier in the decade was that it was, for a short while at least, the largest department in the University with over 60 members. Redeployment of a number of staff, particularly those recent arrivals who were less research oriented, early retirements that were by then being actively encouraged, and "natural attrition" (such as Ash's suicide) meant that by the end of 1996 the number had been reduced to around 44. But, for reasons given at the beginning of this chapter, the call on mathematics, both professionally and as a service subject, had also declined and Grimshaw was told that the number should be further reduced to 33–35. By April 1997, the required number was 30–32. A list of ten names that had been drawn up and presented to a departmental meeting as eligible for "possible removal" contained two that caused "surprise and consternation throughout the mathematical community"—Hans Lausch and Michael Deakin.

Both were versatile and active mathematicians with long associations with Monash University. Lausch was a product of the University of Vienna, appointed to Monash in 1972 and soon promoted to reader, with a publication list at the time of over 70 papers and three books. His interests are in the areas of group theory, universal algebra and history of mathematics. Michael Andrew Bernard Deakin had joined the university at the start of 1967. He had a three year secondment to Papua New Guinea in 1970–1972 and returned then to Monash as a senior lecturer in applied mathematics. With a PhD from the University of Chicago, awarded in 1966, Deakin had over 120 refereed publications covering biomathematics, history of mathematics and mathematical education, and was a respected broadcaster on the ABC.

Lausch and Deakin appealed against the involuntary redundancy that they faced and were successful, but they suffered the consequences of winning when a later round of dismissals seemed likely to encompass them again. They survived again.[14] Deakin retired due to ill health in 2003 and Lausch remained as one of 28 in what had become the Department of Mathematics and Statistics in 1998 and was later to be called the School of Mathematical Sciences.

Other professors of applied mathematics at Monash, after Grimshaw, were David John Karoly, from 1995 to 2002, and the current professors Joseph John Monaghan, Michael John Reeder and the solar physicist Paul Stuart Cally.

Karoly, an expert on climate change, was director of the Cooperative Research Centre for Southern Hemisphere Meteorology at Monash until it closed in June 2000; he is now Williams Chair Professor of Meteorology at the University of Oklahoma. Monaghan's undergraduate studies were at UWA and he has a PhD from Cambridge; appointed to a readership in 1971, his interests are in astronomy and numerical analysis. Reeder began as a lecturer at Monash around 1990. His interests are in meteorology and bushfire dynamics and since 2003 he has been president of the Australian Meteorological and Oceanographic Society (AMOS). Reeder and Cally were appointed to their chairs in 2004.

One of AMOS's activities is the biennial award of the Priestley Medal, named for Charles Henry Brian (Bill) Priestley FRS. London-born Priestley gained first-class honours in applied mathematics from Cambridge in 1937 and came to Australia in 1946 to head a new research group in atmospheric sciences within CSIR. On his retirement from CSIRO in 1977 he was appointed to a part-time chair of meteorology in the Department of Mathematics at Monash; he died in 1998.

Counting Priestley, the number of professors in the Department of Mathematics at Monash University peaked at nine in the late 1970s. The others were Crossley, Ewens, Finch, Miller, Morton, Preston, Van der Borght and Westfold. At the end of 2005 in the School of Mathematical Sciences there were five professors.

Other universities of the 1960s and 1970s

The three universities above and the seven to be described in this section all benefited directly from the commonwealth government's commitment to capital grants for their construction and the consequent recurrent funding, following its adoption of the advice of the Murray Committee. The period of 20 years from 1957 in which this construction took place was the time of greatest growth for the university sector with ten per cent annual increases in student enrolments across Australia commonplace.

All of these seven were new or largely new institutions, not reconstructed older ones except for Deakin University, and all except Deakin and Griffith University appointed professors of

mathematics among their early staff and established departments of mathematics that were to be active in research as well as teaching. The unusual situation at Griffith University will be described towards the end of this section. The seven universities are introduced in the order in which they first took in students.

Flinders University

The Flinders University of South Australia is situated on what was to be the Bedford Park campus of the University of Adelaide. From 1958 the University had intended opening a second campus there with some degree of academic autonomy. However in fulfilment of an election promise, the government of South Australia designated Bedford Park as the site of that state's second university. It was officially opened on 25 March 1966 and operations commenced three months later with 90 staff, four academic schools and just over 400 students.

The foundation professor of mathematics at Flinders University was Brian Abrahamson, born in Cape Town on 14 September 1928. He has an MSc from the University of Cape Town and a PhD from the University of Chicago, where he spent four years. He taught at Cape Town, Rhodes University and the University of Toronto before accepting the chair of mathematics that had been advertised as at the University of Adelaide at Bedford Park. Abrahamson was appointed pro-vice-chancellor of Flinders University in 1984 and deputy vice-chancellor in 1989. He retired in 1993 and was awarded an emeritus professorship and an honorary doctorate by the University.

Abrahamson's interests were in functional analysis and later quaternions. He was joined almost immediately by Rainer Radok, who took charge of courses in applied mathematics. Raymond Sydney (Ray) Booth, now a senior lecturer at Flinders, was one of Abrahamson's first appointments to a lectureship there but many of the early lecture courses were in fact given by visitors that Abrahamson invited from amongst his former colleagues at the University of Toronto.

Besides Abrahamson and Radok, the early professors of mathematics were John Newton Darroch, Igor Kluvánek and Douglas Barker Sears. Darroch has an MA from Cambridge and a PhD from the University of Cape Town; he was professor of mathematical statistics from 1966 to 1996 when he retired as emeritus professor. Kluvánek's qualifications were from Komensky University in Bratislava, Slovakia. He held a chair at Flinders from 1969 to 1986 and died in Bratislava in 1993, aged 62. Details of Radok, Sears and William Moran, professor of pure mathematics from 1991 to 2001, are given elsewhere in this book.

Garth Ian Gaudry was professor of mathematics at Flinders from 1973 until he moved to a chair of pure mathematics at UNSW at the end of 1993. Gaudry was born on 16 May 1941 in Rockhampton, Queensland, and is able to trace his Australian antecedents to the landing of the First Fleet in 1788. He gained a BSc with first-class honours in mathematics from the University of Queensland and then a PhD from ANU, completed in 1965 with Robert Edwards as supervisor. His studies took him to France, Italy and the United Kingdom and to Yale University as a Gibbs Instructor in 1968–1970. Gaudry went to ANU as a research fellow in 1971 and then to Flinders as reader in mathematics. A year later he was promoted to the chair there. Gaudry was president of the Australian Mathematical Society in 1988–1990 and he was foundation president of the Australian Mathematical Sciences Council in 1989.

The other professors of mathematics at Flinders since its beginning are the analyst Gopal Gopalsamy, appointed to a chair in 1998, and Peter Gerard Dodds.

Dodds gained a BSc with first-class honours in mathematics from UNE in 1963, sharing the university medal with Alan McIntosh, and continued with first-class honours in physics in the following year. His PhD is from the California Institute of Technology. With continued research interests in functional analysis, Dodds joined Flinders in 1970 as a lecturer, was promoted to senior lecturer in 1975, reader in 1986 and professor in 1999.

John William Rice joined the mathematics staff in 1973 as a senior tutor. Born in Sydney in 1948, he studied at UNSW for an honours BSc in applied mathematics and a PhD in functional analysis. At Flinders, Rice needed trade union backing and a court appearance to be able to obtain promotion to a lectureship in 1985 and was an associate professor and former head of school when he left there in 2004 for the position of Dean of Science at UTS.

Garth Gaudry

In 1976 Noel Cressie joined the staff as a lecturer. Born in Fremantle, Western Australia, he had a BSc with first-class honours in mathematics from UWA and had just obtained a PhD in statistics from Princeton University when he gained the Flinders appointment. Leaving Australia in 1983 for Iowa State University, Cressie was professor of statistics there until 1998 and from 1993 to 1998 was Distinguished Professor in Liberal Arts and Sciences. He was then appointed professor of statistics at Ohio State University and since 2004 has been Distinguished Professor of Mathematical and Physical Sciences.

Sid Morris, who would later hold chairs at the University of New England, the University of Wollongong, the University of South Australia and the University of Ballarat, gained a PhD at Flinders University in 1970, supervised by Kluvánek. In the same year, Patrick John Browne was awarded a PhD under Sears' supervision. Browne was born in 1945 in Balaklava, South Australia. Soon after his PhD thesis was submitted he left Australia for a post-doctoral fellowship in the University of Toronto where his supervisor was Frederick Atkinson, who had been foundation professor of mathematics at Canberra University College. A year later, he joined the Department of Mathematics and Statistics at the University of Calgary and was professor of mathematics there from 1980 to 1991. Browne then took a chair at the University of Saskatchewan where he is vice-president (academic). His research interests are in functional analysis and the spectral theory of differential operators. Ian Walker Knowles, now professor of mathematics in the University of Alabama at Birmingham, was also one of Sears' PhD students at Flinders; his interests are in ordinary and partial differential equations.[15]

The evolution of organised mathematics and statistics at Flinders University shows a decline from 22 listed staff positions in 1990 to just nine (including 1.5 for statistics) in 2000. The School of Mathematical Sciences that had lasted from 1970 to 1990 was incorporated then into the School of Information Science and Technology and five years later was reduced to being a

Department of Mathematics and Statistics in the School of Informatics and Engineering within the Faculty of Science and Engineering.

By 2000, there was no formal recognised status for mathematics or statistics as independent disciplines but there was a saving grace for mathematics when two years later the South Australian Department of Education and Children's Services established the Australian Science and Mathematics School on the Bedford Park site. It offers the final three years of high school in a manner "designed for highly collaborative, interactive and student-directed teaching and learning," with a curriculum that includes a series of modules developed and delivered jointly by school and university staff.[16]

Among Australian professional mathematicians, there have been a number who made a mark also as conservationists: Winifred Waddell in Melbourne, Keith Tognetti in Wollongong, Shirley Strickland de la Hunty in Perth and, most remarkably of all, John William Wamsley of Adelaide. Wamsley was born in Ourimbah, New South Wales, and by age seven had developed a love of the land. He was already 25 when he enrolled for a BA at the University of Newcastle but just five years later he had a PhD from the University of Queensland and a year after that he purchased a 35-acre dairy farm in the Adelaide Hills. This was to become the Warrawong Earth Sanctuary. Wamsley gained a lectureship in mathematics at Flinders University in 1969, was promoted to senior lecturer in 1972 and reader in 1975. He resigned from the University in 1986, having opened Warrawong to the public in January 1985. Among many accomplishments there, in 1991 he celebrated the first live birth of a platypus in captivity for almost 50 years. Wamsley has received numerous commendations for his work including the Prime Minister's Award for Environmentalist of the Year in 2003.[17]

To the four mathematician–conservationists just mentioned might also be added A. G. M. (George) Michell, the famous brother of John Michell. His forest-farm Ruramihi, 80 kilometres from Melbourne, was aquired in 1911 "as an area in which the indigenous vegetation might be given some protection from the forest burning then, and still, prevalent." The farm, "frequently enlarged by purchases of adjacent wooded lands," was maintained as a sanctuary into the 1960s.[18]

La Trobe University

La Trobe University was opened in March 1967 and teaching began there in the same month. It is named after Charles Joseph La Trobe, the first superintendent of the Port Phillip District from 1839 to 1850 and lieutenant-governor of the new colony of Victoria from 1851 to 1854. The University's original campus is at Bundoora in Melbourne's northeast but there are now six further campuses across Victoria's north including Bendigo, where there is an active group of seven mathematicians and statisticians.

On the main campus there are some 14 teaching staff in the Mathematics Section and six in the Statistical Science Section and these, together with the Bendigo Section, constitute the University's Department of Mathematical and Statistical Sciences in the School of Engineering and Mathematical Sciences.

The first three staff members in mathematics at La Trobe University were Warren Ewens, a statistician appointed as foundation professor of mathematics, and two young lecturers, Wal Wallis and Alan Andrew. Ewens' career and Wallis' are described elsewhere in this book. Andrew was born in New Zealand in 1937 and went to ANU with an MSc gained at Victoria University College, Wellington, part of the University of New Zealand. At ANU from 1962 to 1966, for a

short while he shared an office with Arthur Jones, and Jones was later to supervise his PhD at La Trobe, in an area of numerical analysis. Andrew was promoted to senior lecturer in 1971; he retired in 2003 and is now an "emeritus scholar" there.

Arthur Jones was the fourth mathematician appointed at La Trobe, arriving as a senior lecturer in September 1967. He was born in 1934 and brought up in Essendon, a Melbourne suburb. As a student at the University of Melbourne studying for a PhD with Tom Cherry as supervisor, Jones had become a foundation member of the Australian Mathematical Society. He completed his PhD in 1960 and worked at the University of California, Berkeley, and then ANU, before moving to La Trobe. Cherry, incidentally, was a member of the Interim Council of La Trobe University—there are Thomas Cherry Buildings both there and at the University of Melbourne. Promoted to reader in 1991, Jones retired five years later due to ill health. The "blackboard tutorials" that he introduced as part of an integrated teaching program were highly commended—students would carry out supervised practice in a room lined with blackboards but often with no tables or chairs. He died on 22 January 2006.

The next professors of mathematics to be appointed to La Trobe University were Christie Jayaratnam Eliezer in applied mathematics and Bertram (Bert) Mond in pure mathematics. Eliezer arrived in 1968 and Mond a year later.

Eliezer was born on 12 June 1918 in Jaffna, Ceylon. He graduated from the University College of Ceylon at age 19 and then at Cambridge gained his BA, the Smith's prize and a PhD supervised by Paul Dirac and Homi Jehangir Bhabha. From 1946 to 1949, Eliezer held a fellowship at Christ's College, Cambridge. Early planning for a mid-life change of career, which did not eventuate, led to his admission to the Middle Temple in November 1942 and his call to the bar by the same Inn 17 years later. For the 20 years 1949 to 1968 Eliezer was professor of mathematics in the University of Ceylon and then the University of Malaya before being appointed to the chair at La Trobe University. He retired as emeritus professor in 1983 and died on 10 March 2001. An obituary in *The Age* described Eliezer as "Quantum Physicist, Mathematician, Barrister".[19] He was a tireless advocate for Tamil communities in Sri Lanka and Australia and in recognition of this and his academic achievements he received an honorary doctorate from the University of Jaffna.[20] At Cambridge, Eliezer had been tutor to John Fraser Scott, who was to become reader in mathematics and then professor of applied statistics at the University of Sussex from 1967 to 1977; Scott was appointed that year as the second vice-chancellor of La Trobe University.

Bert Mond was born in New York City in 1931. He has a BA from Yeshiva University that led to his ordination as a rabbi, an MA from Bucknell University in Lewisburg, Pennsylvania, and a PhD from the University of Cincinnati, gained in 1963. That led to employment as a mathematical analyst at a laboratory at Wright-Patterson Air Force Base in Dayton, Ohio, an hour's drive from Cincinnati. Mond also worked part time as a congregational rabbi in Cincinnati until he left for Australia in January 1969 to take up the post as professor of pure mathematics at La Trobe University. In 1998, some two years after he had retired, the *Journal of the Australian Mathematical Society (Series B)* honoured Mond and Bruce Craven from Melbourne University with a special issue[21] recognising their contributions, often as collaborators, to the areas of mathematical programming, non-smooth analysis, optimal control and variational techniques. Since his retirement, Mond has been a part-time tutor in mathematics at Melbourne University.

Peter Brockwell followed Ewens as professor of mathematical statistics and held the post for four years. Brockwell, born in Melbourne on 12 October 1937, had his first degree, from the

University of Melbourne, in electrical engineering. He followed that with an honours BA, then an MA, and in 1967 gained a PhD from ANU supervised by Jo Moyal. Before the La Trobe position, Brockwell was at Michigan State University. He left La Trobe in 1976 to become professor in the Statistics Department of Colorado State University and is there now, as Professor of Statistics and Electrical and Computer Engineering. But in the meantime he held chairs in the University of Melbourne (1988–1989) and RMIT University (1993–1996), where he was foundation professor of mathematics. Brockwell's interests are in time series and stochastic processes and their applications.[22]

His chair at La Trobe was taken by Stephan Maritz, professor of statistics from 1979 to 1988. Maritz was born on 14 April 1928 at Wepener in the Orange Free State, South Africa. He has a DSc from the University of the Witwatersrand and first came to Australia in 1961, to a senior lectureship in the University of Melbourne. The chair at La Trobe followed three years as professor of mathematical statistics at Monash University and then three years as senior principal research scientist with CSIRO. He returned then to South Africa. One of Maritz's PhD students at La Trobe, Simon Sheather, was appointed professor and head of the Department of Statistics at Texas A&M University in 2005. He had previously spent 18 years with the Australian Graduate School of Management at UNSW as professor and head of the statistics and operations group there. Sheather's first degree was a BSc with first-class honours from the University of Melbourne.

The next professor of statistics at La Trobe University, after Maritz, was Niels Becker. Born in Germany in 1942, he had migrated to Australia in 1953. After studies at the University of Melbourne, Becker gained a PhD in probability and statistics from the University of Sheffield in 1970 and began as a lecturer at la Trobe the following year. He held the chair there from 1990 to 1999 and then took a chair of biostatistics in the National Centre for Epidemiology and Population Health at ANU.

Currently, the senior statisticians at La Trobe University are Paul Kabaila (reader and head of section) and Robert Staudte. Kabaila studied first at UNSW, gaining a BSc in 1973 and then a BE in electrical engineering with first-class honours in 1975. His PhD is from the University of Newcastle and his main research interest is in time series analysis. Staudte was born in Boston, Massachusetts, in 1940, gained a PhD from the University of Illinois, Champagne-Urbana, in 1968 and came to La Trobe as senior lecturer in 1973. He was promoted to associate professor in 1993.

An Adelaide graduate, Kenneth Robert Pearson, was appointed senior lecturer in mathematics at La Trobe in January 1970 and was a reader when appointed to the Centre of Policy Studies of the Faculty of Business and Economics at Monash in 1999, subsequently becoming a professorial fellow there. Pearson's PhD from the University of Adelaide in 1966 was supervised by Jim Michael but he left his early interests in ring theory to concentrate on the development of software for the solution of large economic models.

For much the same period, 1972–1995, Gary Davis was in the Department of Mathematics at La Trobe having joined it soon after obtaining a PhD from Monash. Davis was a reader in the department and director of the University's Institute of Mathematics Education when he left Melbourne to take a chair in the Graduate School of Education of the University of Southampton, England. In 2002 he was appointed Boeing Distinguished Professor of Mathematics Education at Washington State University and he is now at the University of Massachusetts in Dartmouth.

Peter John Stacey joined La Trobe University as a lecturer in 1975. Born in 1949 in Chelmsford, Essex, he has a BA through St John's College, Cambridge, and a DPhil in group algebras from Balliol College, Oxford, 1973. He came to Australia that year having the year before married Kaye Vale who was travelling and studying with Cheryl Praeger, as related in Chapter 6. At La Trobe, Stacey was promoted to senior lecturer in 1983 and to associate professor in 1994. He has served as head of department or head of school (or both) for 14 years altogether since 1984 and in 2002 was appointed associate dean (academic) in the Faculty of Science, Technology and Engineering.

The current professors within the Mathematics Section are Reinout Quispel and Edgar Roderick Smith. Born in Holland in 1953 and with a PhD from Leiden University, Quispel's interests are in numerical integration and dynamical systems. He was appointed to a lectureship at La Trobe in 1990 and won a personal chair there in 2004. Smith, born in Melbourne in 1944 and with a PhD from Imperial College in the University of London, has interests in statistical mechanics of multiple systems. He worked with Barry Ninham in the Department of Applied Mathematics at ANU before moving to a readership at the University of Newcastle in 1977 and then to a similar post at the University of Melbourne in 1985. After a term as La Trobe University's pro-vice-chancellor (information technology), he returned to the Mathematics Section in 2005 but continued to act as director of the University's Centre for Online and Multimedia Educational Technologies.

The section head in 2005 was Grant Cairns. Cairns had studied electrical engineering at the University of Queensland before doing a doctorate in differential geometry in Montpellier, France; now a reader, he was appointed to La Trobe University in 1988. Geoffrey Eamonn (Geoff) Prince, a mathematical physicist and an executive director of the Australian Mathematical Sciences Institute until the end of 2005, and Brian Davey, an algebraist, are also readers in the Mathematics Section. Davey, born in Temora, New South Wales, first joined the University as a lecturer in 1975; his PhD is from the University of Manitoba.

Cairns was one of the founders in 1998 of the Quintessentialist Society, a group of up to 25 mathematicians and students who meet fortnightly over dinner in the back room of a Melbourne café to share their enjoyment of mathematics. They work within annual themes, such as probability and measure theory (1999) and the continuum hypothesis (2002).[23]

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The Bendigo campus of La Trobe University is the former Bendigo College of Advanced Education, formed in 1976 and known previously as La Trobe University College of Northern Victoria. It traces itself back to the Bendigo School of Mines, dating from 1883, which became the Bendigo Institute of Technology in 1965. The Bendigo College of Advanced Education combined the Bendigo Institute of Technology with what was originally the Bendigo Teachers College formed in 1926.

Geoffrey Watson, the famous Princeton University statistician, was born in Bendigo, as was Ruth Jeannette Williams, who was invited to deliver the first of the G. S. Watson Annual Lectures in La Trobe University's Bendigo Section in 1999. Williams gained a PhD from Stanford University in 1983 and joined the University of California, San Diego, the following year. She is now professor of mathematics there, with interests in stochastic processes and their applications.

Terence Michael (Terry) Mills was appointed to the Bendigo Institute of Technology in 1975 and to a personal chair in mathematics in 1993. His mathematical interests are in approximation theory, inequalities and health statistics and since 1998 he has held the post of honorary

senior research fellow in collaborative health with the Bendigo Health Care Group. Mills' first qualifications are from the University of Sydney and the University of Melbourne, and he has a PhD from the University of Florida.

John William Schutz arrived in Bendigo two years before Mills. He had studied first at the University of Melbourne and in 1969 enrolled for a PhD at Monash in the area of axiomatic space-time. He was promoted to associate professor in 2001.

Peter Gavin Lawrence Leach, born on 28 November 1941 in Hawthorn, Victoria, completed a BSc at the University of Melbourne and a PhD at La Trobe in 1979. He also holds a DSc from the University of Natal, Durban, awarded in 1996. Leach taught at the Bendigo Institute of Technology from 1970 to 1975 and then at La Trobe, before heading for South Africa where he is now professor of mathematics in the University of KwaZulu-Natal. His interests are in differential equations and their applications.

Macquarie University

A number of events of the late 1950s and early 1960s led directly to the foundation of Macquarie University at North Ryde in Sydney's northwest in 1964. There was at the time pressure of escalating student numbers at the University of Sydney and a perceived "obloquy" of its having to impose quotas on matriculated students, although in later decades this became commonplace across the country. The Murray Committee's report and the commonwealth government's resulting financial commitment to tertiary education prompted the New South Wales government to respond to the pressure with a committee of enquiry into higher education, announced in June 1960.[24]

The findings included an expectation that university enrolments would double during the 1960s. UNSW was seen as able to accommodate the growth in the technologies and the Murray report had suggested it expand into medicine and arts, but the demand in science, economics and arts, particularly in Sydney's northern suburbs, would be beyond the capacity of the University of Sydney. Having recognised the need for a new university, in March 1963 the government in cabinet undertook the purchase of 134 hectares of "gently undulating land" at North Ryde, not the first choice of site by all involved, and five months later determined that teaching would begin in 1967. It also agreed at that time that by 1965 "an evening college would begin operating in suburban centres [with] external offerings in science and commerce". The latter was designed to act as a feeder to the new university[25] but developed instead into the second New South Wales Institute of Technology.

Frederick Chong, 1915–1999. (Division of Information and Communication Sciences, Macquarie University)

The first meeting of the first council of Macquarie University was on 17 June 1964. Two months earlier, the name of the institution had been imposed on the interim council by cabinet over its preference for "The University of Northern Sydney". Macquarie University chose deliberately to be unconventional, a reaction against the inflexibility of the University of Sydney. There would for example be a single first degree, a Bachelor of Arts, across all the disciplines of science, arts, economics and education, and this was to last as the "Macquarie hallmark" for 15 years.[26]

In March 1965 the council filled the first five chairs. "The selection committee for Mathematics recommended that two chairs be offered, one to Fred Chong—since 1956 Professor of Mathematics at Auckland—and the other to a productive scholar in Applied Mathematics, but the committee of Council members [which had been] assembled to receive and co-ordinate the recommendations of the selection committees held to the view that the first appointments should be spread as widely as possible."[27]

Chong had taken the Auckland appointment following six years at Iowa State University where he obtained a PhD for a thesis on boundary-value problems. His experiences at the New England University College and the University of Sydney, recounted in earlier chapters, and then at Iowa and Auckland culminated in the Macquarie appointment. Furthermore:

> He was known, too, in wider educational circles, in the Australian Chinese community and in the Presbyterian Church, as a sociable personality, a delicate raconteur and a shrewd committeeman. He had a dazzling reputation as a teacher and ... could bring to Macquarie a refined interest in program planning and curriculum.[28]

When Chong won the Auckland chair his "dazzling reputation as a teacher" was emphasised by Keith Bullen who was quoted in a *Daily Telegraph* news report (13 August 1955) saying he was the "best mathematics expositor that Sydney University had known."

Chong was also innovative in his course planning, adapting well to Macquarie's ideals. He is particularly remembered for his in-service course for school teachers, known as the Special Masters Program for Mathematics Teachers, which he began at the time when the Wyndham scheme was being introduced; he taught the three-year course almost singlehanded on Saturday mornings for about 15 years. There was a much wider involvement with teachers and teaching through his work for the Mathematical Association of New South Wales, of which he was president in 1953–1954, and on the New South Wales Board of Senior School Studies, with which he was involved from 1940 to 1978 apart from periods overseas.

Freddy Chong retired in 1980 and was appointed emeritus professor. He was awarded an honorary DSc by Macquarie University in 1992 and was to receive a similar degree from the University of Sydney in June 1999 but died on 14 May from complications after a car accident. The award was made posthumously.[29]

The circumstances regarding the appointment of Alf Pollard to the chair of economic statistics were entirely different—but that story comes later. In Chapter 5 the details were given of Pollard's early university and actuarial training while working with the MLC Assurance Company and of his time in the RAAF. During the latter period he enrolled for and completed a BEc from the University of London. That was July 1945. Three months later he submitted a thesis for an MSc in mathematical statistics from the University of Sydney and seven months after that he obtained an MEc from London. Pollard's own account of his introduction to mathematical statistics is fascinating:

> I noted in the Sydney University *Calendar* that, as an honours graduate, I could obtain a Master's

degree by submitting a thesis and paying 5 pounds examination fee. I had been doing a fair amount of reading and research in mathematical statistics, purely as a matter of interest and education so I decided to write this up as a thesis which I typed and bound myself with stitching, hot water glue, clamps etc. It consisted of 100 pages of condensed mathematics. I posted it to the Registrar with a cheque for 5 pounds and became an M.Sc.—no registration, no supervisor, no contact with anyone.

I did find an error in a paper by the very distinguished statistician Professor Sir Ronald Fisher FRS. I pointed this out in my thesis and presented the correct solution. I thought it no big deal. Not long after, Sir Maurice Kendall's major text was published quoting Fisher's incorrect result. I went thoroughly through this 521 page volume, worked out every problem and wrote to Kendall on 7th May 1946 pointing out over 100 errors and misprints on 92 pages, including a special mention of Fisher's incorrect result. He replied on 14 May 1946 thanking me, and saying he would check my version of Fisher's result. Many years later, in 1983, I noted in a later edition of Kendall that he gave credit to Gayen for correcting Fisher's equation in a paper published by Gayen in *Biometrika* in 1951. I then wrote, sending a copy of Kendall's 1946 reply to my letter, and I believe in the latest edition I now get credit for being the first to note the error![30]

Pollard's MEc was awarded in May 1946. By the end of that year he had completed his thesis for a PhD in economics from the University of London but was required to wait the minimum time of a further six months before he could submit the work. All of his higher studies had been carried out privately, not at all encouraged by his employer, and he now had the problem of getting to London for an oral examination towards the doctorate. Pollard accomplished this, and even had the MLC pay half the air fare, by successfully setting out to win a prize sponsored by the Institute of Actuaries, the winner of which was required to be present in London. Among his memories of the four weeks spent there was a meeting with Pat Moran, later foundation professor of statistics at ANU, who he was embarrassed to learn had been the proof reader for Kendall's text.[31]

The MLC was subsequently highly pleased to have "Dr Pollard" on staff and he progressed rapidly through managerial positions. In 1954 he was promoted to be Deputy General Manager, a position he held until he left the company in 1966.

He left the company because, in his own words, he was "sacked" following the collapse of H. G. Palmer Consolidated Limited, a chain of electrical stores whose takeover by MLC had been strongly recommended by Pollard in 1963 and realised soon after. However, he wrote, the "darkest hours precede the brightest dawn."[32]

Pollard had been president of the Statistical Society of New South Wales in 1951–1953. Assisted by his friends and co-workers for the society, Oliver Lancaster and Stewart Rutherford, he quickly sought an academic position at Sydney University, only to be told that the processes to appoint another professor of statistics might take up to nine months. He applied instead for an existing but unfilled associate professor's position, giving the name of a fellow university student, Frederick Chong, as a referee. As soon as Chong was contacted to write a report he started the processes in motion that led within two weeks to the offer of a specially funded chair of economic statistics at Macquarie University. In total ignorance of the existence of this university but impressed by the speed with which the offer came, Pollard accepted the post and began there on 21 March 1966.

On 11 May that year he was charged in connection with the H. G. Palmer affair and with other Palmer directors was subsequently sent for trial. Exactly eleven months later, after what became a classic trial, the case against Pollard was dropped.

The Pollard family, 1982, on the occasion of Alf's graduation with a DSc. Standing from left: John, Geoff, Graham and Ian; seated from left: Christine, Pearl, Alf and Anne. (Reproduced from *Nature's Masterpiece—The Traditional Family*, p. 234, with the family's permission.)

For both Chong (in the School of Mathematics and Physics) and Pollard (in the School of Economic and Financial Studies) the year 1966 was dedicated to course planning despite, in Pollard's case, one period of three months spending every day in court. Pollard was responsible for courses in mathematical statistics as well as economic statistics and also provided a basic service course which was taken by almost every student in the university. The service course in introductory statistics still exists—it has the largest enrolment of any single subject in any Australian university. Planning for Pollard's degree course in actuarial studies, first suggested by him in a presidential address to the Actuarial Society of Australasia in 1955, began a week after his arrival at the University and continued through all of 1967. It developed into the first course in the world to have its graduates recognised for accreditation as actuaries but Pollard's early concern was to staff the course with actuaries with university qualifications. The problem was solved in part by employing John and Geoff, the two eldest of his six children.

John Hurlstone Pollard, born in June 1942, has a BSc with first-class honours in mathematical statistics from the University of Sydney and a PhD in mathematical genetics from the University of Cambridge. He had spent a year as a research associate in the Population Research and Training Center of the University of Chicago when he was appointed associate professor of actuarial studies and population mathematics at Macquarie. By then an associate of the Institute of Actuaries, he gained his fellowship in 1972. John Pollard was president of the Statistical Society

of Australia in 1974–1975 and, with acclaimed accomplishments in mathematical demography, mortality and stochastic modelling of insurance processes, was the clear candidate (and the only candidate) to succeed his father in the chair of actuarial studies. Both father Alf and son John would become fellows of the Academy of the Social Sciences in Australia.

Geoffrey Neil Pollard, John's brother, was born in January 1944 and has a BSc with honours in mathematical statistics from the University of Sydney and an MSc gained in 1966 for a thesis in demography. Also an associate of the Institute of Actuaries, he was appointed lecturer at Macquarie in the following year and promoted to senior lecturer in 1975. He retained that position until 1989 when he was elected president of Tennis Australia and left to work full time for that organisation.

Of the other Pollard children, Graham became professor of applied statistics at the University of Canberra—his career was described in Chapter 7—and Ian became one of Macquarie University's top actuarial students, completed his fellowship examinations by age 20 and won a Rhodes scholarship to Oxford.

Alf Pollard retired from Macquarie in 1976, aged 60, prompted by "a couple of heart attacks," numerous offers of directorships and a desire to see John take on his chair. He received a DSc in 1982, the first to be awarded by the University, for his research into human populations and an honorary Doctor of Letters in 1995. He died suddenly on 4 December 2000 following his usual three sets of early morning tennis.

Pollard's very private autobiography of over 300 pages, *Nature's Masterpiece: The Traditional Family*, was written solely for his children—only six copies were produced. With copious beautifully reproduced photographs and abundant newspaper clippings, all the family's considerable academic, sporting and musical achievements are fondly described in great detail, as are the tender moments and tragic moments of almost 60 years with his wife Pearl, who died exactly five weeks before Alf. In his 85th year he wrote a 35-page update of *Nature's Masterpiece* including full details of his wife's memorial service; the work was completed by daughter Christine with similar details of his own memorial service.

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José Enrique (Jo) Moyal, 1910–1998.

When Pollard retired in 1976 his department, incorporating actuarial studies, demography and statistics, was split into a Department of Actuarial Studies, with John Pollard as professor, and a Department of Statistics. Further details of actuarial studies at Macquarie University and of developments in this area at other universities, notably the University of Melbourne and ANU, are given by Clare Bellis in her survey[33] of actuaries in Australia. Bellis is herself a product of actuarial studies at Macquarie, and currently a senior lecturer in that department.

Donald Roy (Don) McNeil was appointed foundation professor of statistics when Pollard's original department was split. McNeil was born in Launceston on 1 July 1941, gained

an MSc from the University of Tasmania and a PhD from ANU and held teaching positions in the Gordon Institute of Technology in Geelong, the University of Tasmania, ANU and UWA before taking the Macquarie chair. He retired as emeritus professor in 2001 but remains active on campus with statistical computing. There are now three professors of statistics there: Malcolm Hudson, Barry Quinn and Graham Wood.

A student in the very first intake to Macquarie in 1967, John Sydney Croucher, became the University's first mathematics honours graduate in 1971 and then took out an MSc and a PhD in game theory from the University of Minnesota. He returned to a lectureship at Macquarie in 1974 and is there still, promoted to professor of statistics in 1995 and now professor of management in the Macquarie Graduate School of Management. In 2005 he received a second PhD, this time from Macquarie in the field of modern history. Croucher is well known for his books on statistics, management, humour and fraud and as a newspaper columnist and television presenter of sports statistics.

Victor Solo was the other professor of statistics during this time, arriving in 1991 and leaving in 2000 for a chair in the School of Electrical Engineering and Telecommunications at UNSW. He now has a similar position in the University of Michigan. Somewhat earlier, from 1969 to 1976, Murray Aitkin had held the position of senior lecturer in statistics jointly in the School of Economic and Financial Studies and the School of Behavioural Sciences. He went from there to the University of Lancaster in England where he was professor of applied statistics from 1979 to 1987. Aitkin moved then to the chair of statistics at Tel Aviv University, until 1995, and finally to the University of Newcastle-upon-Tyne.

Meanwhile, in the School of Mathematics and Physics, a second chair of mathematics was filled in 1972 when Jo Moyal left his position as senior scientist with the US Atomic Energy Commission. His expertise was in probability and stochastic processes, and much more, as described in Chapter 7 in connection with the six years he had spent as reader in Pat Moran's Department of Statistics at ANU. He retired at the end of 1977 and died in 1998 and is remembered by Macquarie University's annual award of the Moyal Medal for research contributions to mathematics, physics or statistics. The seed donation for the medal came from his widow Ann, a distinguished historian of Australian science and technology. Winners since the first award in 2000 have been Joe Gani, Gerard Milburn, Alan McIntosh, Terry Speed, Denis Evans and Bob Anderssen.

Much has been said of Gani, Speed, Evans and Anderssen in Chapter 7. Milburn is a physicist deeply involved in quantum nanoscience and currently a Federation Fellow in the University of Queensland. McIntosh has also been mentioned in previous chapters but more needs to be said. Alan Gaius Ramsay McIntosh was born on 17 January 1942 in Sydney. His family moved to Armidale in 1947 and at UNE he graduated BSc with first-class honours in mathematics and the (shared) university medal in 1962. With a PhD from the University of California, Berkeley, awarded in 1966, and after a year spent in the Institute for Advanced Study at Princeton, McIntosh was appointed to a lectureship in mathematics at Macquarie in 1967. He won a personal chair there in 1990 and moved to the Centre for Mathematics and its Applications at ANU in February 1999. The Moyal Medal recognised McIntosh's fundamental contributions to harmonic analysis and the study of partial differential equations.

After Moyal retired, more than a year passed before Alf van der Poorten was appointed, without interview, to the chair Moyal had vacated. According to Bruce Mansfield and Mark Hutchinson, authors of a history of Macquarie University after its first 25 years,

> Van der Poorten's selection was part of the drive for the university to lift its research profile. He had an international reputation as a number theorist. He was barely 'through the door,' however, before he began to be sensible of the problems he faced as a researcher (or, in his own colourful words, 'the barrenness of the desert which I have entered'), for there were no others at Macquarie working on number theory.[34]

The solution, as far as number theory was concerned, was the employment over a ten-year period of a number of staff in the area, namely John Loxton, Gerald Myerson, Rodney Yager, Frank Garvan and later William Chen, whose undergraduate and postgraduate studies had been at Imperial College, London, and the Cambridge-trained Peter Arthur Barry Pleasants. There was also the founding in 1991 of the ceNTRe for Number Theory Research, always so written.

John Harold Loxton had become a colleague of van der Poorten's at UNSW in 1973 when he returned from Cambridge with his PhD on sums of roots of unity and Gauss sums. Born in Melbourne on 19 September 1947, Loxton took out a BSc with honours and then an MSc in 1970 under Russell Love at the University of Melbourne. He went from UNSW to Macquarie as professor of mathematics in 1988 but left the school to pursue an administrative career as the University's deputy vice-chancellor (academic) in 1995.

Frank Garvan was at Macquarie only in 1988–1989. Australian born, he has a BSc and an MSc from UNSW and a PhD from Pennsylvania State University, supervised by George Andrews, and is at present professor of mathematics at the University of Florida.

Alfred Jacobus van der Poorten was born in Amsterdam on 16 May 1942 and migrated to Sydney with his family when he was not quite nine years old. At UNSW he obtained a BSc with first-class honours and the university medal in pure mathematics (in 1965), a PhD supervised by George Szekeres and Kurt Mahler (1968), a BA with honours in philosophy (1970) and an MBA (1973). He was appointed lecturer in mathematics at UNSW in 1969, promoted to senior lecturer in 1972 and associate professor in 1976. At Macquarie he was elected head of school on two occasions, serving in that position for over 14 years altogether, and for many years he was also chair of the university's academic senate.[35]

Van der Poorten's areas of expertise include Diophantine analysis and transcendence theory. His reputation as an expositor of mathematics was recognised when his 1996 text on Fermat's Last Theorem[36] gained the Professional/Scholarly Publishing Award for Excellence in Mathematics from the Association of American Publishers. He was also the recipient of an honorary doctorate from the Université Bordeaux I in 1998. A constant worker on behalf of organised mathematics in Australia, van der Poorten was president of the Australian Mathematical Society in 1996–1998 and was awarded its inaugural George Szekeres Medal (jointly with UNSW's Ian Sloan) in recognition of his career research achievements and contributions in 2002. He retired that year as emeritus professor and remains totally committed to his research.

The current professors of mathematics at Macquarie University are Ross Howard Street, William Chen and the applied mathematician Paul Smith, who was appointed to replace van der Poorten. Smith completed a PhD at Cambridge University after undergraduate studies at the University of Adelaide, and was previously professor of applied mathematics at the University of Dundee, Scotland. The only current associate professor (in late 2005) is the analyst Xuan Duong, who arrived in Australia as a refugee in early 1987 and by 1991 had completed a PhD in mathematics at Macquarie University.

Ross Street is a world-renowned category theorist and director of the Centre of Australian Category Theory, established in the University in 1999. He was born in Sydney on 29 Sep-

tember 1945. After completing a BSc with first-class honours in 1966 and his PhD with Max Kelly at Sydney University in 1969, Street taught for two years in the United States and was then appointed by Chong, without advertisement or interview, to a lectureship at Macquarie. He replaced Neil Trudinger who had been one of the first appointments in 1967. Street was promoted rapidly—to senior lecturer in 1972 and associate professor in 1975—and gained a personal chair in 1990.

The Department of Computing at Macquarie also contains some exceptional mathematicians. Igor Shparlinski, born in 1956 in the Ukraine and with a PhD in mathematics from the Moscow State Pedagogical Institute in 1980, first joined Macquarie in 1992; his interests are in classical number theory and its applications to cryptography, theoretical computer science and coding theory. Michael Sterling James Johnson, another professor of computing, has been there since 1989. Born in Sydney in 1959, he has a BSc with honours in both pure mathematics and psychology and a PhD in pure mathematics, all from the University of Sydney. Johnson's interests include category theory and he is associate director of the Centre of Australian Category Theory.

In fact, Macquarie has four professors of computing but the first, Jan Hext, was not appointed until 1981. At that time, it was the only university in the country not to have a professor of computing or the equivalent although computing courses were offered through the mathematics department. Freddy Chong had realised very early in the piece that computing would be an essential feature of the new university and H. S. (Harry) Hancock, one of the first staff in his department, was instrumental in obtaining a "revamped" IBM 1460 machine and designing and teaching courses around it. But there was insufficient recognition that computing comprised a distinct discipline. When the realisation came, there were arguments by Don McNeil, who was professor of statistics, and others against having the new Department of Computing too closely aligned with the mathematicians. The outcome nonetheless, coinciding with Hext's arrival, was the expansion of the School of Mathematics and Physics into MPCE—the School of Mathematics, Physics, Computing and Electronics.[37]

But the discipline of statistics was never to be included in such a school. Alf Pollard's special qualities and qualifications saw statistics sit naturally alongside actuarial studies in the School of Economic and Financial Studies but by 1973 Pollard himself was prepared to acquiesce in a working party's recommendation that statistics, demography and actuarial studies be formed into a separate School of Statistical Studies. An alternative scheme was proposed by Murray Aitkin, "whose relations with Pollard were not easy", involving a School of Mathematical Sciences and this turned out to be the preference of a majority of staff. In the event, neither proposal was acted upon and the question was not raised again until a review of the School of Mathematics and Physics in 1979 recommended the formation of a School of Mathematics, Statistics and Computing. Although McNeil was in favour, his staff now was not, "fearing domination by a Mathematics discipline experiencing some resurgence under the indomitable Alf van der Poorten."

In 1982 another review committee made a recommendation along similar lines which, for McNeil, "would release the statisticians somewhat from the embrace of Finance and Accounting" but again the move was resisted and there the matter rests.[38]

James Cook University

One of the founders of the Queensland University College of Townsville in 1960, and chair of its first advisory council, was Henry Thomas Priestley, son of Henry James Priestley, first professor of mathematics in the University of Queensland. The college became James Cook University of North Queensland in 1970.

B. B. Newman was the first staff member in mathematics when the department was established in 1961, followed by Kenneth Capell who was appointed temporary senior lecturer there in February 1962.

The first chair of mathematics was not filled until 1965. It was offered originally to an English applied mathematician, Charles Plumpton, but when he declined it Basil Cameron Rennie was appointed.[39] The closest university to James Cook, from 1967, was the University of Papua New Guinea in Port Moresby and Rennie was a regular visitor to Max McKay's mathematics department there. They would exchange their experiences of small departments in new but isolated universities.

In George Szekeres' words, Rennie was to establish a reputation for "his rather unconventional, should I say eccentric, views on educational and other matters".[40] The eccentricity was widespread: "He invariably came to work without shirt or shoes and reluctantly put on a shirt to conform with conventional expectations, but shoes were only for relatively special occasions."[41]

Rennie's early life has been detailed in Chapter 5, but there is more to tell. As editor of *The Mathematical Scientist* from 1985 until 1989, he was often embarrassed to publish too many articles under his own name. Consequently, five of his twelve articles there were under the pseudonym David Cameron, which is a hybrid of his own and David Elliott's names. It came about after Elliott had refereed one of Rennie's papers, prompting a suggestion, declined by Elliott, that they become joint authors.

Rennie also had over 60 articles, mostly anonymously, in the *James Cook Mathematical Notes* which he started publishing in September 1975. The first issue comprised a single foolscap sheet. Subsequent issues appeared irregularly until the end of 1978 after which there were three issues a year, delivered free of charge by the University until 1983. After his retirement, Rennie continued to publish and circulate the *Notes* from his home, back in Adelaide, and an enclosure in the final issue (volume 7, issue 70, dated December 1996) stated that the issue was "practically completed and ready for distribution when Basil passed away" on 15 November 1996.[42] The *Notes* were subscription based for a few years but the last ten issues were again sent free of charge. In an article extolling Rennie's *Notes*, George Gerzsenyi wrote that "Basil asked his readers who wanted to give something in return to make a gift to an animal welfare society in their own countries."[43]

In his obituary of Rennie, Szekeres, who signed the enclosure just mentioned and was a colleague of Rennie's in Adelaide in the 1950s, wrote: "a strict classification into 'pure' or 'applied' mathematics does not seem to work for Basil Rennie, and with his passing away Australian mathematics . . . lost one of its more unusual personalities."[44]

Apart from his own work, Rennie sought little emphasis on research at Townsville from the department as a whole, and his view of service teaching was simply to offer a "broad and somewhat abstract mathematics program".[45] That was to change with the appointment of Rennie's successor, Roger John Hosking, in 1988 and of Danny Henri Germain Coomans as associate professor of statistics in 1992. Coomans' background was in pharmacy; he has a doctorate from

the Free University of Brussels. Hosking was born at Port Pirie, South Australia, in 1940 and took out a BSc from the University of Adelaide and a PhD from the University of Western Ontario. He had academic posts at Flinders University, the University of Waikato in New Zealand and the Asian Institute of Technology in Bangkok before succeeding Rennie at James Cook University. Since 1999, he has been professor of mathematics at the University of Brunei Darussalam.

A major restructuring in the University in 1995 saw the Department of Mathematics amalgamated with physics and computer science departments into a single school but in 1997 these split with the formation of a School of Mathematical and Physical Sciences and a School of Information Technology, both within a Faculty of Science, Engineering and Information Technology. The mathematicians' research at James Cook is concentrated into areas relevant to its tropical site (ecology, groundwater flow, fluid dynamics and oceanography) and the statisticians are concerned with bioinformatics and climatology. There are currently (in December 2005) nine members of staff in these areas; Wayne Read, a member of the Department of Mathematics since 1989 and himself a graduate of James Cook University, is head of the School of Mathematical and Physical Sciences.

Yet it might be argued that Townsville's most noted product in the mathematical sciences had nothing to do with the university there, and little to do with the town itself. William John Youden was born in Townsville in April 1900 but his family returned to England when he was just two. Youden was educated mainly in the United States, obtaining a PhD in chemistry from Columbia University in 1923. In the 1930s, a growing interest in the statistical design of experiments, which was then still a very young field of research, led to his appointment to the US National Bureau of Standards in 1948, by which time he was acknowledged as a leading statistician as well as a chemist. He died in March 1971, in Washington DC.

Murdoch University

Perth's Murdoch University, named after the foundation professor of English at the University of Western Australia, Sir Walter Murdoch, was the second university to be founded in Western Australia and the 17th in the country. It was formally constituted on 25 July 1973 and classes began in 1975 with 672 undergraduate students and six professors, one of whom was Alex Robertson.

Alexander Provan Robertson, born in Glasgow on 16 June 1925, received his primary and secondary education at the Shawlands Academy, a state school that fostered study in Latin and Greek as much as science and mathematics. That combination of studies continued for Robertson at the University of Glasgow from which he graduated with an MA in January 1946. Eighteen months later, he moved into St John's College, Cambridge, and in the following four years completed his studies for a BA and then most of his doctoral research. The PhD was finalised in the University of Glasgow where he was to lecture for over 14 years. In 1965 he was appointed to the chair of mathematics at the University of Keele in Staffordshire.

While in Cambridge, Robertson met another functional analyst, Wendy Sadie, and they married in August 1951. The Robertsons became well-acquainted with Perth through visiting appointments at UWA (Alex visited first in 1963 and then Alex and Wendy in 1969) and in July 1973 Alex took up duties at the newly founded Murdoch University. At the same time, Wendy Robertson accepted a senior lectureship at UWA.

Robertson played an important role in the formation of the university during the 18 months until it admitted its first students and he continued in a dominant administrative position until

Above: Alexander Provan Roberston, 1925–1995
Left: Lynette and Walter Bloom.

his retirement in January 1990. As an emeritus professor he maintained an interest in the activities of the Department of Mathematics until his death five years later. Academically, he is remembered best for joint work with Wendy including the book *Topological Vector Spaces*,[46] which was first published in 1964, went to three editions and has been translated into German and Russian.[47]

There were three young lecturers, Walter and Lyn Bloom and Ronald McKay, appointed by Robertson in January–February 1975 to begin teaching with him at Murdoch a month later.

Walter Russell Bloom gained a personal chair at Murdoch in 1995. Born in Auckland on 2 December 1948, he had come to Australia in 1960 and studied at the University of Tasmania where he gained a BSc with first-class honours in mathematics in 1971. His PhD is from ANU and he was awarded a DSc by the University of Tasmania in 1994; his current research interests are in Fourier analysis, harmonic analysis and approximation theory. After lecturing at the University of Tasmania during 1974, Bloom was appointed to the Murdoch position, promoted to senior lecturer in 1982 and associate professor in 1988. A keen numismatist (with twelve papers in numismatics) and secretary of the Australian Mathematical Society throughout the 1980s, Bloom married Lynette Myra Butler in 1971 while both were at ANU studying for their PhDs under Robert Edwards. Lyn Bloom resigned from Murdoch at the end of 1981 to join the Western Australian College of Advanced Education, later part of Edith Cowan University.

Ronald McKay had previously been at the Canberra College of Advanced Education. A statistician, he was promoted to senior lecturer in 1982 and associate professor in early 1990 but resigned a year later to become deputy vice-chancellor at the Northern Territory University, now part of Charles Darwin University. He was appointed vice-chancellor there in 1996, retired in September 2002 due to ill health, and died in May 2006.

Kenneth Harrison, with a PhD from Monash University, was the next to be appointed to the mathematics staff at Murdoch. He began as a lecturer there in February 1976 and has been associate professor since 1998. Peter Kloeden was appointed to a lectureship early in 1977 and was an associate professor when he went to a chair of mathematics at Deakin University in 1991. Josephine Anne (Jo) Ward, lecturer and then senior lecturer from 1981 to 1998 and then

associate professor until 2003, is now dean of science at Curtin University of Technology. Her PhD from ANU was awarded in 1979.

Murdoch University is currently partitioned into academic divisions. The School of Engineering Science within the Division of Science and Engineering contains Mathematics and Statistics as one of its discipline areas. One of the smallest universities in the country, it has eight full time members of the teaching staff in this discipline besides the two professors, Bloom and the biostatistician Ian James. James' PhD was obtained at Flinders, supervised by John Darroch. From June 1978 until 1990 he had been a lecturer, then senior lecturer and associate professor at UWA.

Griffith University

Griffith University differed from other Australian universities in having multi-disciplinary, theme-oriented schools. Named for Sir Samuel Griffith, who had been Premier and Chief Justice of Queensland and the first Chief Justice of the High Court of Australia, it began operations in 1975 on its main campus at Nathan in Brisbane and expanded rapidly until it had six campuses in the Brisbane – Gold Coast area of southeast Queensland.

Planning had begun in 1971: mathematics was to be included as an area of applied research in its School of Australian Environmental Studies and was taught there and in its School of Science. The foundation professor of environmental studies, Calvin Rose, formerly a scientist in CSIRO's Division of Land Use Research, was aware of "a lot of very good biologists being limited by their lack of mathematical ability and statistics [so he] insisted that Environmental Studies have a strongly quantitative dimension—even though this was not within the original conceptualisation." [48] Bill Hogarth and Annette Dobson were among the first to have to teach mathematics in that school—within a subject called SPIM, Self-Paced Introduction to Mathematics—and had to cope with students who thought they had avoided the subject by choosing to study the environment.[49]

By 1996 Hogarth was professor of environmental modelling there. His PhD, awarded in 1977 for a thesis in perturbation theory, is from the University of Newcastle, supervised by Mel Lieberstein, and he returned to that university in 2002 as pro-vice-chancellor for the Faculty of Science and Information Technology. Annette Dobson was in the School of Australian Environmental Studies only from 1975 to 1977, when she joined the University of Newcastle. Her story is given elsewhere in this book.

In the School of Science, initially at least, mathematics was not to be taught by mathematicians. Hans Peter Wolfram Gottlieb was one of the first to be appointed to that school. He answered an advertisement for a lecturer in applied mathematics who was to be a "theoretical biologist/chemist/physicist" responsible for teaching the "Supporting Course" in second-year mathematics in its BSc program.[50] Born in Sydney in 1944, Gottlieb had studied mathematics and physics at the University of Melbourne before undertaking a PhD at Cambridge on theoretical elementary particle physics, completed in 1971. In 1987 he was promoted to associate professor, and in 2004 received a DSc from the University of Melbourne for his work on vibrations and related phenomena.

Roger Braddock joined the School of Australian Environmental Studies in mid-1977, after gaining a PhD in applied mathematics at Flinders University, and became a professor in the School of Environmental Engineering at Griffith. The eminent soil physicist Jean-Yves Parlange was professor of applied mathematics there from 1978 to 1984 and was influential in the research

work of Hogarth and Braddock; he was appointed professor of biological and environmental engineering at Cornell University in 1985.

They, among others, taught mathematics to honours level until the course was transferred to the School of Applied Mathematics and Statistics, which existed as part of both the Faculty of Science and the Faculty of Environmental Science from 1990 to 2000. Its inaugural head was a statistician, Janet Chaseling, now an associate professor in the University's Australian School of Environmental Studies. Following the demise of the School of Applied Mathematics and Statistics, in 2003 the honours degree was moved back to the two faculties and taught in part by Gottlieb and four others who constituted the applied mathematics staff of the School of Science. One of those, Anthony J. (Tony) O'Connor, a senior lecturer with interests in optimisation problems, has been at Griffith University since 1977. He has an MSc from Victoria University of Wellington, New Zealand, and an MA and a PhD from Princeton University.

The discipline of applied mathematics at Griffith University has secured its position after an irregular start and is, if anything, expanding as a result of increased service teaching and the consolidation of the honours course.

Deakin University

Named for Australia's second prime minister, Alfred Deakin, the original campus of Deakin University was at Geelong. The headquarters are still in Geelong although the largest of five campuses is now in the Melbourne suburb of Burwood. The University was established in 1974 and teaching began in 1977, by which time it had absorbed the Gordon Institute of Technology, and with it a mathematics major in a Bachelor of Applied Science program, and the State College of Victoria at Geelong. In 1990, Deakin amalgamated with Warrnambool Institute of Advanced Education and in 1992 merged with all of Victoria College except the College's Prahran campus. (Victoria College, formed during the first round of forced amalgamations in the early 1980s, encompassed four previously independent colleges of advanced education: the State Colleges of Victoria at Burwood, Rusden and Toorak, all involved mainly in teacher education, and the Prahran College of Advanced Education which had previously been a technical college.)

Kevin McAvaney was one of the early mathematicians at Deakin University, having been first appointed to "the Gordon", as it was known, in 1970. With an honours degree from the University of Adelaide, he completed an MSc and, in 1984, a PhD in graph theory at the University of Melbourne under the supervision of Derek Holton. At Deakin, McAvaney was a senior lecturer when he accepted a redundancy package in 1997. He gained a position as associate professor at the Sultan Qaboos University in Muscat, Oman, and there "enjoyed the respect for the fundamental disciplines".[51] McAvaney returned to Australia, to a position with the Australian Mathematics Trust in Canberra, in mid-2006.

Mathematics within Deakin's School of Computing and Mathematics had begun strongly—the university's first international conference was in mathematics, organised by McAvaney—but was, according to McAvaney, "progressively marginalised with the decline of sciences, the closure of engineering, the takeover of service subjects, the dilution of secondary school mathematics, and ultimately the ascendancy of computing."[52] The amalgamation with Victoria College saw the situation worsen, despite the appointment of Peter Kloeden to the chair of mathematics in 1992; he also resigned in 1997. At the end of 2002 the School of Computing and Mathematics changed its name to the School of Information Technology.

Peter Eris Kloeden was born in Ringwood, Victoria, on 12 January 1949. He gained a BA with first-class honours in mathematics from Macquarie University in 1972 and a PhD from the University of Queensland in 1975 for a thesis supervised by Rudolf Výborný. Twenty years later he was awarded a DSc by that university. Kloeden taught briefly at Melbourne University and then Monash before joining the newly opened Murdoch University in 1977. He was promoted to senior lecturer in 1982 and associate professor in 1984. In 1992 he gained the chair at Deakin and was also appointed director of its Centre for Applied Dynamical Systems and Environmental Modelling. Kloeden left to become Professor of Applied and Instrumental Mathematics at the Johann Wolfgang Goethe University, Frankfurt am Main, where, he wrote, "academics are treated as assets of the university rather than as financial liabilities."[53] His research covers a number of areas, many of them coming together in the text *The Numerical Solution of Stochastic Differential Equations*,[54] written with Eckhard Platen in 1992 and now in its third edition.

Besides Kloeden there has been only one other professor of mathematics at Deakin University: Lynn Margaret Batten, who arrived there at the beginning of 2000. British by birth, she also holds Canadian and Australian citizenship. Her PhD in geometry was awarded by the University of Waterloo in 1976 and she subsequently held positions at the University of Winnipeg and the University of Manitoba in Canada. Lynn Batten's research interests are in information security and reliability, cryptology and finite geometry and she is head of the Applied Security Research Group at Deakin.

There is also a Mathematics and Computational Theory Group, headed by senior lecturer John Carminati until the end of 2005. The 17 staff members in mathematics and statistics at Deakin in the mid-1990s had been reduced within ten years to five statisticians scattered over three campuses and 5.8 mathematicians. Just 2.8 of these, and a number of postgraduate students, were on the Geelong campus within Carminati's group, but he resigned as its leader when he was himself subject to a further round of cutbacks. Batten and the other two are on the Burwood campus.

The former institutes of technology

The latter half of the 1960s was the period in which institutes of technology sprang from the professional courses being offered in technical colleges across the country, again largely in response to the report of the Murray Committee in 1957. The Martin Committee's report of 1964 soon saw them designated as colleges of advanced education and then, from the mid-1980s, under the Unified National System they were reorganised, one way or another, as universities.

Apart from Victoria, each state had just one Institute of Technology, as well as numerous Colleges of Advanced Education and Institutes of Higher Education and the like. Victoria had the Royal Melbourne Institute of Technology (RMIT), which joined the New South Wales Institute of Technology (NSWIT), the Queensland Institute of Technology (QIT), the South Australian Institute of Technology (SAIT) and the Western Australian Institute of Technology (WAIT) in a grouping called the Conference of Directors of Central Institutes of Technology (DOCIT). These were the largest colleges in the system and had garnered privileges almost matching those of the universities. Each became a university with the introduction of the Unified National System, often merged with other colleges of advanced education in its capital city. As universities, the former members of DOCIT maintained a linkage to share common interests through what they called the Australian Technology Network (ATN).

Victoria was different because it also had ten or so other institutes of technology. Swinburne Institute of Technology became the Swinburne University of Technology. Victoria University of Technology, which was officially renamed Victoria University in 2005, grew out of Footscray Institute of Technology and Western Institute of Technology. Caulfield Institute of Technology and Chisholm Institute of Technology were combined with Monash University; Bendigo Institute of Technology was one of a number of antecedents of La Trobe University at Bendigo; Gordon Institute of Technology became part of Deakin University; and Phillip Institute of Technology was itself formed from Preston Institute of Technology and then amalgamated with RMIT.

There was also the Tasmanian State Institute of Technology, which merged with the University of Tasmania in 1992, and the Darwin Institute of Technology, which became part of the Northern Territory University.

As far as the mathematical sciences go, the universities that arose from the institutes of technology succeeded in adding an emphasis on research to their earlier concentration on teaching and the immediate applicability of their courses. And they have been able to maintain the dual responsibilities except for Swinburne University of Technology where there is no longer an explicit section responsible for mathematics teaching, let alone research.

Swinburne is one of four selected for a more detailed treatment in this section. The other three are RMIT, the University of South Australia (formerly SAIT) and the Queensland University of Technology (formerly QIT). These three, with the University of Technology, Sydney (UTS) and Curtin University of Technology in Perth constitute the five ATN universities. Swinburne and Victoria University are not included in the network.

First, the following paragraphs give brief accounts of mathematics at Curtin University, UTS and Victoria University.

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WAIT was created in 1966 from the Perth Technical College, originally called the Perth Technical School. It later incorporated the West Australian School of Mines which opened in 1902. Stan Waddell and Brian White oversaw the move of the Department of Mathematics from the Perth Technical College to the new WAIT campus south of the city. Waddell was WAIT's inaugural head of mathematics, a position he held until 1978. White saw the further transition to Curtin University of Technology in 1987 and, as the last remaining member of the original college staff, was associate professor there when he retired in 1995. Waddell was succeeded as head by William Stanley (Bill) Perriman and then Louis Caccetta.

Perriman, born in Melbourne in 1941, went to WAIT as head of the School of Mathematics and Computing in 1979. From 1989 until well into the 1990s, he was influential in initiating and consolidating scientific exchange and collaboration with mathematicians in Vietnam.[55] Perriman's research interests were in industrial statistics and mathematics education; he retired in 1998 to become an adjunct professor in the Division of Engineering and Science at Curtin.

Caccetta received a PhD from UWA in 1977. He succeeded Perriman as head of what was by then the School of Mathematics and Statistics at Curtin and in the ten years to 2004 was obliged to oversee the number of full-time staff in the department fall from 22 to 16. Caccetta first joined WAIT in 1981 and in 1992 was appointed to a personal chair. In the same year he was elected president of ASOR, a position he held for over twelve years. In 2001 he piloted the establishment of the Western Australian Centre of Excellence in Industrial Optimisation, formed in recognition of "the significant contribution that industrially focussed optimisation technology can make towards increased efficiency and productivity of local business and industry."[56]

The centre provides postgraduate coursework, a research environment and consultancy services in operations research; Caccetta is director.

Only Caccetta and Kok Lay Teo have held chairs in mathematics at Curtin University and there have been no chairs in statistics. Teo, originally from Singapore and with a PhD from the University of Ottawa awarded in 1974, was previously at UNSW and then UWA. He was appointed professor of applied mathematics in 1998. As part of a university-wide restructure, the school that Caccetta had headed became a department within the School of Applied Science (later renamed the Faculty of Science) in 2000 and Teo followed Caccetta as its head. His interests are in optimal control and signal processing.

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The main campus of UTS is located in central Sydney. It was established in 1965 as NSWIT, became a university in 1988, and in 1990 amalgamated with the Kuringai College of Advanced Education and the Institute of Technical and Adult Teacher Education, a part of the Sydney College of Advanced Education. The Kuringai campus accommodates the Faculty of Education and includes four staff members in the area of mathematics education.

Within the Faculty of Science at UTS, the Department of Mathematical Sciences consisted of around 18 teaching staff in 2005, down from the 23 that were in the School of Mathematical Sciences in NSWIT's Faculty of Mathematical and Computing Sciences in the mid-1980s. The department's main areas of research are in quantitative finance, electromagnetic optics and photonics, operations research, applied statistics, and mathematics and statistics education.

Many details of past and present senior staff, including the current professors Lindsay Botten, Alex Novikov and Eckhard Platen (a joint appointment with the School of Finance and Economics) have been given elsewhere in this book. Tony Shannon was the first to be appointed as professor in the School of Mathematical Sciences, apart from the long-serving head Barry Thornton whose background in physics and computing has been described in Chapter 6. Born in Sydney in 1938, Shannon had taught at the University of Papua New Guinea before being appointed to NSWIT in 1970. He was foundation dean of UTS's Graduate School when he

UTS professors, from left, Alex Novikov, Lindsay Botten, Eckhard Platen.

Production staff for the *Journal of Inequalities in Pure and Applied Mathematics* in 2000. Standing, from left: Peter Vouzas, Pietro Cerone (foundation editor), George Hanna, Abdelghani Taouti; seated, from left: Sever Dragomir (editor-in-chief), Neil Barnett (foundation editor), Anna Pang (assistant editor), Anthony Sofo (chair, managerial board), John Roumeliotis (managing editor). (*The Australian*, 8 November 2000)

retired in 1997 and took on the position of provost of the private KvB Institute of Technology in Sydney. In 1998 he was the first to be awarded a DSc by UTS and in 2001, still not content to enjoy retirement, he also became Master of Warrane College, a Catholic residential college at UNSW. Shannon and Thornton were awarded emeritus professorships by the University.

UTS is home to the Centre for the Study of Choice (CenSoC), founded in early 2003 as a joint initiative of the statistician Deborah Street in the Department of Mathematical Sciences and Jordan Louviere in the Faculty of Business at UTS. One aspect of the centre's work is the development of methods for constructing choice experiments that are optimally or nearly optimally efficient. Street won a promotion to a personal chair in statistics at UTS in 2006.

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Victoria University, previously the Victoria University of Technology, now enjoys the abbreviation VU. A move away from the technologies is evident in the research of the senior mathematicians there. The School of Computer Science and Mathematics is the home of the Research Group in Mathematical Inequalities and Applications which, among other things, produces the *Journal of Inequalities in Pure and Applied Mathematics*, first published in 2000.[57] It is an electronic publication edited by Sever Silvestru Dragomir, born in Romania in 1960 and professor of mathematics at VU since 1998.

Dragomir is also editor-in-chief of another local electronic journal, the *Australian Journal of Mathematical Analysis and Applications*, published for the first time in 2004. Of the other professors in the school, the foundation professor of computer science, Clement Leung, received a BSc with first-class honours in mathematics from McGill University in Canada, an MSc in statistics and operations research from Oxford and a PhD in computer science from University College, London. He was appointed to VU in 1993.

The present head of school, Pietro (or Peter) Cerone, joined Footscray Institute of Technology in 1982 after a period working for the Australian Bureau of Statistics. Now an associate professor, he was Austin Keane's final PhD student at the University of Wollongong in 1979. One of Cerone's predecessors as head of mathematics at Footscray was Robert E. Johnson. His first degree, from RMIT, is in chemical engineering and he has a PhD from the University of Manchester. Johnson subsequently gained a chair of chemical engineering at the University of Melbourne.

Swinburne University of Technology

The main campus of Swinburne University of Technology is located in the Melbourne suburb of Hawthorn. The University traces its history back to the Eastern Suburbs Technical College, founded in 1908. In 1913 it was renamed Swinburne Technical College and engineering diploma courses were introduced, no doubt including some instruction in technical mathematics. In 1965 it became a college of advanced education—the Swinburne Institute of Technology—and in 1992 the Institute and much of the Prahran campus of the Victoria College amalgamated to form Swinburne University of Technology. In a uniquely Victorian fashion, the University also continues the work of its predecessor technical colleges with its TAFE (Technical and Further Education) Division.

By the end of World War 2 there was an identified group of mathematicians at Swinburne Technical College, headed by Douglas McDonell in the mid-1940s and then Keith Lovitt, who remained as head until his retirement in 1975. By the 1950s there was a formal Department of Mathematics that began with five permanent staff and within 20 years contained more than 25 full-time staff teaching mathematical and statistical techniques to students in virtually all faculties of the institution.

One of those who joined after the war, in 1947, was Kenneth Broughton Watson and he was still teaching there almost 50 years later. Born in North Fitzroy, Melbourne, in 1919, Watson had a BSc and a BA from the University of Melbourne and began teaching RAAF radio mechanics at RMIT in 1941. In 1970, at the Swinburne Institute of Technology, he was promoted to senior lecturer and in 1972 to principal lecturer. Ken Watson retired in 1980 but took on teaching jobs at RMIT and the RAAF Academy at Point Cook before returning part time to Swinburne. He retired again at the end of 1994. Watson is well known in sporting circles as the coach of Australia's Olympic basketball teams in 1956 and 1968 and he no doubt holds a sports administration record as secretary of the Victorian Basketball Association for 44 years, from 1934. Raymond Keith (Ray) Watson, Ken's son, was a member of the 1968 Olympic basketball team at Mexico, coached by his father. His studies at the University of Melbourne culminated in a PhD in statistics there in 1977. He joined its Department of Mathematical Statistics in 1970, was head of department after Chris Heyde left for ANU in 1986 and was promoted to associate professor a few years later.

Two years after the granting of university status, Swinburne's Department of Mathematics was renamed the School of Mathematical Sciences but in 2004 a university-wide restructuring saw the school disbanded. The applied mathematicians, about eight of them by then, went in the main to the Faculty of Engineering and Industrial Sciences and the statisticians, seven of them, to the Faculty of Life and Social Sciences.

Besides its work servicing other disciplines, the former School of Mathematical Sciences at Swinburne University had continued to run a degree course that the earlier department developed in the mid-1970s—a Bachelor of Applied Science in Mathematics and Computer Science—in association with the Department of Computer Science. The mathematics component concentrated on operations research and statistics. But by the late 1990s the course that at one stage was offered on two campuses, Hawthorn and Lilydale, and through which several hundred students had qualified, was no longer being offered.

There were two professors in Swinburne's School of Mathematical Sciences: Peter Jones, who was also its final head, and Stephen Roy Clarke. Jones is a statistician, interested primarily in the teaching and learning of statistics at the upper secondary school level. He has a first degree from Melbourne University and a PhD from Monash. After retiring in 2004, Jones was accorded an emeritus professorship.

Clarke, whose training is in mathematics and statistics (at the University of Melbourne) and operations research (at the University of Lancaster) and who has a PhD from Swinburne University, is generally associated with Swinburne Sports Statistics. He joined the Swinburne Institute of Technology as a lecturer in 1971 and in 1980 wrote one of the first computer programs to predict Australian Rules football results. The weekly predictions were sold to a Melbourne daily newspaper. Over the following 25 years, computer football predictions continued to appear in the Australian media and "have proven to be more accurate than the average expert."[58] In the late 1990s the Swinburne Sports Statistics website was developed and predictions were published on a range of sports events, including Australian Rules football, rugby league, rugby, soccer, baseball, cricket, basketball, netball, tennis, horse racing and Formula 1 racing. With the growth of sports betting, Swinburne Sports Statistics provided research and consulting services for the sport, gaming and media industries. External funding, first granted in 1997, had lessened by 2001 and Clarke took semi-retirement in 2004 but the website continued to be maintained. Clarke's personal research has concentrated on statistical and mathematical modelling in sport, particularly related to forecasting, strategy and home advantage.

Brian Richard Phillips, John Robert Iacono and Nicholas Frederick John (Nick) Garnham all started at Swinburne Institute of Technology around the same time as Clarke and all rose to the position of associate professor or equivalent. Iacono had previously been a schoolteacher and then a lecturer at Toorak Teachers College; he retired in 1996. Garnham retired in 2005 and Phillips remained as "academic leader" of the remaining statisticians. The interests of all three encompass mathematics and statistics education. Manmohan Singh is academic leader of the applied mathematicians amongst the engineers.

Joseph Menachem Steiner was a lecturer, then senior lecturer, at Swinburne from 1975 to 2001 and was then appointed professor of applied mathematics at the Jerusalem College of Technology, Israel. Born in Crasna, Romania, he had gained a BSc with first-class honours in applied mathematics and then a PhD in that area, both from Monash University.

University of South Australia

The South Australian School of Mines and Industries first took in students on 13 March 1889. William Bragg, the Elder Professor of Pure and Applied Mathematics in the University of Adelaide, joined the school's council in 1890 and was an active and influential member until his departure from Adelaide in 1909. His successor in the Elder Chair, Robert Chapman, had taught applied mechanics there from 1890 and also had students of the School of Mines in his advanced mathematics classes in the University. Chapman took a seat on the school's council in 1917 and was its president from October 1939 until his death in 1942. In 1960 the School of Mines and Industries and three campuses of the South Australian College of Advanced Education were formally replaced by the South Australian Institute of Technology although it was some five years before the transition was completed.[59]

And that was about the time, 1965, that Phil Howlett was appointed as a tutor there. Philip George Howlett had a BSc with honours from the University of Adelaide at the time. He progressed though all the ranks (tutor, senior tutor, lecturer, senior lecturer and associate professor), gaining a PhD from the University of Adelaide in 1971. In 1990 the Institute of Technology was redesignated and reproclaimed the University of South Australia (to be abbreviated as UniSA, in preference to the obvious) and Howlett was promoted to professor of industrial and applied mathematics in 2001. He has particular expertise in applied optimal control.

David Harry Lee joined the Whyalla campus of SAIT as a lecturer in mathematics at about the same time as Howlett began at the main campus in Adelaide. By 1967, Lee was head of the School of Mathematics and Computer Studies, a position he held until 1983 by which time there were 33 staff members in the school and its strength in applied research had been established. Lee was pro-vice-chancellor (research) at UniSA at the time of his retirement at the end of 1994. He had a BSc with first-class honours and an MSc from the University of Adelaide and, in retirement as an emeritus professor from UniSA and with an honorary position also at the University of Melbourne, became involved in a number of research projects and consultancies concerned with the application of optimisation and network theory to underground mine designs.

Lee was followed as head of school by Graham Mills who had joined SAIT as a senior tutor in 1962 when George Haskard was head of mathematics. With a PhD in mathematical physics from the University of Adelaide supervised by Angas Hurst, Mills spent the period 1967–1972 developing his skills in operations research at Wayne State University, Detroit, and then returned to SAIT. His ten years before retirement were spent with CSIRO where he had been invited to enlarge its capability in operations research. Before and during this period, Mills had considerable involvement with the Mathematics-in-Industry Study Group (MISG), described in Chapter 8.

Basil Ross Benjamin and David Panton were also among the first mathematicians at SAIT and, with Howlett, Lee and Mills, were among many there who appreciated and worked for the MISG. With a BSc and an honours BA from the University of Melbourne, Benjamin lectured at Caulfield Technical College before joining SAIT in 1966 and was a principal lecturer in UniSA when he retired in 1995. Panton began in 1967. He had a PhD from the University of Adelaide, awarded in 1973, and was promoted to associate professor at UniSA in 2003. His interests are in operations research.

Besides Howlett, there are two other professors in what is now the School of Mathematics and Statistics at UniSA: Jerzy Filar and Vladimir Gaitsgory. Filar's family migrated to Australia from Poland in the mid-1960s. He attended Kew High School in Melbourne, obtained a BSc

with honours in mathematical statistics from the University of Melbourne in 1972, an MSc from Monash in 1975 and then an MA in 1977 and a PhD in 1980 from the University of Illinois, Chicago. After seven years as assistant professor at Johns Hopkins University, Baltimore, and six years as associate professor and then professor at the University of Maryland in Baltimore County, Filar was appointed professor of mathematics and statistics at UniSA in 1992. His research interests cover operations research, the theory of games, environmental modelling, optimal control, linear and nonlinear programming, and the applications of these in engineering and economics.

Gaitsgory has a PhD in applied mathematics from the Institute for System Studies of the USSR Academy of Science (Moscow), gained in 1978. He was appointed to UniSA in 1994 and promoted to professor in 2004. Sid Morris was Research Professor of Mathematics there from 1998 to 2001 and prior to that had served for over a year as deputy vice-chancellor and vice-president of the University.

The School of Mathematics and Statistics is part of the Division of Information Technology, Engineering and the Environment. It promotes itself as the most active applied mathematics department in South Australia with 23 academic staff (down from the 33 in Lee's time) spread over three campuses, the major one being at Mawson Lakes, 20 minutes north of the city. Research in the school is carried out largely through its Centre for Industrial and Applied Mathematics, which was founded by Filar in 1994. Panton is the current head of school.

Queensland University of Technology

The Queensland University of Technology (QUT) has its origins in the Central Technical College which first offered courses on the site of QUT's present Gardens Point campus in 1914. Well before that, the School of Arts and Sciences had opened in Brisbane in November 1849 and there is a record of a Mr H. Knapp who gave classes in the mid-1880s there in "Algebra, Euclid and Advanced Arithmetic"; he was also the teacher of French and German.[60]

QUT took over the professional courses of the technical college in 1965 and its Department of Mathematics was formed around 1969 with Robert N. Gould as head from 1971, replacing Kel Macbeth who had headed the mathematics section in the former School of General Studies. Gould had a PhD from the University of Hull and remained as head at QIT for some 15 years. In 1971 the department consisted of four senior lecturers, including Macbeth, and 16 lecturers.

The Institute of Technology was redesignated QUT in 1989. A year later the Brisbane College of Advanced Education, with a background that encompassed local teachers' colleges dating back to 1907, amalgamated with QUT and the university now has three campuses, all in Brisbane.

Edward Pyle (Ed) Dawson joined QIT as a senior tutor in mathematics in 1974 and gained a lectureship the following year. Born in Tacoma, Washington, on 5 November 1946, Dawson had a BSc from the University of Washington when he came to Australia as a high school mathematics teacher in 1971. He collected three master's degrees in twelve years and then a PhD from QUT in 1991, supervised by William James (Bill) Caelli. Caelli is acknowledged as a pioneer of information technology and Dawson's doctorate, in the area of cryptology, was the first such to be awarded in Australia. Dawson was promoted to senior lecturer in 1991 and associate professor in 1992, and that year moved from the School of Mathematical Sciences to the Information Security Research Centre that Caelli had founded in QIT four years before. Dawson, promoted to a chair of cryptology and its applications in 2000, was director of the centre from 1993 to 2004. It was expanded into the multi-disciplinary Information Security Institute in 2005, draw-

ing on the auspices of the Faculties of Information Technology, Law, Business and Engineering, and has almost 50 researchers attached to it. Jennifer Seberry, in 1990–1992, and Ed Dawson, in 2003–2005, are the only Australians that have been elected as directors of the International Association for Cryptologic Research, based in California.

The School of Mathematical Sciences, within the Faculty of Science, consists (in late 2005) of 20 academic staff members including six professors. The current head of school is a statistician, Anthony Nicholas (Tony) Pettitt, from Nottingham, England, where he obtained a PhD in 1974. The other professors are D. L. S. (Sean) McElwain, Kerrie Mengersen, Vo Anh, Helen MacGillivray and Ian Turner.

McElwain is from Queensland originally and has a PhD from York University, Toronto. An applied mathematician with special interests in mathematical biology, he was lecturer, senior lecturer and then associate professor at the University of Newcastle from 1972 to 1994 before taking the chair at QUT. Mengersen has been mentioned in this chapter in connection with the University of Newcastle. Vo Anh's promotion to the chair took place in 2004. His PhD is from the University of Tasmania, conferred in 1978, and he has since obtained an MEc in econometrics from UNE; he joined QIT in 1985. Helen MacGillivray's chair also dates from 2004; she was appointed senior lecturer in statistics at QUT in 1990, having been in the Department of Mathematics in the University of Queensland from 1977 until then. Her interests are now largely in statistical education. Ian Turner has been a staff member at QUT since 1991 and a professor since 2005; he obtained his first degrees in mathematics from there and a PhD in mechanical engineering from the University of Queensland.

RMIT University

The main campus of RMIT is in the central business district of Melbourne. RMIT dates back to the Working Men's College founded in 1887. Its name was changed to Melbourne Technical College in 1934 and it became the Royal Melbourne Institute of Technology in 1960, officially a college of advanced education from 1965.

The head of the Department of Mathematics and Physics of the Working Men's College from 1908 to 1935 was Alfred Hart, born in Iowa, USA, on 5 December 1870. He had migrated to Australia with his family in 1879 and took out a BA and then an MA from the University of Melbourne before commencing as a teacher in the college in 1902. He also gained an MSc in 1911 and, for his continuing work for the University, was awarded an honorary doctorate in 1940. Hart died on 6 October 1950.

The change of name to Melbourne Technical College came about around the time that Hart handed over his position as head of mathematics to John Maurice Allen, who was to hold that position until he was appointed vice-principal in 1955. Allen was born in Portarlington, Victoria, on 25 June 1897 and while teaching for the Victorian Education Department gained his BSc, DipEd and then MA from the University of Melbourne. He influenced school mathematics across Victoria through his work as chair of a number of Education Department syllabus committees and as an active member of the Mathematical Association of Victoria. Allen died on 26 September 1972. One of his early duties was to preside over the opening of the college's mathematics building:

> In 1938 the college was able to acquire . . . White's Imperial Temperance Hotel at the corner of Bowen and Franklin Streets, a large hostelry in reduced circumstances by this time, but in its heyday a recognised abode for visitors from the country . . .

> The building was formally opened as the "Francis Ormond School of Mathematics" . . . in November 1939. Apart from the teaching of mathematics, the council had decided to use part of the building as an extension to the aero engines section of the Motor School. This choice was not altogether happy, as mathematics classes were often interrupted by fumes and noise as the aircraft engines were run up.[61]

Hartley Halstead became head of mathematics in 1963. Alec Proudfoot was deputy head and their department of almost 20 staff members sat in a Special Division, alongside the Department of Humanities and the Department of Librarianship. Born on 12 May 1918 in Melbourne, Halstead was already teaching in Victorian schools while still at high school himself. He subsequently obtained a BA from Melbourne University, majoring in mathematics, and began at RMIT as a part-time instructor after World War 2. As head of department, he introduced diploma courses in mathematics that required three years post-secondary study (they were later converted to degree courses) and played a key role in the acquisition of RMIT's first computer, an Elliott 803. Hartley was appointed principal of Caulfield Institute of Technology in 1970 and was president of the Victorian Institute of Colleges (established at the time of the Martin Committee's report) from 1977 until his retirement in 1980.[62] He was succeeded at RMIT by Raj Vasudeva.

Vasudeva was born in Lahore in 1936 and on the partition of India in 1947 moved to Bombay, where he completed his undergraduate education with a BSc in mathematics in 1956. He gained an MSc in statistics from the University of London in 1964 and was principal lecturer at Middlesex Polytechnic when appointed to the Queensland Institute of Technology (Capricornia), later Central Queensland University, as one of its foundation staff members in 1968. Vasudeva completed a PhD in the Faculty of Education at Monash University in 1988, was promoted to associate professor in 1991 and retired on the grounds of ill health in 1994.[63] In his last years at RMIT, he saw formal university status accorded and, in a related move, the appointment of Peter Brockwell, introduced previously in this chapter, as the first full professor of mathematics.

In the early 1980s what was by then a Department of Mathematics and Computer Science was split into separate departments and in 1995 nine members of the Department of Mathematics left to form the Department of Statistics and Operations Research. Brockwell became the foundation professor of statistics in the process. Kathy Horadam, who had joined RMIT as a lecturer in 1985, was acting head, succeeding Vasudeva, until William Finlay (Bill) Blyth became head of the Department of Mathematics in January 1996. Born in Adelaide in 1947, Blyth had studied at the University of Queensland and has a PhD from Imperial College, London. He joined RMIT as a lecturer in 1976 and was promoted to associate professor in 1994.

Although the institution is still legally the Royal Melbourne Institute of Technology, it now prefers to be known as RMIT University. In 2002, within the Faculty of Applied Science, the Department of Mathematics recombined with the Department of Statistics and Operations Research to form a new Department of Mathematics and Statistics and then in 2004, when the university underwent a total reorganisation, the new department became part of the School of Mathematical and Geospatial Sciences in the portfolio of Science, Engineering and Technology. The department has 33 academic staff, including two professors: Horadam and John Hearne.

Kathryn Jennifer Horadam, born on 2 April 1951, has a BSc with first-class honours and a PhD from ANU and previously worked at the RAAF Academy at Point Cook and in the Cryptomathematics Research Group at the Defence Science and Technology Organisation. Hearne's first degree, in applied mathematics and physics, is from the University of Cape Town, and he has a PhD from the University of Pretoria, awarded in 1983. His main interest is in the

use of quantitative techniques to solve management problems, particularly those relating to the conservation and sustainable utilisation of natural resources. Hearne succeeded Blyth in 2002 as head of the Department of Mathematics and Statistics and was appointed head of school in the reorganisation of 2004.

The universities founded since the late 1980s

Most of the universities in this final set are a result of redesignations and amalgamations following the reforms introduced with the Unified National System in the late 1980s. The two private universities, Bond and Notre Dame, are also included. The universities are treated more or less in order of their establishment except that Charles Sturt University and Central Queensland University are considered at the end in a little more detail.

Of the twelve universities considered here, only the University of Southern Queensland and the University of Ballarat currently have any professors in mathematics or statistics.

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The University of Western Sydney (UWS) was established in 1989 as a federated university network based on the Hawkesbury Agricultural College (founded in 1891), the Nepean College of Advanced Education (1973), and the Macarthur Institute of Higher Education (1983). There are now six campuses across the Greater Western Sydney region.

In the Hawkesbury Agricultural College, from the earliest days mathematics was part of the curriculum as a requirement for studies in physics and agricultural engineering. It was taught by non-specialist staff as part of the science curriculum. With the advent of a more scientific approach to agriculture, statistics was introduced into the curriculum in the 1930s through the areas of biometry and experimental design in agriculture, including horticulture. These areas were again taught by non-specialist staff, primarily those teaching agronomy. The first specialist staff members were appointed in the 1970s, although the emphasis remained on service teaching. One of those, Graeme Newell, appointed in 1974, went on to become professor of property investment at UWS. In the Nepean College of Advanced Education, Leslie James (Les) McGuiness was seconded from its School of Teacher Education to the Centre of Applied Science to establish and teach transfer degree courses with NSWIT in 1983—the first degree programs in mathematics to be taught in any of the colleges that would later come together as UWS. McGuiness was senior lecturer and foundation head of mathematics at Nepean; he retired in 1997. In 1986 Robert Mellor launched a BSc program with a major in mathematics at the Macarthur Institute of Higher Education.

The various campus departments and their courses remained distinct within UWS until the "federated network" came to an end in 2000. At that time the School of Quantitative Methods and Mathematical Sciences was formed as part of the College of Law and Business, with Mellor as its head. Mellor, born in Sydney, obtained his first degree from the University of Sydney and his PhD from Harvard in 1973. Prior to joining the Macarthur Institute in 1985, he spent 17 years in the Australian Bureau of Statistics. He has also been Assistant Deputy Commonwealth Statistician for New South Wales.

Sydney-born Richard Laurance Ollerton was appointed lecturer at the Nepean campus in 1990, promoted to senior lecturer in 1993 and to associate professor in 2001; he was head of department for much of the time prior to amalgamation. His PhD from UTS was titled *Adaptive Optimal Control and the Insulin Dependent Diabetic*. It was supervised by Tony Shannon and

awarded in 1989, the first in any area at UTS. Ollerton and Shannon have since collaborated in a number of papers in the separate fields of diabetes research and recursive sequences.

The School of Quantitative Methods and Mathematical Sciences has been able to maintain staff numbers in mathematics and statistics at around 24, roughly the total number from the constituent groups of the 1990s, but there is no full professor in the school. Mellor, Ollerton, John MacFarlane (appointed to the Hawkesbury Agricultural College in 1981) and Wei Xing Zheng (a prolific researcher in signal processing and operations research, appointed in 1994) are the associate professors.[64]

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Edith Cowan University, named for Australia's first woman parliamentarian, consists of three campuses in Perth and a fourth at Bunbury in Western Australia's southwest. It is the state's second largest university. Formerly the Western Australian College of Advanced Education (WACAE), established in 1982 from four teachers' colleges dating back to 1902, it became a university in 1991.

Mathematics constitutes one of the five academic programs within the School of Engineering and Mathematics. Lyn Bloom, wife of Murdoch University's Walter Bloom, is coordinator of the program. Born in Cairns, Queensland, she studied first at the University of Queensland, and gained her PhD from ANU in 1979. She joined WACAE in 1982 and was promoted to associate professor in Edith Cowan University in 2000. A prominent member of the National Tertiary Education Union, she was elected to its national executive in 2002 and has been vice-president (academic) since 2004.

Others of long standing on the staff at Edith Cowan include David McDougall, James Cross and Pender Pedler, all associated with one of the predecessor colleges since the mid-1970s. McDougall has an MSc from the University of Newcastle-upon-Tyne (awarded in 1966) and a PhD in group theory from the University of London (1969). Cross received a BMath with first-class honours and a university medal from the University of Newcastle in 1973 and a PhD from ANU, supervised by Neil Trudinger. An associate professor since 1992, he was the first head of department when university status was attained (and before the School of Engineering and Mathematics was formed). McDougall is the current head of school. Pedler's PhD in mathematics education is from UWA, completed in 1988.

Research and postgraduate courses in the mathematics discipline stress statistical applications, geostatistics in particular, as well as mathematics education. There are six staff teaching in the mathematics program, down from a peak of ten.

The famous Olympic athlete, Shirley Barbara de la Hunty, better known by her maiden name, Shirley Strickland, was a mathematics teacher by occupation and became closely identified with Edith Cowan University. Born on 18 July 1925, she had a BSc with honours in nuclear physics from UWA and quickly went into teaching. She taught mathematics in schools and then mathematics, statistics, computing and environmental history at the Claremont Teachers College, which became part of WACAE. Awarded an honorary PhD by Edith Cowan University in 2001 and known also for her work for environmental causes, Shirley Strickland died on 16 February 2004.

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The Australian Catholic University (ACU) is composed of a number of campuses in eastern Australia. It began operations in January 1991 after an amalgamation of the Catholic College of Education in New South Wales, the Institute of Catholic Education in Victoria, Macaulay College

in Queensland and Signadou College of Education in the Australian Capital Territory. Bernice (Bernie) Sharp joined the Catholic College of Education in 1984 and is now associate professor at ACU in the School of Arts and Sciences (New South Wales). Born in England, her first job in Australia was as a primary school teacher at Woomera, South Australia. She subsequently gained a PhD from the University of Newcastle with John Giles as supervisor.

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The University of Southern Queensland is based in Toowoomba, 135 kilometres west of Brisbane. Originally the University College of Southern Queensland, established in 1990 under the sponsorship of the University of Queensland, it became an autonomous university in 1992. The college was formed from the Darling Downs Institute of Advanced Education (DDIAE), which was established in 1971 as a college of advanced education to replace the Queensland Institute of Technology (Darling Downs). The latter had opened on the site in 1967.

From the beginning, mathematics was one of the disciplines within a School of Applied Science with service teaching to science and engineering students always a dominant feature. For that reason, staff numbers in mathematics reached and stayed in the region of 15 to 20. Among the early staff members were Edward Siebuhr, who began in 1969, Henry Eastment (1970) and Walter Spunde (1973). Siebuhr chaired the Queensland Senior Mathematics Syllabus Committee for many years and both he and Eastment served terms as associate dean in what was later a Faculty of Sciences. Siebuhr retired in 1997 and Eastment in 2003, while Spunde is there still, now as a senior lecturer. In 1993 a Department of Mathematics and Computing was formed in the new university with Christopher John (Chris) Harman appointed as its first head. Harman completed a PhD in pure mathematics at the University of Adelaide in 1972, taught at the Mitchell College of Advanced Education in Bathurst for nine years and joined DDIAE as a principal lecturer in 1984. Reclassified as an associate professor in 1990, he retired at the end of 2005.

Anthony John (Tony) Roberts is the foundation professor of applied mathematics in the University of Southern Queensland and still the only professor in the Department of Mathematics and Computing. He was born in Lagos, Nigeria, in 1957, came to Australia in 1961 and graduated BSc with first-class honours in applied mathematics from the University of Adelaide. In 1982 Roberts obtained a PhD from the Department of Applied Mathematics and Theoretical Physics at Cambridge. After six months as lecturer at UNSW and then ten years as lecturer and senior lecturer at the University of Adelaide, he was appointed to the chair in Toowoomba in 1993.

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When the Ballarat School of Mines and Industries opened on 23 January 1871, classes were held that day in surveying, mathematics and chemistry with two teachers and five students. In the institution's annual report for 1882, the lecturer in mathematics, Arthur A. Buley, began by saying: "The students under my charge have made marked progress in Mathematics during the past year . . . The pupils in the upper division have been studying advanced geometry and conic sections, Todhunter's larger algebra and trigonometry, analytical and spherical." Elsewhere in the report, Buley said:

> There is no occupation in which anyone may be engaged in which Mathematics are not exceedingly useful and in many cases they are indispensable . . . Latin and Greek may be dispensed with as being not absolutely necessary to the acquirement of scientific knowledge.[65]

From 1887 to 1894, there was an affiliation with the University of Melbourne that allowed subjects to be taught in Ballarat towards the University's BA. After that time the School of Mines

began offering its own diplomas in engineering. Most notable among the early mathematics staff was Richard Walter Richards who joined the junior technical school within the Ballarat School of Mines as a teacher in 1914. He was reappointed as a lecturer in mathematics in the senior wing from 1917 and was principal of the School from 1946 until his retirement in 1958. Richards, born near Bendigo in 1893, was a physicist with the Shackleton Trans-Antarctic Expedition of 1914–1917 and was highly decorated for the heroism he showed on that mission.[66] He died in 1985.

When Richards became principal, the responsibility for mathematics teaching was given to Aurel Charles Miller who, prior to that, was a teacher with the Victorian Education Department. Miller was head of the Department of Mathematics from 1970 to 1976,[77] the year in which the Ballarat College of Advanced Education was formed from the School of Mines. Through a renewed affiliation with the University of Melbourne, this became Ballarat University College in 1990 and autonomy came with the founding of the University of Ballarat in January 1994.

Sid Morris has been professor of informatics and head of the School of Information Technology and Mathematical Sciences there since 2001. The other professors in the school are Mirka Miller and Alex Rubinov. Miller's first degree was from the University of Sydney and she has a PhD from UNSW, awarded in 1990. She previously held positions at UNE and the University of Newcastle, and came to Ballarat in 2004 as professor of computer science. Her interests include combinatorics and graph theory. Rubinov is director of the school's Centre for Informatics and Applied Optimisation; his interests are in non-smooth analysis and optimisation.

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Southern Cross University has its main campus at Lismore in northern New South Wales. The university has its origins in the Northern Rivers College of Advanced Education, which was established in 1974 incorporating the then Lismore Teachers College. Originally a campus of UNE, the present university was established in 1994 following abandonment of the merger. Some 300 kilometres north of Lismore, on the other side of Brisbane, is the University of the Sunshine Coast, in Maroochydore. It was established in July 1994 as Sunshine Coast University College, sponsored by QUT. In 1999, it became autonomous and obtained its current name. Neither of these universities has a substantial program in mathematics or statistics.

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In the Northern Territory, tertiary mathematics was first taught in the Darwin Community College, which was founded in 1974 and renamed the Darwin Institute of Technology in 1983. The Northern Territory University was established in 1989 through a merger of the University College of the Northern Territory (opened in 1987 and teaching courses of the University of Queensland) and the Darwin Institute of Technology, and was the major part of Charles Darwin University when it was established through further amalgamations in 2003.

The Discipline of Mathematics and Physics in Darwin is within the School of Engineering and Logistics. Ian Roberts is longest serving of the mathematicians there and is now senior lecturer. Appointed in 1980, his undergraduate studies were at the University of Newcastle. An MLitt and an MA in functional analysis followed, both from UNE, and a PhD in combinatorics from Curtin University of Technology, supervised by Jamie Simpson, was completed in 1999.

At different times since the mid-1980s there were as many as six full-time staff members teaching mathematics and related courses up to postgraduate level and supervising higher degree students, but a university-wide rationalisation in the mid-2000s saw all higher-level mathematics subjects withdrawn.

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There are two main private universities in Australia.

Bond University, at Robina on Queensland's Gold Coast, opened in 1989 as Australia's first private university. Like many of the public universities, it has seen its offerings in mathematics and statistics decline since the late 1990s. William Dunsmuir, Bruce Murtagh and Leslie, or Les, Berry were among the first to join the University's School of Information Technology (then called the School of Information and Computing Sciences), all as full professors of mathematics or statistics. Richard Tweedie, whose career has been described in Chapter 7, was also there from the beginning as one of four foundation deans. Berry left Bond in 1991 to become professor of computer systems engineering at RMIT University. Dunsmuir left at the same time as Tweedie, in 1993, for a chair of statistics at UNSW. Murtagh, a specialist in operations research and co-inventor of MINOS, a software package for solving large-scale optimisation problems, also left around then to become professor of management at Macquarie University. John Eccleston, appointed as associate professor in the school when it began, took over from Tweedie as head and later became a professor of statistics in the University of Queensland.

Neville John de Mestre joined Bond University a few months after it opened. Before moving to Queensland, he had lectured for 28 years at the Royal Military College, Duntroon, and then at ADFA. At Bond, he was appointed associate professor and was promoted to professor of mathematics in 1997. At his retirement at the end of 2003, aged 65, de Mestre was made emeritus professor. The chairs that he and the others had held were not filled again and the former staff of eleven, teaching courses in mathematics, statistics and operations research, was reduced to three.

The University of Notre Dame Australia is Australia's second private university. Located in Fremantle, Western Australia, it was established in 1989 and teaching commenced in 1992 in its undergraduate courses in arts, education, business, law and theology. As one of a number of jobs that Bill Perriman took on after early retirement from Curtin University, he is adjunct professor there, almost solely responsible for the development and rationalisation of its mathematics and statistics programs. The University has recently established another campus, in Sydney.

Charles Sturt University

Charles Sturt University was established in 1989 to operate through much of central and southern New South Wales. It comprised the former Riverina-Murray Institute of Higher Education, founded in 1985 with campuses at Wagga Wagga and Albury-Wodonga, and the Mitchell College of Advanced Education founded in 1971 at Bathurst. The Wagga Wagga campus was formerly known as the Riverina College of Advanced Education, also dating from 1971, and both the Wagga Wagga and Bathurst sites were previously well-established local teachers' colleges with affiliations also to agricultural colleges established almost 80 years before.

The creation of Charles Sturt University fulfilled the ambition of the Riverine University League, which was formed in essence in 1952 and disbanded in 1981. The University operates now on campuses at Wagga Wagga, Bathurst, Albury-Wodonga, Orange and Dubbo as well as at a number of smaller centres.[68]

John Peter Louis first joined the Riverina College of Advanced Education as a lecturer in mathematics and statistics in 1975. He had graduated from UNSW with a BSc with first-class honours in mathematics and the university medal in 1972 and, in his first years at Wagga Wagga, completed a PhD on the mathematics of edge waves, also from UNSW but working through

Wollongong University College. Louis was promoted to senior lecturer in 1990, in what was by then Charles Sturt University, and to associate professor (of "mathematics and spatial science") in 2004. In the late 1980s Louis's research focus changed from physical oceanography to remote sensing and image analysis so that he could be more closely aligned with the strategic research initiatives of a rural faculty in a newly emerging university. He became the founding director of the university's first designated research centre, in the area of image analysis.

The only mathematics staff members that preceded Louis at Wagga Wagga were Keith Hutcheson (who resigned in 1975), Bruce Whitfield King (who moved into computing around 1981) and Louis Du Plessis (who retired in 1985). It was only around the time of Du Plessis's retirement that regional students in southern New South Wales first had an opportunity to study locally for a major in mathematics, a result of a transfer course in mathematics and computing between the Riverina-Murray Institute of Higher Education and the New South Wales Institute of Technology developed by Louis and Du Plessis. As part of Charles Sturt University, there is now a mathematics major conducted within a BSc program at Wagga Wagga and there are graduate certificate courses in mathematics and biometrics.

In a de facto capacity if not by title, Louis has been leading what is currently the Mathematics and Statistics Discipline within the School of Science and Technology, in the Faculty of Science and Agriculture, at Wagga Wagga since the mid-1980s. His responsibilities now extend across the entire university. In mid-2005 there was an establishment of seven staff members in mathematics at Wagga Wagga, three at Bathurst, one at Albury-Wodonga and one at Orange.[69]

The three at Bathurst are the remnants of a mathematics staff at Mitchell College that numbered 24 in the mid-1970s. At that time the new college's charter was to produce first-rate undergraduate vocational courses and in accepting that challenge the Mathematics Department developed new degree courses in industrial mathematics and general mathematics while continuing the work of the Bathurst Teachers College in training secondary mathematics teachers.

Leslie John (Les) Brady, who graduated from UNSW through the Newcastle University College in 1962 and had an MSc from the University of Waterloo, was principal lecturer and head of the department until the mid-1980s. Lawson Lobb (with a BSc from Rhodes University and an MSc from the University of Illinois) looked after the pure mathematics subjects; Charles J. Presland (with an MSc from Macquarie University) was in charge of the statistics subjects and John Cormack of the operations research subjects. Ian William Stewart was second in charge of the department and headed the mathematics education section with Colin R. Billington looking after the mathematics components in the primary teacher education program.

A course leading to the degree of Bachelor of Applied Science (Industrial Mathematics and Computing) was offered both internally and by distance education. The latter became popular as the first degree course in Australia with a significant computing component to be offered externally and in 1988 the department also began a Graduate Diploma in Industrial Mathematics and Computing. In 1992 an honours year was introduced allowing students to undertake honours in pure mathematics, numerical analysis, statistics or computing.

The Mathematics Department at Mitchell College was split as part of a general restructuring in 1982. The staff in mathematics education went to the School of Teacher Education, the computing staff to the School of Business and Public Administration and the remaining staff to the School of Mathematics, Applied Science and Planning.

The coming together of the two departments at Wagga Wagga and Bathurst with the formation of the new university and the need to operate a common degree course in mathematics led to a

strained relationship between the two. Despite the relative success of the courses in industrial mathematics and computing, in 1996 Charles Sturt University chose to close down all formal mathematics programs at Bathurst including also a Bachelor of Education program in secondary mathematics and within five years all but three of the mathematics staff had departed. Kevin Wilkins, who began at Mitchell College in 1974, was sub-dean for mathematics and statistics and responsible for all relevant courses throughout the university from 1992 until the troubles in 1996. A senior lecturer there since 1988, he remains as the most senior of the three.

Located now within the School of Information Technology, they are involved in the service teaching of business statistics for the School of Business and of discrete mathematics for a degree course in information technology. There was some compensation in 2000 when a new course leading to a Bachelor of Computing Science (Games Technology) was developed at Bathurst. The course contains five mathematics subjects as part of its core: an introductory subject, discrete mathematics, linear algebra, ordinary differential equations and dynamics. The three at least are fully occupied.[70]

Central Queensland University

Opening its doors for the first time in 1967 as the Queensland Institute of Technology (Capricornia), and known as the Capricornia Institute of Advanced Education from 1971 and then as the University College of Central Queensland in 1990, the University of Central Queensland came into being in January 1992 and has settled finally on its preferred name: Central Queensland University (CQU). It has ten mathematicians active across three of its five regional campuses, namely the original Rockhampton campus and those at Mackay and Bundaberg.

John David Smith, born in 1934 in Edinburgh and educated there, arrived in Rockhampton as senior lecturer in mathematics in 1968. He spent the period 1970–1973 as an industry consultant and then returned to Rockhampton as head of the Department of Mathematics and Computing and was appointed professor shortly before university status was granted. An applied mathematician with interests in operations research, Smith died on 6 August 1995, two months after being diagnosed as having cancer.[71] Milton Fuller joined the Queensland Institute of Technology (Capricornia) around the same time as Smith and is there still, although now semi-retired. Fuller was instrumental in establishing CQU's Mathematics Learning Centre in 1984.

The department's main offering, the Bachelor of Applied Science (Mathematics and its Applications), accepted enrolments from 1974 and enabled students to study at a distance, an innovation for its time. A university restructure in 1998 saw the department become the School of Mathematical and Decision Sciences first headed by Kevin Tickle, a statistician with a PhD from Griffith University, appointed in 1987 and now serving as dean of the Faculty of Informatics and Communication. The algebraist Robert McDougall then served as head until an internal faculty restructure in 2003 saw the discipline of mathematics incorporated into the School of Computer Science.

Graham Wood, with research interests that include stochastic global optimisation, was appointed professor of mathematics in 1994 and, in addition to building strong links with the regional secondary school communities, led the development of a Bachelor of Mathematical Science which accepted enrolments from 1996 to 1999. He is now professor of statistics at Macquarie. David Bulger, CQU's first PhD in mathematics, supervised by Wood, is also at Macquarie University. McDougall, now a senior lecturer in the School of Computer Science, also has a PhD from CQU.

The senior staff members of that school include Russel Stonier (PhD, University of Queensland), first appointed in 1982 with research expertise in intelligent computation; Ross Shepherd, appointed in 1993 with a PhD from UNE, active in statistical and computational aspects of quantitative genetics as applied to animal breeding; and Moscow-trained Victor Korotkich, appointed in 1995 and working in global optimisation and complex systems.

These three and Tickle are all associate professors; there is no longer a professor of mathematics or statistics. Enrolments in specialist mathematics courses have been in decline over the last six years and many advanced courses have disappeared. Mathematical research and postgraduate supervision continue to have a presence but teaching duties are focused on service courses in the areas of business, science, engineering and education.[72]

Since July 2004, the vice-chancellor of CQU has been John Anthony Rickard. Born in England, Rickard studied at Queen Elizabeth College, University of London, and gained a PhD in geophysical fluid mechanics from University College, London, in 1969. He moved then to Australia to take up a lectureship in mathematics at the University of Melbourne. Rickard's interests shifted towards economics and finance and after a number of professorial and senior administrative positions he became vice-chancellor of Southern Cross University in 2000 before taking the position at CQU.

Chapter 10

The Australian Mathematical Society

Larry Blakers was professor of mathematics at UWA for 30 years from 1952. He has described the formation of the Australian Mathematical Society in 1956 as very much his initiative. The first part of this chapter is the story of the beginnings of the Society, much as he wrote it himself. The narrative is then brought up to date, including a separate section on the history of ANZIAM which, although a division of the Society, is in large measure a separate organisation.

The major participants in this story have all been introduced. It is unclear why they waited so long to coordinate Australian mathematics since the physicists and statisticians were by then organised and mathematics teachers' organisations had been established in Sydney and Melbourne. What is clear is that with or without Blakers they would not have waited much longer. The Australian Academy of Science had been formed in 1954 with Tom Cherry as a key worker, mathematics at ANU was about to make an official entry with Bernhard Neumann at the helm, and the 1960s would see massive growth in the university sector and the number of mathematicians employed. The Australian Mathematical Society had to happen.

The founding of the Society

Gatherings of mathematicians in Australia prior to the formation of the Australian Mathematical Society in 1956 occurred only within Section A of the meetings of ANZAAS, or of AAAS before it evolved into ANZAAS in 1930. That section also included astronomy and physics and tended to be dominated by the physicists. "From my familiarity with the relationship of the various mathematical organisations and the American Association for the Advancement of Science," Blakers wrote in the Society's *Gazette* in 1976, "I did not believe that ANZAAS, Section A, could be a very suitable forum for mathematical communication at the research level."[1]

Blakers' assessment of the place of mathematics within ANZAAS, aligned as it was with physics, was mirrored by the physicists themselves, and a resolution for them had in fact begun much earlier. In 1923, A. D. Ross, also at the University of Western Australia, began a campaign to have local physicists join the London-based Institute of Physics. In effect, he created an Australian branch of the Institute and "initiated the practice of calling a formal meeting . . . during each AAAS congress, thus giving the informally constituted branch a visible identity of its own."[2] By 1928, the group was meeting separately on a regular basis, as well as within AAAS and then ANZAAS, and in 1939 was constituted as an Australian Branch of the

Institute of Physics. However, it was not until the 1960s, well after the formation of the Australian Mathematical Society, that an independent Australian Institute of Physics was founded.

With a view to establishing personal contacts with his "professorial colleagues" around the country, and prior to the ANZAAS meeting to be held in Canberra in January 1954, Blakers decided to drive some 5,800 kilometres from Perth, through Adelaide, Melbourne and Sydney, ending in Brisbane, and then back to Perth via the meeting in Canberra. The forward trip included a visit also to Hobart to see Edwin Pitman. Blakers was accompanied by his wife Terri and their twelve month old daughter Nancy. Harold Sanders in Adelaide "was close to retirement and not very interested in discussing developmental possibilities" and Eugene Simonds in Brisbane "was also close to retirement and unfortunately too ill to see me". But Blakers established lasting contacts with Tom Cherry in Melbourne, T. G. Room in Sydney and Pitman, all of whom he was meeting for the first time.[3] These four were to dominate the planning that led to the formation of the Society.

The initial reaction, however, was not seen as enthusiastic. Cherry "was concerned that the formation of a separate society might tend to isolate Australian mathematicians from their scientific colleagues in other disciplines" and all expressed doubt that a local society could maintain a journal of international standing. Pitman later spoke of this as the "Cambridge resistance" to the concept—he said that initially Room didn't think it was necessary to found an Australian mathematical society, and that Cherry was "doubtless" being pushed to do something, while he (Pitman) was firmly in favour. Pitman did not mention Blakers' role but gave credit to the Australian Academy of Science, formed in 1954, for bringing Cherry, Room and himself together for talks that had a direct bearing on the formation of the Society.[4]

Blakers is silent on whether any further discussion took place at the 1954 ANZAAS meeting, but plans were laid for an extensive debate to occur at the subsequent ANZAAS meeting, in Melbourne in August 1955.

Cherry took on the responsibility of circulating all university mathematics departments to foreshadow that discussion, but he approached it in a peculiarly negative fashion. He suggested in a letter to the departments in July 1954 that "mathematicians would wish to spend most of their time [at the 1955 ANZAAS meeting] attending lectures in other branches of science."[5] A month later, in a second circular, he acknowledged that mathematicians may well wish to meet in a separate section, and that this need not necessarily be as part of ANZAAS. In January 1955, in Cherry's absence overseas but on his behalf, Angas Hurst circulated the following for inclusion in the program of Section A in August that year:

(a) A discussion on the teaching of mathematics in Australia, including comments on contents of curricula both in schools and universities;
(b) lectures by experts on their specialities, of a type that is intelligible to mathematicians who are non-specialists;
(c) a session on Statistics;
(d) a discussion on the question of arranging a separate section for mathematics at future meetings of ANZAAS.

As Blakers wrote, there "was no specific mention of a separate society, but Professor Cherry's comment about the possible inadequacy of ANZAAS as the only forum for mathematicians, and the limiting character of item (b) on Dr. Hurst's schedule, suggest a growing feeling that something more than ANZAAS might soon be needed." Blakers originally thought Cherry's low key approach was at best a pessimistic view of a possible new society, but admitted later that

this judgement had been unjustified. In fact, he later wrote of Cherry, "a self-awareness of his inability to do a superficial job was a significant factor in his cautious approach to new ideas; before I knew him very well I mistook this caution for opposition".

The date 24 August 1955, the last day of the ANZAAS meeting that year, marked the formal announcement of the intent to form the Australian Mathematical Society. Cherry chaired "a vigorous discussion at a well-attended meeting. After due consideration of possible alternatives (including that of doing nothing) a firm decision was reached." Blakers lamented that no official communiqué of the ANZAAS meeting quoted the decision, but a letter to him from Cherry a few days later recorded it as follows:

> At a meeting of the Mathematics and Mathematical Statistics Sub-Section of ANZAAS on 24 August 1955 it was resolved that steps be taken to form an Australian Mathematical Society, with the objects (1) to hold meetings of Australian mathematicians (in the wide sense, including theoretical physicists, statisticians etc.) in conjunction with ANZAAS conferences and perhaps at other times, and (2) to sponsor the publication (as soon as it can be arranged) of an Australian Mathematical Journal.

The same letter went also to Maurice Belz, Edwin Pitman, T. G. Room, Alf Cornish and Henry Finucan of the University of Queensland, standing in for Clive Davis whose arrival to take up the chair there was imminent. These recipients, together with Keith Bullen and Pat Moran, and with Cherry as convener, constituted the committee established at the ANZAAS meeting to work towards the inauguration of the Society. Blakers noted that there had been no formal proposal that Cherry become, in effect, the "President designate", but that this had been a suggestion of Room's, "thus avoiding what could have been a difficult problem—how to choose between these two distinguished Fellows of the Royal Society".

By December 1955, the Planning Committee had agreed that the inaugural meeting of the Australian Mathematical Society should take place at the University of Melbourne during the week 13–18 August 1956. A notice to this effect was distributed to a list of "some 182 persons". After detailing the intent of the notice and the names of the committee members, it continued as follows:

> *Qualifications for Membership*: No explicit statement seems necessary. No-one without some knowledge of and an interest in advanced mathematics is likely to apply for membership. Membership of such a society does not confer any professional status as does, for example, membership of the Royal Australian Chemical Institute or of various engineering institutes. It would seem wise, however, to provide, as a routine, that those desirous of joining should be formally proposed and elected; but this provision would not come into force until the Inaugural Meeting had adopted Bye-laws.
>
> *Subscription*: Full 3 or 4 guineas* (if a journal is to be produced the higher figure seems indicated), students 1 guinea.
>
> *Journal*: There is a great need for an Australian Journal of Mathematics. At present Australian mathematicians have to publish their work overseas, usually in England or in U.S.A. This is inconvenient and causes great delay in publication. An Australian Mathematical Journal would greatly stimulate and encourage Australian research in mathematics, and we now have enough mathematicians in Australia to be able to run it properly.

The list of recipients was very broad. It aimed to include all mathematicians and statisticians in the nine Australian universities of the day, as well as Canberra University College, the Royal Military College and Melbourne Technical College. From the University of Sydney, by way

**1 guinea = 21 shillings; 10 shillings = 1 dollar. Therefore one guinea is $2.10*

of example, there were members of the departments of theoretical physics, economics, veterinary physiology, aeronautical engineering, electrical engineering and electronics, and physical chemistry. Others were from CSIRO; the Department of Supply (specifically, the Aeronautical Research Laboratories in Melbourne and the Weapons Research Establishment at Salisbury); the Departments of the Interior and Health; the RAAF; the Commonwealth Bureau of Census and Statistics; and the New South Wales government observatory. At the end there was a further list of statisticians, "not geographically classified". The complete list is reproduced as Appendix C in Blakers' *Gazette* article although he states that this is only the "initial" list and that he had no knowledge of the final version. Only 15 on the list are identifiable as being women's names. (The *Gazette*'s list contains just 181 names, despite the reference to "182 persons". The original list has a pencilled addition, not included in the *Gazette*.[6])

One of Blakers' original suggestions, dating from his round-Australia car trip, was that Albert Tucker be invited to Australia as a Fulbright scholar to offer advice "because of his wide editorial experience and, most especially, because of his close involvement in the recent founding of the Canadian Mathematical Congress". Tucker was Blakers' former teacher and Princeton colleague and is credited with creating the mathematical foundations of linear programming. Cherry, Room and Pitman agreed and ultimately the inaugural meeting of the Society was timed to occur during Tucker's visit. There was less success in attracting other overseas speakers to the meeting, despite some vigorous attempts. For example, Room wrote to Blakers in November 1955 that "Cherry, Bullen, Pitman and I . . . are anxious that Sir Harold Jeffreys should be invited to attend the inaugural meeting."[7]

On 20 March 1956, Cherry wrote again to members of the "provisional committee", and to heads of mathematics departments who were not on the committee (Harold Sanders, Bert Green, Maurice Belz, Russell Love, Geoffrey Bosson, Derick Atkinson and Andy Guinand) giving a report on progress to that date. On the question of visitors, he wrote:

> Blakers has done excellent softening and galvanizing work towards securing a set of distinguished overseas visitors for the occasion. Tucker (USA) we already know about. I have sent official invitations to India (Chandrasekharan) and Malaya (Oppenheim) and have extended feelers to Great Britain (where I have asked Bullen to follow up) and New Zealand; my guess is that from these four we shall have about three acceptances. (The remaining possibility is Canada, but there I have no personal contacts, and it seems best to save Canada for another occasion. If any members of the committee think that there is here an excessive lack of tact would they let me know immediately.)[8]

In the end, Desmond Sawyer, Freddy Chong and Harry Silverstone, all from New Zealand, were the only overseas visitors, besides Tucker.

Cherry went on to suggest an outline of the program for the meeting, and Blakers wrote in 1976 that this was a "format which has not varied greatly in the ensuing 20 years". Nor has it varied greatly in the 30 years after that.

At the end of May, the announcement of the inaugural meeting was distributed:

> *Inaugural Meeting*
>
> The Inaugural Meeting of the Society will be held from August 15th to 18th at the University of Melbourne, commencing with a Business Session on Wednesday 15th at 2.00 p.m. and concluding with a Dinner and social evening on Saturday 18th. For various reasons it is necessary to compress the meeting into these four days, and evening as well as day sessions will be held.
>
> The provisional Committee invites all those who are interested to attend this meeting, particularly those who contemplate joining the Society.

At the business sessions it will be moved that the Society be formally constituted, and if this is approved there will follow an election of committee and office bearers and consideration of (1) bye laws, (2) subscription, (3) arrangements for future meetings (frequency, place, character), (4) publication of a Journal.

At the scientific sessions there will be (1) a set of specially invited lectures, chosen so as to cover between them a wide field at a level suited to a general mathematical audience, and (2) sessions for more specialized communications, which are hereby invited from anyone attending the meeting. In the first category two of the speakers will be Professor A. W. Tucker (Princeton) and Dr. D. B. Sawyer (Otago), and there is a chance of one or two other overseas visitors.

Accommodation for men coming from outside the Melbourne area has been arranged at Ormond College, adjacent to the University. The charge, inclusive of meals, will be £6.15.0 (covering lunch on Aug. 15th to breakfast on Aug. 19th and including the special Saturday dinner). The College can provide bed linen and towels for a limited number only of guests, and it would be appreciated if those who can bring their own would do so. The charge will be roughly pro rata for those who cannot attend for the full period.

Equivalent accommodation for a limited number of women will be arranged, as required. The available facilities will not permit the attendance of non-mathematician wives.

Inaugural dinner. This will be held at Ormond College on the evening of Saturday Aug. 19th for all those attending the meeting; day dress. The charge to locals (not living in the College) will be 25/-.

Excursion. A country excursion will be arranged on Sunday August 20th, for those visitors who can fit it in before leaving Melbourne. Visitors will here be the guests of the locals. Unfortunately it will not be possible for visitors to remain in Ormond College for the Sunday night, and it is suggested that they defer their departure till the latest available transport on Sunday.

Registration fee of 10/-, to meet organizing expenses, will be charged to all those attending the meeting.

Registration date. Would those proposing to attend the meeting please return the attached form, together with the registration fee of 10/-, by June 30th. Later entries will be accepted, but it is necessary to know the approximate numbers in sufficient time. Send forms to

Australian Mathematical Society,
c/o Mathematics Department,
The University,
Melbourne N.3.

Detailed programme will be sent during July to those who reply to this circular.

For the provisional Committee,
T. M. Cherry (Convener).[9]

Out of the 107 attending the conference, there were 79 mathematicians present when the inaugural business meeting was called to order by Cherry at 2.15 pm on Wednesday, 15 August 1956. Blakers wrote: "After welcoming visitors, and reading a number of greetings, Professor Cherry accepted a motion that 'we agree to form an Australian Mathematical Society'. After considerable discussion this motion was carried, and it seems fair to regard this decision as signalling the birth of the Australian Mathematical Society." The motion to form the Society was moved by Edwin Pitman and Eric Barnes.

The next item of business was an invitation to Tucker to describe his experience with the organisation of the American Mathematical Society and the Canadian Mathematical Congress. He spoke also on the costs of publication of mathematical journals. Tucker turned out to be

a good friend of the Society in its early years. He had arranged for Princeton University Press to donate a set of books to the Society, "to be displayed and later sold to members as a means of augmenting the funds of the Society";[10] he personally donated 20 guineas; and he became a foundation member.

The meeting discussed a "précis of draft Rules" which had been prepared by Room, and then adjourned until the following Saturday. The minutes then record: "A *Conversazione* was held at 5 p.m. with Prof. and Mrs. T. M. Cherry as hosts."

At the resumption of business, the following motions were carried:

1. That for the year commencing August 1956 there be a category of Full Membership for which the subscription shall be payable, at the option of each member, either at an Ordinary Rate or at a Sustaining Rate.
2. That the Ordinary Rate shall be 2 guineas and the Sustaining Rate 5 guineas.
3. That a President, and eleven other members of Council be forthwith elected, and that this Council appoint other officers from amongst its members.
4. That the Council be instructed to prepare draft Rules for the Society, to make inquiries regarding the publication of a Journal, and to make such other plans for the conduct of the Society as seem expedient.

The "Sustaining Rate" was aimed at encouraging members to contribute towards the anticipated cost of a future journal.

The elections to Council saw Cherry elected as president, along with the following ten members: Blakers, Davis, Green, Oliver Lancaster, Harry Levey, Moran, Pitman, Room, John Ryan and Les Woods; one further member was to be co-opted.

Improperly perhaps, the minutes of the inaugural meeting end as follows:

> *Dinner:* An Inaugural Dinner was held at Ormond College from 6 p.m., followed by a social evening, which was at once sober and hilarious as members wrangled over mathematical puzzles and the like.
>
> *Sunday:* Melbourne members entertained a number of visitors on a trip to the near hill country.

There will be more below of the "wrangling" of members over mathematical puzzles.

The first meeting of Council followed the inaugural general meeting. Two secretaries were appointed, Ryan as general secretary and Room as publications secretary, and Davis was appointed treasurer. The meeting agreed that Alf Pollard, then with the MLC Assurance Company, should be invited to accept cooption to the Council (and the invitation was promptly accepted); Pitman "undertook to prepare a register of recent research publications by members for possible use in connection with the proposal to publish a Journal"; and Room agreed to prepare another draft set of rules.

There was a suggestion from Cherry that the next Council meeting be in six months time, in Adelaide "in conjunction with a symposium to which all members might be invited", but it was instead held a year later during the Society's second conference in Sydney. That began the custom of just one main meeting of Council each year, held prior to the commencement of the annual conference, with a short follow-up meeting towards the end of the conference at which the newly elected Council assembled. The symposium that Cherry alluded to was a conference held the following June in Salisbury, South Australia, on data processing and electronic computers.

The full program of the inaugural meeting is given as Appendix H in Part 1 of Blakers' paper. Hour-long talks were given by Tucker on the Wednesday night, 15 August; Guinand, Sawyer,

Levey and Cornish on the Thursday; and Bullen, Chong, Love and Green on the Friday. There were 16 shorter talks. Cornish's paper, "The correlation of monthly rainfall", is annotated as the "Presidential address to the Biometric Society", although there is no mention anywhere in Blakers' paper of any other involvement of the Biometric Society.

On the Saturday afternoon, there was a demonstration of the "electronic computer CSIRAC". Basil Rennie attended the conference and wrote of the demonstration in his diary, which is still in the possession of his widow Barbara:

> It calculated a 6-figure table of tan x in just the time it took to type the result, then, using a loud speaker which is fitted to help with fault finding, it played Gaudeamus Igitur. Prof. Cherry remarked that it played music better than a Wurlitzer could do sums. The third demonstration was the inversion of a 5 x 5 matrix. This however was not so successful. Prof. Cherry, watching the flashing lights, diagnosed that after reducing the matrix to triangular form the machine had got into a "closed loop" round which it would go until stopped.

With regard to the earlier part of the program, Rennie wrote that the lectures kept "a good standard, both interesting and intelligible, with a few exceptions."

Shortly after the inaugural meeting, there was a call for applications to join the new society. Those who applied by 30 September 1956 were to be regarded as foundation members, and all 121 of those, as given originally in *Newsletter No. 1*, are listed by Blakers in his second article on the foundation of the Society[11] and in Appendix 3 of this book. Two more foundation members were admitted somewhat later, "after appeal", at the discretion of the president, Cherry. One of these was Geof Watson, who wrote to the treasurer, Clive Davis, some months after the event with apologies for missing the business meeting, having gone instead to the Melbourne Zoo, and enclosing his cheque for membership at the sustaining members' rate.[12]

Of these 123 members, 45 were from Victoria, 28 from New South Wales, 18 from South Australia, eight from the Australian Capital Territory, seven from Tasmania, six each from Queensland and Western Australia, two from New Zealand and three from the USA. About 75 are identifiable as university academics, mostly of course from various departments of mathematics, but there were others, such as Victor Bailey, professor of experimental physics at the University of Sydney, and the Council member Les Woods, by then professor of mechanical engineering at the New South Wales University of Technology. Compared to recent membership figures, a large proportion of the original members were described as being from the "Public Service etc." This included many sections of CSIRO (such as Dr F. E. Binet from the "Poultry Research Centre" and Mr H. Weiler from the "Sheep Biology Lab") and the Weapons Research Establishment in Salisbury. There were five members from "Private Industry". Francis Emeric Binet, incidentally, was a Hungarian refugee mathematician who, in the years before joining CSIRO, had been a senior tutor in mathematical statistics in the University of Melbourne.

A notable absentee from the list was Keith Bullen. He attended the meeting in Melbourne and gave a "stirring" paper titled "The spirit of applied mathematics", which Blakers described as his strongest memory of the mathematical program and which has already been referred to in Chapter 6. It is reprinted here as Appendix 2. Copies of the actual paper were distributed widely at the time, with a few copies "still available from the General Secretary", according to the first newsletter. It was Bullen's contention that the Society would not serve well the interests of applied mathematics, although he was not generally opposed to the concept and in fact made a donation of five guineas as an expression of his goodwill.

Others who were interviewed in recent years for the Australian Mathematical Society

History Project, or who wrote to David Elliott in the late 1990s when, as secretary, he called for memories of the Society's early days, also have a good recollection of Bullen's paper. Ren Potts, however, recalled Bullen's attitude to joining the Society differently: "The antagonism between him and Room at Sydney was the talk of the town, and the common view was that if Room joined the Society, Bullen would not. This is how it transpired, and I think applied mathematicians in Australia suffered in consequence."[13] Angas Hurst, who had deputised for Cherry in 1954 as noted earlier in this chapter, recalled in that connection: "I wrote to Room only, and somewhat later received an acid letter from Bullen, complaining that he had not been approached. Bullen spoke at the first meeting of the Society in 1956, and as Bert Green loves to recount, a fair portion of his talk was on why he was not going to join the Society because Applied Mathematics was going to be shut out."[14] Les Woods claimed that Bullen's view was that "Pure and applied mathematicians do not mix well together".[15]

For most at the conference, however, the strongest memories of the time seem to be the dinner and the "wrangling" over mathematical puzzles, mentioned above. Those attending the dinner were asked to invent and wear name tags or other symbols, not giving their own name but cryptically labelling some famous mathematician. Hurst's recollections[16] include sketches of some of those name tags, as does Rennie's diary. Hurst felt that "Les Woods certainly won it with his Lipschitz but Fenton Pillow got very close with Lefschetz." On the evidence, these were very naughty cryptograms. Rennie wrote:

> I hung a stone on a piece of cotton from my lapel (for Einstein). George Szekeres had *A.N = N.A* (for Abel). Ren Potts had a small Möbius band . . . The dinner in Ormond Hall was unexpectedly good but the drinks rather mixed, beer, hock & claret. Afterwards we had a mathematical party and games. Prof. Moran produced three problems from the 11+ exam in English schools, nobody could solve them. When the time came to reveal the cryptograms and see who had guessed most, Fenton Pillow was absent, the winner was Prof. Guinand, the prize half a bottle of brandy.

The involvement of Australian mathematicians with ANZAAS did not cease with the formation of the Society, nor within a few years of that. Thirty years later, in the December 1986 number of the *Gazette*, an extensive mathematical program to take place within Group I of the coming congress was outlined. That meeting was held in New Zealand, and the mathematical program concentrated on contributions to the community and to teaching, rather than research, but it involved a number of Australian contributors and was allied with the Society's applied mathematics conference to follow it.

The first 25 years

In *Newsletter No. 1* there was an announcement that "a meeting of the Society will be held in Sydney on 28th–31st August 1957". According to Blakers, the "Sydney Meeting later became referred to as the *First* General Meeting of the Society, which presumably makes the Inaugural Meeting the Zeroth Meeting."

The "Summaries of Papers" presented at the Sydney meeting refers to it, incorrectly if logically, as the second general meeting. Cherry gave a presidential address on pathological properties of nonlinear systems of ordinary differential equations that are not solvable by quadrature. He introduced the paper by saying that the topic of ordinary differential equations was where he had begun his research in the early 1920s and "has, I think, remained my favourite." The summaries are of 14 papers given in the applied mathematics section, and eleven each in the pure mathematics and statistical mathematics sections.

The preceding year had been a busy one for the council. The minutes of the second council meeting, held on 27 August 1957, and of the first general meeting, held on the 31st, are included as Appendices K and L, respectively, in Blakers' second article. Among more routine matters, they show that considerable progress had been made in drawing up the rules of the Society and in preparing a costing for a new journal. Clive Davis had assumed responsibility for the new constitution and his proposal was accepted with minor changes, subject to confirmation a year later. Despite acknowledging that journal costs might well need to be subsidised by the Society, perhaps through sponsorship, and without consensus on the title of the new journal, the Council was nonetheless "directed to endeavour to organize the publication of a Journal". The meeting was warned that "the success of the Journal would depend on the willingness of members to offer a fair proportion of their best work" and that "this might involve some sacrifice." There is more on this below.

Maurie Brearley has recalled that when nominations for Council were called for during this conference, Cherry asked nominees how they would like to be specified in terms of their qualifications. Pitman replied that he regarded himself as a pure mathematician who had been bold enough to work on some applied topics, so Cherry wrote beside his name on the blackboard: "Pure and bold".[17]

Pitman's earlier offer to prepare a research register, listing the fields of interest of all local mathematicians, was left to Peter Sprent in the University of Tasmania to carry through. The job was completed in time for the Sydney meeting, but not published until April 1958, and comprised 61 pages. A second, more comprehensive, edition[18] appeared in 1963, produced by Cynthia Bartlett, who was then in the Research School of Social Sciences at ANU. By that time, membership of the Society had doubled and, in all, 225 mathematicians within Australia were asked for publication lists. Seventy per cent replied and the final register contained over 210 pages, listing the fields of interest and all publications of the respondents.

The third and final *Directory of Mathematical Research Interests* was a comprehensive but less ambitious register compiled by Richard Tweedie for the "Research Subcommittee" of the Australian Mathematical Society in 1982. Published as a 30-page article in the *Gazette*,[19] it listed staff members in the universities "in a state by state order followed by selected Colleges of Advanced Education and other institutions," the latter including various divisions in CSIRO, and gave their research interests and whether or not they were prepared to supervise research students.

Such a task today would be prohibitive, of course. What remains is the Society's *Administrative Directory*[20] which lists all known Australian mathematicians with a coded indication of their fields of interest, along with a great deal of other information.

Another comprehensive Australia-wide register was compiled on the Society's behalf by Jim Douglas, a statistician at UNSW, as convenor of the Society's Library Cooperation Committee. He presented his list of holdings of mathematical periodicals in university libraries in August 1972, completing a task that was begun in 1967. The state of such holdings proved to be a recurring concern of the council.

On the other hand, a resolution of Council[21] in 1960 that a register be made of "the staff of the universities in past years" was not acted upon. Nor was a resolution in 1990 that a register of female graduates be set up and "made available to departments seeking to fill pos- itions,"[22] but the Society's electronic site, particularly the web pages devoted to "Careers, Employment Opportunities and Jobs" might be considered to have made this redundant. The website was established in 1994, largely as an enterprise of mathematicians at UNSW, particularly David

Hunt and Ian Doust. It was taken over by Ross Moore of Macquarie University in 2003.

From around 1959, Douglas also began the practice of annually collecting data on numbers of honours graduates and titles of higher degree theses in pure mathematics, applied mathematics and statistics in Australian universities. Summaries of the results were published in the Society's newsletters and then in the *Gazette* each year, beginning with an article in volume 1, number 1, which appeared in May 1974. When Douglas relinquished this task in 1983, it was taken up by Peter Petocz, then at UTS, and most recently the work has been continued by Peter Johnston of Griffith University.[23]

The Society showed its appreciation to Jim Douglas in 1984 when he was elected to honorary membership, an honour rarely bestowed on members other than some former presidents and other long time workers on the Society's council. Before the introduction of various medals and prizes, to be described later, honorary membership was the only honour that the Society could award. The concept was initiated in 1965, during Bernhard Neumann's term as president, and was incorporated in a new constitution which replaced the rules that had been adopted in 1958. The constitution specified honorary membership as being for persons "distinguished for the promotion and extension of mathematical knowledge." Kurt Mahler, for example, who had been a member of the society since his arrival in the country, was accorded honorary membership, also in 1984, solely for the distinction he had achieved in mathematics.

Edwin Pitman and T. G. Room were the first honorary members, elected in 1968. It was not until nine years later that the next honorary membership was bestowed, and that was on William Pye, then at the Secondary Teachers' College in Melbourne, "in recognition of his outstanding contribution to the Society whilst being its Secretary for nearly half its life."[24] Twenty-eight members, of whom twelve are deceased, have now been recognised with honorary membership.

For a great many years, there was little done by the council that might be described as political activity. Blakers in the *Gazette* wrote of his suggestion to Cherry in March 1957 that the Society might make a submission to the Murray Committee which had recently been established by Prime Minister Robert Menzies and was to have a profound effect on the future of Australian universities. He went on:

> The President replied in May that he did not believe there was a need for any action on the part of the Society, as the Academy of Science proposed to make a submission, "and what we might say would best be said there and would carry greater weight". In my reply I suggested that we might, through the Academy, express concern for the growing problem with regard to the training and supply of university mathematics staff.

The first council did however express a view regarding a public inquiry into the proposal to adopt decimal currency in Australia, when requested to do so by the Decimal Currency Council: it was in favour of the inquiry, in principle.

There was nevertheless an early concern with the quality of mathematics teaching in Australian schools. The Society's council in 1991 established a Standing Committee on Mathematics Education but there had been a similar committee formed as a result of a resolution of Council agreed to at the third general meeting in Perth in 1959. The first nationwide seminar on mathematics education was conducted by the Society three years later at the University of Sydney; its *Proceedings* were published as an issue of *The Australian Mathematics Teacher*. The actions of Council and its education committee, particularly directed at the need for teachers of school mathematics to possess relevant tertiary qualifications, were often carried out in conjunction with the AAMT.

There was also a submission made to the Committee on the Future of Tertiary Education in Australia, chaired by Sir Leslie Martin as head of the Australian Universities Commission. The submission was prepared in 1961 and made use of data on student and staff numbers, whether full-time or part-time, in the various mathematical disciplines as determined by a questionnaire prepared and circulated by the Society. The report of the Martin Committee in 1964 formalised the alternative higher education sector consisting of colleges of advanced education. Chapter 21 in Volume III of the report, headed *The Need for Mathematicians*, was a totally sympathetic view of the situation as it existed then. It included encouragement for high school teachers of mathematics to be university trained and held to the opinion "that there is room for a master's degree in mathematics which is awarded primarily on the basis of satisfactory performance in advanced courses without the need for original creative work." The coursework master's degree subsequently became commonplace. The chapter was thoroughly in accord with the thinking of the Australian Mathematical Society—not surprising since Blakers annotated a copy with: "See Ch 21 which is merely edited from what I wrote."[25]

The later Standing Committee on Mathematics Education, incidentally, was very much involved in the first place with the debate on a national curriculum for high schools, described towards the end of Chapter 8. Furthermore, as president at the time, Cheryl Praeger wrote with the Society's views to all state and territory education ministers and to the federal minister. The chair of the education committee at that time was Desmond Fearnley-Sander, who was at the University of Tasmania for almost 30 years until his retirement in 2003; Tony Guttmann was chair from 1997 to 2003 and was succeeded by Frank Barrington.

The publications of the Australian Mathematical Society

The early thinking on the journal was recorded by Blakers as follows:

> It had been agreed from the beginning that publication as a journal in the Australian Journal series by CSIRO would not be likely to produce a journal of the desired quality, and Professor Room had accepted the position of Publications Secretary on the understanding that he would have the full support of the Society in producing a journal of recognised international standard. At the same time it was appreciated that it would not necessarily be seen to be of such a standard at the very beginning, and that this created problems for the younger mathematicians in Australia who needed international recognition through publication in established international journals. On many occasions both Room and Cherry exhorted the more senior and established mathematicians to recognise the conflict for the younger people and to contribute to the journal in its early years. A study of the contents of Vol 1, Part 1 shows that many senior mathematicians responded to this appeal.

In October 1957, a pamphlet was prepared for the purpose of soliciting funds for the proposed journal. These were to be received through a Mathematical Publication Fund established by the Australian Academy of Science, to which it donated £100 itself and which thereby ensured that all donations were tax deductible. Room and his editorial board, consisting of Cherry (*ex officio*), Barnes, Lancaster and Woods, settled on the name of the journal, even if a general meeting had not, and announced that the first number would appear in late 1958. Obviously enough, this objective could not be met due to "the fact that no manuscripts were then in hand," notwithstanding the statement in *Newsletter No. 1* (January 1957) that one paper "has already been submitted for publication in our projected journal."

The second general meeting of the Society was held at the University of Adelaide in August

1958 in conjunction with the ANZAAS meeting that commenced two days later. Responsibility for its organisation was accepted by Harold Sanders just prior to his retirement; the "joint secretaries" were Maurie Brearley and Angas Hurst.[26] There had been no change to the Council officers during the Sydney meeting, as had been agreed a year earlier in Melbourne, but in Adelaide Pitman replaced Cherry as president and took his position on the editorial board, which otherwise remained unchanged. The publication fund now held some £1000 and by the end of the year 16 papers had been submitted. Room, now appointed editor, and Tim Wall who was added to the editorial board as business manager at the third general meeting in Perth in 1959, had negotiated a contract with the Dutch publishers P. Noordhoff Ltd and Noordhoff would continue as the journal's printers for the next 13 years.

Volume 1 of *The Journal of the Australian Mathematical Society* was dated 1959–1960, with the first of four parts appearing in August 1959. The full volume contained almost 500 pages, with papers from most of Australia's leading mathematicians and statisticians of the day. There were also many papers from distinguished international contributors, such as Derek Lawden, Samuel Wilks and Emma Lehmer in part 1 and Paul Erdős, Helmut Wielandt and V. Krishnamurthy in part 2. The very first paper published in the *Journal* was Cherry's presidential address from the 1957 meeting in Sydney.

Volume 2 also covered two years, 1961–1962, but then it was mostly one volume per year until 1972 after which there were two volumes per year, each in four parts. Early issues carried occasional information on Society activities: the final page of volume 1, part 1, consisted of "Proceedings of the Society" but contained little more than a list of papers presented at the meeting in Adelaide in 1958. John Ryan had been succeeded as secretary of the Society by Oliver Lancaster in 1959 and Lancaster was succeeded four years later by C. J. F. (John) Upton from Melbourne University. Upton provided further brief reports, which included information on new members, resigned members and so on, in volumes 6 and 7 of the *Journal*, but nothing of that nature has appeared since then.

The Jerusalem Academic Press took over as printers of the *Journal* with volume 14 in 1973. According to Vincent Hart,[27] the treasurer of the Society for 15 years from 1968, wars in Israel saw printing "scuppered", in production delays although not in quality, and new printers were sought within a few years. John Wright and Sons Ltd, in Bristol, England, were appointed but by the late 1970s inflation saw the Society's journal production costs more than doubled. By then, the journal had been split into *Series A (Pure Mathematics and Statistics)* and *Series B (Applied Mathematics)*. The Society bore the extra expense until able to make an arrangement with the American Mathematical Society for computer typesetting using the TEX system. As a result, costs plummeted to well below John Wright's original charges, and Hart could breathe easily again.

The contract with the American Mathematical Society was not renewed in 1992 and Ernie Tuck, then professor of applied mathematics in the University of Adelaide, undertook the production of the journals on a commercial basis. Twelve years later, the Society was in a position to implement its own typesetting.

The editors of the *Journal* and then the *Journal (Series A)* have been predominantly from Monash University. The work of Gordon Preston and Tom Hall has been mentioned in the preceding chapter. Between their periods in office, the editors included John Crossley, John Miller and Hans Lausch, all from Monash University. And when the editors weren't from Monash they were from other Melbourne universities: Bert Mond, John Groves and currently Chuck Miller.

Returning to the late 1960s, two other problems to do with the *Journal* had become evident by that time. They were related—an over-abundance of submitted papers and an unconscionable production backlog. Bernhard Neumann had a partial answer, at least so far as a detailed refereeing process was seen as a cause of the delays in publication. He bemoaned the fact that his first paper appeared within five months, whereas "Mathematicians nowadays consider a publication delay well in excess of a year as inevitable and normal." His solution, the *Bulletin of the Australian Mathematical Society*, appeared in 1969 and he edited it for its first ten years.

Neumann's target for publication was "a median of 5 months from *receipt* of a paper", and to this end he set a limit on the amount of refereeing a paper would receive, he imposed zero tolerance of any revision of a paper, and he introduced a fast photo-offset printing process. He undertook to conduct much of the refereeing himself, assisted in-house by his colleague, Laci Kovács. Where more extensive external refereeing or some revision was required, the paper would be returned to the author with no opinion expressed as to its suitability for publication elsewhere. And if the time were to come when more "good" papers were submitted than could be published quickly, then they would simply be returned to their authors at once.[28]

The *Bulletin* has maintained its mission of fast publication, with an editor now supported by a raft of associate editors and an output of two volumes of three numbers per year. From the outset it has also included abstracts of Australasian PhD theses. Many of the first papers published were taken over from the *Journal* and no doubt eased its original problem of an oversupply, but the problem was to recur continually. Council minutes are replete with motions to increase the number of *Journal* pages, particularly those of *Series A*, to have the backlog reduced to a perceived acceptable maximum of 18 months and to declare a moratorium on the receipt of papers. It is in many ways a problem which the Society is happy to endure.

The *Australian Mathematical Society Gazette* was the initiative of Alf van der Poorten at the beginning of his very prominent career in Australian mathematics. The Society's early newsletters became sporadic in their appearance and van der Poorten was invited in May 1973 to prepare a specimen copy of a new periodical.[29] It was to contain news of members, details of overseas visitors, Douglas's statistics referred to above, notices of forthcoming meetings, minutes of the annual general meeting and articles of general interest—a program still recognisable in today's issues.

There was no longer the requirement of early newsletters to record all new members (with the advice in 1960 that "Members are to write if they disapprove of new candidates"[30]). Instead, whole issues of the *Gazette* were intermittently used to provide a list of members. Before that, the first such comprehensive list was printed by the *Journal*'s printers, Noordhof, in 1969. It included also seven institutional members among whom might be mentioned the British Tobacco Company (Australia) Limited and Carlton and United Breweries.

Early in the 1980s, during Gordon Preston's presidency, negotiations were undertaken with Cambridge University Press for a new publishing venture. Under the banner of the Australian Mathematical Society Lecture Series, the intention originally was to edit and produce a series of lecture notes at upper undergraduate, honours and junior postgraduate levels. An editorial panel was established with Sid Morris, who had led the planning of the concept and the negotiations with Cambridge, as editor-in-chief, and the first in the series, Neil Cameron's *Introduction to Linear and Convex Programming*, appeared in 1985. Morris had succeeded Bernhard Neumann as editor of the *Bulletin* and held that post for five years; he then stayed on as chair of the

editorial panel of the lecture series for a further ten years. The theme of the series was broadened to include research monographs and conference proceedings, to the extent that there was no longer a discernible theme, and in its first 20 years 18 titles were produced.

The Summer Research Institute

Of all the early activities of the Australian Mathematical Society, the Summer Research Institute (SRI) is the one that is recalled most often and always with some degree of affection by long-standing members. In concept and organisation, it was modelled on the SRI of the Canadian Mathematical Society in its original guise as the Canadian Mathematical Congress. It was early in its existence, in 1950, that the congress introduced the SRI and the success of these annual meetings was reported on by Albert Tucker to Larry Blakers during Tucker's visit to Perth in July 1956, prior to the Society's inaugural meeting.

The Canadian SRI was a residential summer school in which "Canadian mathematicians . . . moved to Kingston, Ontario, for periods of up to ten weeks, to pursue their own research and to provide the opportunity for mutual stimulation, mostly on an informal basis."[31] Blakers was impressed with Tucker's description but had a mixed reaction when he proposed that a similar concept be introduced in Australia:

> Early discussions with colleagues (at the 1956 and 1957 meetings) seemed to provide two significantly different reactions: considerable enthusiasm for the idea from most of the less senior people, who were keen to support any proposal which might help to alleviate some of the problems of their professional isolation; and a much more lukewarm reception from a few more senior people . . . who were concerned that nothing should divert any of our energies or resources from the job of establishing the Journal.

Without lessening his own support and endeavours for the journal, Blakers by early 1958 had taken steps to have the council approve in principle the running of an Australian SRI, but the move was complicated by his anticipated departure that August on a year's study leave. He was successful in having Joe Gani coopted in his place following his necessary resignation from the council, "and I knew that he would give his full support to the idea of the S.R.I.," he wrote.

The proposal that went to the council meeting on 17 August in Adelaide included the results of Blakers' own survey of 83 members of the Society. Fifty-six of the 59 respondents were in favour of the concept. Gani was able to report to Blakers, then in Princeton, that the meeting approved in principle, if without enthusiasm, the proposal "to inaugurate a combined Summer Research Institute and Seminar . . . provided only that this does not prejudice finance for the Journal."

Gani was at that time in Blakers' department at UWA and Harry Levey had recently been appointed professor of applied mathematics there. Largely due to their efforts, Blakers wrote, the SRI finally became established. Gani conceived the idea of asking ANU for sponsorship, even though mathematics had no official presence there at that time. He checked first with Pitman, as president of the Society, and then wrote directly to the University as well as to Pat Moran in the Research School of Social Sciences. Mark Oliphant, as director of the Research School of Physical Sciences, also became involved. It was left to Levey to follow up when Gani himself took overseas leave.

While Blakers was coincidentally attending the Canadian SRI in June 1959, news was received from Oliphant that his school "could provide the sum of £1000 for an initial gathering of this kind early next year."[32] The third annual meeting of the Australian Mathematical Society was

held that August in Perth and allocated a further £200 for the holding of the first Australian SRI, intended for early 1960. As Blakers remarked, this was "a generous decision, in view of the continuing concern for the financial problems associated with the Journal."

Just a few days later, Blakers, on his way back to Perth from Princeton, visited Canberra and was informed that ANU's offer could not go ahead as previously indicated; it was replaced only by an indefinite suggestion of future sponsorship. This was a "bitter blow" which made it impossible to proceed with a "Summer Research School" in 1960.

Gani had gone to UWA in 1953 as a lecturer in mathematics. He left a readership there at the end of 1960 to take up a senior fellowship at ANU, a position which Blakers was happy to exploit as it remained the best possibility that an SRI be held there in 1961. This was confirmed by the fourth annual general meeting of the Society, held at UNE in August 1960, when it determined to hold the SRI in Canberra during January 1961, with Cherry as director and Gani and Levey as joint secretaries. In the end, ANU gave financial assistance and help with facilities and secretarial assistance.

The first Australian SRI was held over a four-week period, 3–31 January, and was attended by 19 participants, who were styled "fellows" for the occasion. There were two fields of interest, namely the mechanics of continua, for which four papers were presented, and probability and statistics, with six papers. "Some of the papers . . . were read at seminars by their authors; others were worked upon during the authors' attendance at the Institute."[33]

Fellows of the first Summer Research Institute, January 1961. From left: J. E. Drummond, W. Hoffman, E. J. Hannan, E. J. Williams, D. Elliott, J. J. Mahony, T. M. Cherry, P. E. Wynter, H. C. Levey, J. Billings, G. Yeo, J. C. Burns, D. McVean, W. W. Wood, S. Adke, J. M. Gani.

These first fellows overwhelmingly endorsed the idea of the SRI and recommended that a second one be held a year later under the direction of Eric Barnes, then of Adelaide. Gani was invited to remain as secretary for a further year. The fourth annual general meeting of the Society, in Brisbane in May 1961, agreed to the request with the noted approval also of Oliver Lancaster as secretary of the Society. He had "earlier opposed the S.R.I. in preference for advanced post-graduate summer courses." Bernhard Neumann had by that time been appointed to his chair at ANU and added his strong support to the proposal.

The Council meeting in Brisbane that year agreed to detailed regulations covering the conduct of the SRI. In particular, it confirmed the early practice that it be organised by a director appointed a year in advance, to be assisted by two secretaries and a treasurer, and that at least two of these people should be from the host university. It also specified that the next two meetings, in 1962 and 1963, would be held at ANU. A formal constitution of the SRI was adopted in May 1964 and published in the following year along with the constitution of the Society itself.

Eight of the first twelve SRIs were in fact held at ANU with a continued deep involvement by Joe Gani. His interest in the SRI did not abate and he was appointed director of the 20th meeting, held in 1980, again at ANU.

The pattern into which Australia's SRIs settled and the fondness with which they came to be regarded are evident from the report of the tenth meeting, to take an example. It was held at the University of Tasmania from 12 January to 27 February 1970 and was directed by David Elliott, professor of applied mathematics there. Appeals to business companies had led to the raising of some $4000, additional to more than $1100 carried over from the previous SRI. This enabled invitations to be issued to three distinguished visitors: Philip J. Davis from Brown University, Arthur Erdélyi from Edinburgh University and Kurt Mahler. Ninety-five people, now designated as members rather than fellows, registered for the meeting including also Richard Guy from the University of Calgary who was visiting Australia in a private capacity at the time.

The official visitors each gave a series of five or six lectures: Davis on numerical analysis, Erdélyi on generalised functions and integral transformations and Mahler on "A theorem of A. Baker". Guy organised a continuing seminar on research problems in intuitive mathematics and Neil Trudinger, then at Macquarie University, one on differential equations. There was also a less formal seminar in algebra. But the essence of the SRI was captured in the members' reports, reproduced in the general report of the meeting. Fifty-three of the members wrote of their activities over the period that they were present. Besides attending lectures and participating in one or more of the seminars, some used the meeting as a time of concentrated personal study or research with colleagues while others worked on their PhD theses with the opportunity of discussion with experts in the field. For some, their study was to write up notes on the lecture series, those of Erdélyi and Mahler being included with the report. Whatever the activity, no-one ever spoke adversely of an SRI.

The last 25 years

By the middle of the 1980s, as the number of Australian mathematicians increased, the seminars and lecture courses that had been a dominant feature of the Summer Research Institutes took on a separate life as meetings of distinct interest groups held away from the SRI itself. A single meeting could no longer cope with the expected number of research fields or the number of participants. The last SRI, the 28th, was held at the University of Newcastle in 1988. ANU had continued as the dominant site, with 13 meetings there, and on one occasion, in 1985, the meeting went abroad, to the University of Auckland.

The first moves by the Society to accommodate the change had in fact begun in 1982 when the council established a committee "to investigate the way in which the Society caters for relatively large subgroups of members with similar specialised mathematical interests." The Society's constitution was altered to reflect the modern mood: it would now accommodate specialist groups (and regional branches, but there was little general interest in these) and the Society would lend support to individual conferences of these groups.

There are currently two groups: the Tertiary Mathematics Teachers Group, admitted in 1986, and the Victorian Algebra Group, 1988. Four others are subgroups of the Society's applied mathematics division, ANZIAM. Many aspects of the Summer Research Institutes have also been taken on by the Australian Mathematical Sciences Institute (AMSI), its International Centre of Excellence for Education in Mathematics (ICE-EM) and the New Zealand Mathematics Research Institute, and by individual workshops such as that on mathematical methods in finance organised to precede each national symposium on mathematical finance. A feature of the four week ICE-EM/AMSI Summer Schools is that honours students may, with suitable arrangements, make use of them as credit towards their degree studies.

By far the biggest change of this nature following the demise of the SRI was the formalisation of support for conferences held around the country, deemed "Special Interest Meetings" of the Society. Applications are called for twice a year and grants totalling up to $12,000 a year in recent years are made available. Well over 50 special interest meetings, together with meetings of the specialist groups, have been supported since the first in 1986 and they have taken place in all states and territories, including the intriguingly titled "Wet and Discrete" at the Northern Territory University in 1998. The rules for the meetings are such that there are numerous other conferences that have not been supported by the Society. The figure of "well over 50" does not include some meetings of applied mathematicians that were supported separately by ANZIAM.

There was one area of mathematical endeavour, other than statistics which had long before gone its own way, whose advocates determined emphatically that they would also not have a formal relationship with the Society as either a division or a specialist group, although they had been known to accept the Society's donations towards the holding of their conferences. During 1984, there were discussions "in support of some form of association with the Combinatorial Mathematics Society of Australasia."[34] The group traces its history to the first Australian Conference on Combinatorial Mathematics, held in Newcastle in June 1972 and organised by Wal Wallis and Jennifer Seberry. The conferences have been held every year since then except 1988 and since 1989 have been known as the Australasian Conferences on Combinatorial Mathematics and Combinatorial Computing. Those held in 1977, 1987 and 1997 were international conferences.

The Combinatorial Mathematics Society of Australasia was formed during the seventh conference in 1979. It declined to become a specialist group of the Australian Mathematical Society following sometimes spirited discussion at its general meetings which reflected in particular the interests of many of its members who were based outside Australia and did not want the wider association and consequent extra fees. The organisation operates now as a separate and successful component of Australian mathematics with a journal, *The Australasian Journal of Combinatorics*, that first appeared in 1990 as a continuation of the red series of *Ars Combinatoria*. The earlier journal had begun publication in 1976 as a joint venture of combinatorialists in Canada and Australia and its red series consisted originally of occasional special volumes.[35]

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There were a number of other structural changes in the Society's operations during the 1980s, besides the ending of the Summer Research Institute and the introduction of specialist groups and funding of special interest meetings. During 1979, a working party was established to consider the incorporation of the Society and within 18 months it was determined that the publishing arm alone be separated out as the Australian Mathematical Publishing Association Incorporated (AMPAI). As a result, by May 1981 "all business arrangements in connection with the printing and sale of the Journal Series A and B, Bulletin and Gazette of the Society" were to be carried out by AMPAI.[36] Further financial considerations concerning the liabilities of the Society led to the incorporation in the Australian Capital Territory of the remaining part of the Society in 1995. Its constitution was altered to refer to the Australian Mathematical Society Inc.

For the three years 1979 to 1981, during the terms as president of Joe Gani and Larry Blakers, a third meeting of Council was held each year, additional to the two traditionally associated with annual meetings, but that was discontinued by Blakers and not reintroduced when Gordon Preston became president in 1982. By then, the business of both the Society and AMPAI were conducted at those meetings and, in an effort to control its expansion, Bob Anderssen, as Preston's successor, introduced an executive committee that was to be known as the Steering Committee of Council. The steering committee now meets formally each summer during the conference of the applied mathematics division as well as during the regular annual meetings, and also conducts electronic meetings as required; its decisions are forwarded to the full council, often electronically, for endorsement or otherwise.

The 1980s was also the decade of increasing awareness of the need to promote mathematics nationally, by lobbying governments and through a public relations campaign, as universities' competition for funds from grant agencies and postgraduate student fees became government policy. One consequence was the formation of the Australian Mathematical Sciences Council. The parts played by Bob Anderssen and Garth Gaudry and of the Australian Mathematical Society itself in this have been mentioned in Chapter 8. The first investigation within the Society on the formation of such a roof body occurred during 1982 when a committee consisting of Anderssen, Preston and Ted Hannan from ANU was set up for the purpose.[37]

At about the same time, disquiet became evident as to whether mathematics was sharing equitably in the Australian Research Grants Scheme, administered from Canberra by the forerunner of the Australian Research Council. However, between 1983 and 1987 a series of articles in the *Gazette*,[38] at first critical, began to recognise the number of additional grants made in categories not directly described as mathematics. This may have resolved one problem, but it raised another—the perceived lack of identity, even amongst academics, of mathematics as a profession.

The general perception was hardly new and various approaches were adopted to counteract it. In 1985, Jack Gray from UNSW was behind the Society's production of the first of its glossy pamphlets, *Mathematics Graduates are Highly Employable*. This was distributed to universities and schools throughout the country and updated as *Maths—A Smart Move*, also produced as a poster, in 1997.

Separate negotiations had already begun in 1983 to have Reyn Keats, who had recently retired as professor of applied mathematics in the University of Newcastle, appointed the Society's Public Relations and Fundraising Officer with a modest budget to be spent largely as he saw fit on relevant expenses. Keats took the position early in 1985 and it was renewed

for two years in 1986, and again in 1988, with the title changed to Adviser on Public Relations. He spent several months during 1986 travelling through North America and the United Kingdom, visiting numerous mathematical organisations in connection with his new role and he reported extensively to Council on his return.[39]

Keats, in his report, urged the formation of a roof body of Australian mathematical organisations. The Australian Mathematical Sciences Council, formed in 1989 was the realisation of his proposal. Keats would not have claimed full credit for this, nor for other actions that took place at the time, but a modicum of recognition for his encouragement is in order. He saw a need for a more professional public relations base and renewed participation in ANZAAS, and he championed the publication by the Society of a popular mathematics magazine.

The only action on the latter was some talk of turning *The Mathematical Scientist* into such a magazine when the Society, or more strictly AMPAI, took over its publication in 1985. The magazine had been launched by CSIRO in 1976. The Society had joint responsibility for it during 1985, and then full responsibility, and appointed Basil Rennie to be its editor for a "trial period" of three years. It continued as a generalist magazine, but not one suitable for sale in newsagencies as Keats was seeking. Falling sales led to support for *The Mathematical Scientist* being withdrawn in 1988 and proprietorship was transferred to the Applied Probability Trust, which maintains the journal to this day.[40] Presumably, the *Gazette* might also have aimed for a populist role, given the council's resolution in 1982 that "the Editor of the Gazette be encouraged to explore ways of making this a lively and entertaining periodical."[41]

Keats also called for a strong mathematical presence in the Australian Science and Technology Centre that was to be established in Canberra, in part as a gift of the Japanese government towards Australia's bicentennial celebrations in 1988. On completion, it was known as the Questacon National Science and Technology Centre, recognising its origins as the modest school-based Questacon Science Centre. Neville de Mestre, then at ADFA in Canberra, had been associated with a hands-on mathematics exhibit, the ACT Mathematics Centre, since its inception in 1975 with funding from a Commonwealth Schools Commissions Innovations Grant. It was located in a classroom in Campbell Primary School for over a decade before being transferred to Questacon, by then housed magnificently on the shores of Lake Burley Griffin. De Mestre and others, including John Blake who was then at the University of Wollongong, were involved in negotiations with Questacon regarding mathematical exhibits there and an associated travelling component, and for some 15 years the Society has donated towards the construction and maintenance of these exhibits. Since 1995, this donation has included all interest earned from a modest but appreciated bequest from Edwin Pitman's estate.[42]

Promotion of the profession of mathematics was behind the move, dating from 1985, for a form of accreditation of membership to be introduced and Keats was a wholehearted supporter of the concept. In an article in the *Gazette* he summarised the proposal as "offering members the possibility of accreditation as a means of establishing the Society as a professional organisation to be recognised as such by business, industry and academe, and as a means of attracting new members to the Society, especially those outside universities, colleges and CSIRO."[43]

The scheme was suggested originally by Graeme Laurence Cohen, then at UTS. (On retirement as associate professor after 36 years there, Cohen embarked on the Australian Mathematical Society History Project, culminating in a text on the history of mathematics in Australia.[44]) The council was generally supportive of the move towards accreditation, but it took three separate committees of investigation, involving Cohen, Neil Cameron from Monash University (who in

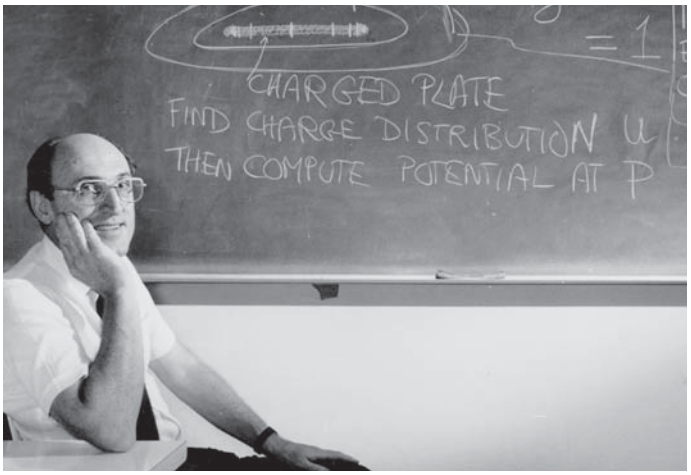
The Australian Mathematical Society Medal, designed and sculpted by Michael Meszaros in Melbourne.

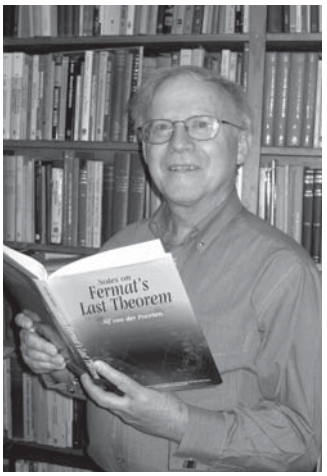
the end did not favour the concept), David Widdup from FASTS and Anne Street from the University of Queensland, as well as the carriage of constitutional amendments, before optional accreditation of membership was introduced during Cheryl Praeger's presidency in 1994.[45] A similar scheme was subsequently introduced by the New Zealand Mathematical Society and a more extensive scheme by the Statistical Society of Australia.

The changes allowed members the opportunity to have themselves recognised as fellows, accredited members or graduate members of the Society, depending on qualifications and experience, and thereby to label themselves as FAustMS, MAustMS or GAustMS. The determination of the grade of membership is made by Council's accreditation committee, chaired originally by Cohen who remained a member of the committee for ten years. More than 100 members of the Society, or approximately ten percent of its membership, have been accepted as fellows. (Abbreviating the Society's name when necessary to Aust M S, so written, was first suggested by Bernhard Neumann in 1984. It was common before then to use AMS which was much more widely understood as standing for the American Mathematical Society.[45])

Accreditation of university and other courses in mathematics was not initially contemplated by the Society, but an acknowledgment of the Society's competence in that regard was evident

On the occasion of the second award of the Australian Mathematical Society Medal, to Gavin Brown in 1982. From left: Brown, Neil Trudinger, Bernhard Neumann and Gordon Preston.





Ian Sloan in 1988, above left (UNSW University Archives), and Alf van der Poorten, winners of the first George Szekeres Medal (awarded in 2002 and presented in 2003).

in a request in 2001 for the Society to undertake a review of the mathematics department of Macquarie University. That prompted the setting up of a formal procedure for such reviews and in 2002 a program review committee with extensive rules of conduct was established for the purpose, largely through the work of Ian Doust from UNSW. The Bachelor of Mathematics degree course at QUT has subsequently been accredited through that process.

From the early days in the discussion of members' accreditation, honorary members of the Society were to be automatically granted fellowship, with no requirement for a specific application. It took a little longer to offer a similar right to recipients of the Australian Mathematical Society Medal. In 2000 Council resolved that they all be invited to become fellows and all but a few accepted the offer.

The medal had been instigated at the end of 1980 and was first conferred in the following year. It was "to be awarded to a member of the Society under the age of forty years, for distinguished research in the mathematical sciences" and was not normally to be awarded more than once in every two years. In 1994 the rules were changed to allow the medal to be awarded annually and on three occasions only there has been no award made.[47]

All winners of the medal, starting with Neil Trudinger who was awarded the first in 1981, are listed in Appendix 3. The Society's other medals and prizes are the B. H. Neumann Prize and the George Szekeres Medal, besides a number of ANZIAM awards to be documented later, and all recipients of these honours are also listed in Appendix 3.

In 1984 it was determined that "at each Annual Meeting of the Society . . . the Society award a cash prize of $100 for the most outstanding talk by a student (postgraduate or undergraduate)" and that the prize be known as the B. H. Neumann Prize.[48] A feature of the annual meeting's dinner each year, including the meeting in 2002 a month before he died, was Bernhard Neumann's presentation of his prize. Its value has since been raised to $400, and there has been only one occasion when it was considered that there was no talk of sufficient merit to warrant its award.

Much more recently, in 2001, the George Szekeres Medal was established to honour mathematical scientists who had been active in research during the preceding 15 years, provided they

Bob Anderssen, right, receives the second George Szekeres Medal from Tony Guttmann in 2004.

were members of the Australian Mathematical Society and normally resident in Australia. The award is made every two years. No age restriction was applied, such as for the Society's earlier medal, and after some debate on the matter it was agreed that a previous winner of that medal could subsequently receive the George Szekeres Medal. That has not happened yet. The winners of the first award in 2002 were Ian Sloan and Alf van der Poorten, jointly, and the winner in 2004 was Bob Anderssen.

Reyn Keats' work as adviser on public relations came to an end in 1990 and it was not until early 1997 that a new appointment of a similar nature was made. Philip Swedosh, with a PhD from Deakin and teaching then at Melbourne University, was appointed part time as the Society's mathematics publicity officer and held that position for two years. At the same time, Council debated the merits of appointing an executive officer "whose duties would be both to prepare formal submissions to various Inquiries on the Society's behalf and also to respond to reports of such Inquiries or Reviews."[49]

Jan Thomas was appointed to the position on a part time basis while continuing to teach at the Victoria University of Technology, and has been reappointed with each review of the position by Council. She now combines that work with a similar post for AMSI. As pointed out in Chapter 8, AMSI itself is the result in large portion of one of her submissions.

And also following on from Chapter 8, much of Thomas's survey work has had the theme of the loss to overseas institutions of many Australian mathematicians. It is a topic which the *Gazette* took up during 2004 with a series of personal essays by some of those mathematicians. John Stillwell, for example, followed up on a letter[50] to *The Age* in Melbourne in which he wrote:

> Those of us who left did so because of unreasonable administrative demands, broken promises, pressure to pass full-fee-paying students, and the generally philistine attitude of government and business in Australia.

Stillwell's major interests are in the history of mathematics in the 19th and 20th centuries. He was born in Melbourne in 1942, gained an MSc from the University of Melbourne and a

PhD from the Massachusetts Institute of Technology, and spent 31 years at Monash University before taking a chair at the University of San Francisco.

Philip Broadbridge is another recent, but temporary, departure. With a PhD from the University of Adelaide in mathematical physics, teaching experience at Curtin University of Technology and La Trobe University, four years work in between for CSIRO, and then eleven years as professor of applied mathematics at the University of Wollongong, Broadbridge left in 2002 for the University of Delaware where he was professor and head of the Department of Mathematical Sciences. "I would be influenced to return," he wrote, "if there were signs that the country had bottomed out of its anti-intellectual slide, and if the mathematics and science disciplines had regained some of their zeal and pride."[51] Broadbridge did return, in August 2005, as director of AMSI.

Peter Hall, who is considered by many to be Australia's most outstanding mathematical scientist (and who is still resident in Australia) is also scathing in his remarks on the "relative indifference of the Commonwealth Government's science and education policies to the consequences . . . of lack of investment in the mathematical sciences." In particular, he has written that "the much-lauded Federation Fellowship program has done little to keep Australia's top mathematical scientists in the country."[52]

Such explicit and outspoken support for the profession of mathematics and for the professionalism of its specialists, and against much of current government policy, is the main aspect of principle in which the Australian Mathematical Society today differs from the Society that was founded 50 years ago.

Overseeing the work of the Society has of course been the responsibility of its council. By the rules of the Society, the position of president cannot be held by one person for more than two consecutive years, and none has come back later for a second term, so there have been 25 presidents in the 50 years of its existence. Just one has been a woman, Cheryl Praeger. Only two have not been university professors at the time they held office, namely Joe Gani and Bob Anderssen who were elected from CSIRO. Four would describe themselves as statisticians, but none since Gani in 1980; 15 (plus or minus a couple) as pure mathematicians; five (minus or plus a couple) as applied mathematicians and one as a mathematical physicist. The complete list is included in Appendix 3.

Secretaries are rarer: just eight in the 50 years. After Ryan, Lancaster and Upton, the secretary was William Pye, already mentioned as receiving honorary membership after more than ten years in the position. That set a worthy trend. Ryan was followed by David Hurley, from UWA; Walter Bloom from Murdoch University; David Elliott from the University of Tasmania; and, since 2001, Elizabeth Billington from the University of Queensland. Bloom and Elliott were honoured in the fashion of Pye before them. Tim Wall, who was president in 1970–1972, has acknowledged that at least in his day the greater part of the work of running the Society was carried out by the secretary and treasurer.[53]

There have been only four treasurers in 50 years and each for more than ten years. The first three—Clive Davis, Vincent Hart, who claims he was "given" the job by Davis, and Barry Jones—were from the University of Queensland and all were accorded honorary membership on retiring from office. Two years into Hart's term, in 1970, he was authorised to hire a secretary for routine recording and invoicing work—the beginnings of the business office for the Society and AMPAI which was later positioned in the neighbouring shopping centre of St Lucia in Brisbane. From around 1974 the redoubtable Priscilla Hodges was in charge: she was "a tower

of strength and often telephoned me at home for guidance on some burgeoning problem," Hart wrote.[54] She remained well in command through most of Jones's term as well.

Since 1993, the treasurer has been Algy Howe from ANU. The business office moved then to Canberra where it sits now with May Truong as business manager, a position she has held since August 2000 and succeeding Val Pearson and then Alanna Smith in that role. The office occupies a room of the John Dedman building, the current home of ANU's Mathematical Sciences Institute.

The Division of Applied Mathematics — ANZIAM

The Society's Division of Applied Mathematics (DAM) is now known as ANZIAM, an easy acronym for Australia and New Zealand Industrial and Applied Mathematics, even if this does not actually label the group as a division, a society, or anything else.

Its history is intimately bound up with the applied mathematics conferences that have been held in Australia each year since the first on Kangaroo Island, off South Australia, on 26–27 August 1966. Now held every February, and almost never on a university campus, they often attract a larger attendance than the general meetings of the Society and have come to be known as the Society's summer conferences. Only 18 people attended that first meeting.

Credit for the concept belongs to Rainer Radok,[55] although he saw it largely as a means to show off the field station he had established on the island through the beneficence of Flinders University's Horace Lamb Centre for Oceanographical Research. The organisation of the conference was the responsibility of one of Radok's PhD students, "a rather young and inexperienced Roger Braddock". The actual site of the meeting was at Cape de Couedic on the southwest tip of the island, as far as it was possible to get from the only township there.

Braddock, now a professor in the Australian School of Environmental Studies at Griffith University, Queensland, has written the full story of that meeting and of the subsequent meetings until 1984 in an *Anecdotal History*,[56] a very breezy but well-documented story of the early days of DAM and the source for most of the present account. Dave Panton, now associate professor in the University of South Australia, also warrants mention for stoic attention to duty in the organisation of the early conferences; see the *Anecdotal History* for details too lurid for this volume.

The first three meetings were small and largely the province of the South Australians alone. But Bruce Morton of Monash University was present at the third and offered to organise the fourth, which was held at Hall's Gap in the Grampians, Victoria. That signalled the widespread acceptance of meetings every February of Australia's applied mathematicians, attended also by New Zealanders from 1976. There were 56 participants at Hall's Gap, 71 at Victor Harbour, South Australia, in 1969 and 82 at Lorne, Victoria, in 1970 (and in excess of 150, on average, during the 1990s). The first meeting to be held in New South Wales was at Smiggin Holes, a ski resort, in 1971, organised by Neville de Mestre and Trevor Parkes from the Royal Military College, Duntroon. The college commandant provided a free army bus to transport participants from Canberra to the conference site.[57]

Invited speakers, often visitors to Australia for other reasons, became standard features of the program. Robert McCredie May was one of the guests in 1993; he is Australia's most eminent scientific export. May was born on 8 January 1936 in Sydney and obtained a PhD in theoretical physics from the University of Sydney in 1959. He was professor of physics there until 1972 but,

following a shift of interest to population dynamics, obtained a chair in biology in the University of Princeton in 1973 and then a chair at Oxford from 1988. Knighted in 1996 and dubbed Lord Robert May of Oxford in 2002, he has made fundamental discoveries in various branches of mathematical biology, such as chaos theory and its application to ecological problems and the spread of AIDS. In 1995 he was named chief scientific adviser to the UK government and from 2000 to 2005 he was president of the Royal Society of London.[58]

By the early 1970s, wrote Braddock in his *Anecdotal History*, there was a general feeling among the applied mathematicians that the Australian Mathematical Society tended to cater mainly for pure mathematics, despite the presence of applied mathematicians and statisticians on its lists of founders and early council members. "In fact," he added, "the early growth of the Applied Mathematics Conferences was a reaction to this feeling and it played a large part in future developments."

The lack of a structure that would effectively determine each subsequent conference venue was also apparent. Austin Keane, at the University of Wollongong, had organised the 1972 meeting and, in the prevailing fashion, had the responsibility for ensuring the viability of the following meeting. That proved difficult until a recent arrival in Australia, Mel Lieberstein, who had taken the chair of applied mathematics in the University of Newcastle, agreed to arrange the 1973 meeting. He also resolved to act on the succession problem by including as an agenda item the management of applied mathematics in Australia. Lieberstein's appearance on the Australian scene was all too brief: he was appointed to the chair in Newcastle in 1971 and died in August 1973 aged just 47.[59]

In anticipation of the discussion that Lieberstein's agenda would invoke at the coming meeting, to be held at Surfers Paradise in Queensland, Ted Buchwald, a professor of applied mathematics at UNSW, on 1 November 1972 initiated correspondence with colleagues around the country. The result was a preliminary meeting in Sydney on 9 February attended by almost the full complement of Australian professors of applied mathematics: Buchwald, John Burns (RMC, Duntroon), Austin Keane (University of Wollongong), John Mahony (UWA), Bruce Morton (Monash), Fenton Pillow (University of Queensland), Ren Potts (University of Adelaide), Peter Richmond (a Queen Elizabeth II Fellow in the Department of Applied Mathematics at ANU), Simon Rosenblat (University of Melbourne), Roy Smith (UNE), Colin Thompson (University of Melbourne) and Peter Wilson (University of Sydney). During the conference, held from 11 to 13 February, the following motions were passed:

1. That the Australian Mathematical Society Council be asked to investigate the possibility of forming a separate Division of Applied Mathematics within the Australian Mathematical Society.
2. That this meeting of the Applied Mathematics Conference held at Surfers Paradise considers that an Australian Journal devoted to the applications of Mathematics is viable and recommends that a proposal be put to the Australian Mathematical Society that the *Journal of the Australian Mathematical Society* be henceforth published in two parts:

a. Pure Mathematics, and

b. Applied Mathematics

and that Professors J. J. Mahony, A. F. Pillow and R. B. Potts be asked to collect evidence and present the case to the Australian Mathematical Society.

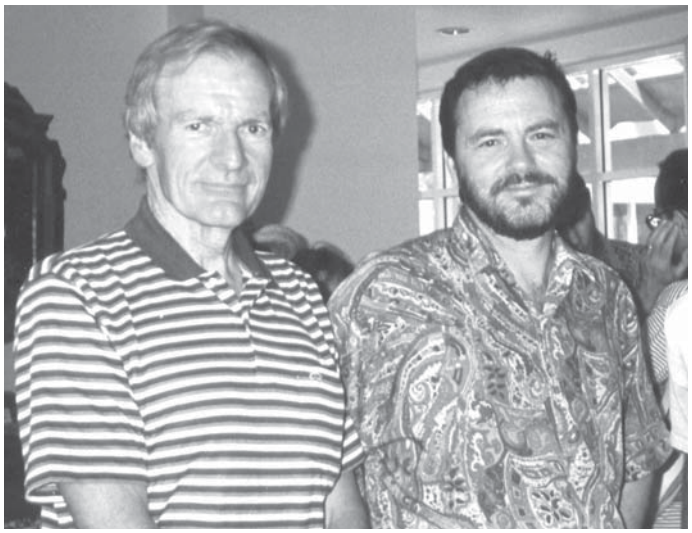
The Society was generally receptive to the idea of a separate division, a term coined and facilitated by Bernhard Neumann to accommodate New Zealand mathematicians, but taken

up by the applied mathematicians. (The approach to the New Zealanders was declined, but led to the formation of the New Zealand Mathematical Society in 1974.[60]) Formal discussion of the concept took place at the Society's annual meeting in Hobart that year, with some disquiet shown with regard to the future of the *Journal*, in particular.

In November, a poll on the question was taken of the Society's members; Buchwald, Morton and Rosenblat were working on varying the Society's constitution to allow the formation of divisions while also working on a new constitution for the Division itself; and branches of the Division were instituted and operating in New South Wales and Victoria ahead of the formation of the parent body.

At the applied mathematics conference in Lorne in February 1974, discussion continued, with some promoting the formation of an entirely separate organisation with its own journal of applied mathematics. For financial reasons if no other, the latter was too daunting a prospect and when the proposal to form a division within the Society was put by Buchwald, it was carried by 66 votes to eight. The splitting of the *Journal* into *Series A (Pure Mathematics and Statistics)* and *Series B (Applied Mathematics)*, as urged by Vincent Hart,[61] treasurer of the Australian Mathematical Society and reader in applied mathematics in the University of Queensland, was also agreed as a sensible way forward and the whole process was endorsed formally by the Society at its annual meeting in May.

The Division of Applied Mathematics dates its establishment to the conference held from 2 to 4 February 1975 at Tanunda in the Barossa Valley, South Australia, the state where it all began; but a provisional committee had already been elected in the previous year. Buchwald and Rosenblat were chairman and vice-chairman, respectively; Edward D. (Ted) Fackerell from the University of Sydney was secretary; David Elliott was treasurer and remained in that position until 1980; John Mahony was editor of the *Journal of the Australian Mathematical Society (Series B)*; and the ordinary members were A. J. (Joe) Gilks, Tony Guttmann, Bruce Morton, John Philip, Fenton Pillow, Ren Potts and Irving Tang. (Gilks was at Deakin University and Tang was head of the Department of Mathematics in the New South Wales Institute of Technology.) Buchwald and Rosenblat continued in those positions for a further two years. Planning for the



Ren Potts, left, and Ernie Tuck, winners of the first and third ANZIAM Medals.

Journal (Series B) began immediately and the first issue, labelled Volume XIX in continuation of the *Journal*'s numbering, appeared in 1975. Subsequent volumes, of around 500 pages, appeared in four parts published over two years.

Mahony was the editor of *Series B* until 1978. His recommendation when he stepped down from the position was that the journal be closed down as early submissions were few and printing problems, alluded to above, were causing publication delays. At the 1976 applied mathematics conference held in Jindabyne in the Snowy Mountains, Buchwald prevailed upon Ian Sloan, recently converted from theoretical physics to numerical analysis and attending his first conference with "mathematics" in the name,[62] to take over as editor. Through the introduction of issues devoted to special topics and other devices, Sloan was able to ward off the crisis.

A characteristic of the applied mathematics conferences, the earlier ones at least, was the large proportion of postgraduate students who attended. From 1969 a prize was awarded, annually when warranted, for the best student paper presented at the conference and in May 1976 it was agreed that this be known as the T. M. Cherry Prize. (The retaliatory Cherry Ripe Prize was instigated in 1995 for the best presentation by a non-student, as judged by a panel of students.)

The T. M. Cherry Prize was the first of a number of prizes within the Australian Mathematical Society. (There would have been some disquiet among the membership of DAM when it was suggested four years later that the Australian Mathematical Society Medal might be known as the Cherry Prize.[63]) The division's name change to ANZIAM came about in August 1993 and the ANZIAM Medal was instituted soon after to honour lifetime achievements in research as well as contributions to the division. The recipients, since the first award in 1995, have been Ren Potts, Ian Sloan, Ernie Tuck, Charles Pearce and Roger Grimshaw. The division has also instituted the J. H. Michell Medal, awarded annually for outstanding new researchers who have conducted their research within Australia or New Zealand and, generally, are within the first ten years of receiving a PhD or equivalent. The first award, in 1999, was to Harvinder Singh Sidhu for work done at the University of Queensland in the modelling of oscillating and chaotic chemical reactions.

With the change in name to ANZIAM, there was a corresponding change for the *Journal of the Australian Mathematical Society (Series B)*. From volume 42 in 2000, it was *The ANZIAM Journal*, edited by Charles Pearce who had edited the *Journal (Series B)* since 1993, and *Series A* then reverted to the original name of the journal. Four years earlier, the Division had instituted an electronic form of its journal: the printed papers constituted Parts 1 to 4 annually, with the electronic papers constituting Part E. It is now referred to as *The ANZIAM Journal—Electronic Supplement*, still edited by the original editor and proponent of Part E, Tony Roberts from the University of Southern Queensland.

Braddock's *Anecdotal History* concluded around 1984. Its continuation[64] by Neville de Mestre took the history through to the successful holding of the Fifth International Congress on Industrial and Applied Mathematics (ICIAM 2003), held in Sydney from 7 to 11 July 2003.

De Mestre, chair of ANZIAM from 2001 to 2003, is one of its most stalwart supporters. William Summerfield is another. A senior lecturer in mathematics in the University of Newcastle, he was elected secretary of the Division in 1984, when de Mestre's continuation of its history began, and remains in that position still. Summerfield, with a PhD from Flinders University of South Australia awarded in 1970, joined the University of Newcastle in 1972. He was made an honorary member of the Australian Mathematical Society in 1999.

Features of the second half of the Division's history are the development of regional branches and the establishment of special interest groups. There are branches now in each state except Tasmania, and in the Australian Capital Territory and New Zealand.

The Computational Mathematics Group was the first of the special interest groups and is by far the largest. It was established at the 1983 annual general meeting of DAM and is mainly concerned with the enhancement of computational mathematics within Australia. It achieves this through the biennial Computational Techniques and Applications (CTAC) Conferences and Workshops, the first of which was held at the University of Sydney in 1983. Mike Osborne, of ANU's Centre for Mathematical Analysis as it was called at the time, has described the beginnings of the group:

> Rainer Radok was something of a singular point in the evolution of Australian Applied Mathematics. He may not have been a comfortable colleague, but his interests and influence have lived on and prospered in the Computational Mathematics Group of ANZIAM, and in the very successful series of CTAC Conferences. Important names in the early and pre-history of CTAC include Bob Anderssen, Alan Easton, Rob May, and, in particular, John Noye. All were students directly influenced by Radok at Adelaide or Flinders Universities. In one way or another, they were all active in promoting computational mathematics within the Victorian Branch of ANZIAM—then the Applied Mathematics Division of the Australian Mathematical Society—and in enlisting the contributions of others.[65]

Mentioned here, besides Anderssen whose career has already been described, are Alan Easton, now professor of mathematics in the University of Papua New Guinea and before that at Swinburne University of Technology and its predecessor from 1977 to 2001; Rob May, the associate professor of mathematics at RMIT University (not Lord Robert May); and Brian John Noye, associate professor of applied mathematics at the University of Adelaide at the time of his retirement in 2000.

There are three other special interest groups. The Engineering Mathematics Group, which has run biennial conferences since 1994, came about through the work of Easton and Joseph Steiner at Swinburne University of Technology. The Mathematics-In-Industry Study Group linked up officially as a special interest group in 1997. The third is the MathSport Group. This is a "loose forum for Australian and New Zealand sports scientists to interact," according to its website. Biennial conferences have been held since 1992: five of the first six were at Bond University, with the meeting in 2000, since that was the year of the Sydney Olympics, being held in that city, at UTS.

The principal activist behind MathSport is Neville de Mestre who is himself an extraordinary sportsman: in his continuation of the *Anecdotal History*, he wrote with regard to the 1998 applied mathematics conference that "Dr John Belward . . . directed the latter half of the Conference when Neville de Mestre . . . took off to New Zealand . . . to successfully defend his World Masters Iron Man Surfing Championship." De Mestre also organised the First Australian Conference on Mathematics and Art, at Bond University in 2000, at which a keynote speaker was Peter James Smith from RMIT University in Melbourne. Smith holds professorial positions there in both the Department of Mathematics and Statistics and the School of Creative Media.

It is fitting to conclude this description of ANZIAM with an account of one of the largest mathematical events ever undertaken in Australia and, for applied mathematicians everywhere, the most important event of the preceding four years.

The idea to hold ICIAM 2003 in Australia was first floated at the applied mathematics conference in Busselton, Western Australia, in February 1995, one year after ANZIAM had joined

the governing international body, the Committee for International Conferences in Industrial and Applied Mathematics (CICIAM). It was in fact the intention to join CICIAM that prompted the rebadging of DAM as ANZIAM as that name connoted a distinct organisation of applied mathematicians.[66] Noel Barton, then a principal research scientist with CSIRO Mathematical and Information Sciences and chair of ANZIAM, made the first approach to CICIAM in April that year. CICIAM approved the proposal in July 1997, appointing Barton as congress director. He in turn sought the involvement of Ian Sloan, professor of applied mathematics at UNSW, by suggesting he stand as chair of CICIAM's International Program Committee. This duly came about and allowed Sloan to fulfil a corresponding role in the planning of ICIAM 2003. The congress would be held at the Sydney Convention and Exhibition Centre at Darling Harbour, with additional facilities supplied by the nearby UTS .

By November 2000, Barton and Sloan had finalised the full planning committee and associated subcommittees and had hit on the idea of further meetings embedded within the main congress. It was to be far more than a meeting of the world's applied mathematicians. ICIAM 2003 incorporated the Sixth Australia – New Zealand Mathematics Convention; the 11th Computational Techniques and Applications Conference; the 17th National Conference of the Australian Society for Operations Research; the Second National Symposium on Financial Mathematics; and the Sixth Engineering Mathematics and Applications Conference.

ICIAM 2003 attracted 1730 participants from 57 countries, offering some 1700 presentations. The budgeting turned out to be acceptably accurate, which was gratifying in particular to the Council of the Australian Mathematical Society because ANZIAM, as a division of the Society, had no financial backing of its own and was unable to enter legal agreements. The Society's support for the congress was essential: it provided bridging finance; it was the underwriter in case anything went seriously wrong; and it was the legal entity through which the congress was arranged. Without this backing, ICIAM 2003 could not have been held and without the tireless efforts of Noel Barton, Ian Sloan and their colleagues it would not have been a success.

To end this story of ANZIAM and of Australian mathematics, CICIAM had in 2003 changed its name to the International Council for Industrial and Applied Mathematics, and as a further great honour to Australia, but especially of course to Ian Sloan, at the conclusion of ICIAM 2003, he was elected chair of that international body.

Appendix 1

A Snapshot of Australian Mathematics, 1914

Horatio Carslaw's 1914 review of mathematics in Australia, modestly titled *The Teaching of Mathematics in Australia*, has been introduced in Chapter 4 and referred to again in Chapter 8. The report comprised 80 pages, separated into six chapters. That scheme is followed in the ensuing summary. All quotations are from the report.

The influence of the universities on the work of the secondary schools

At the time the report was written, the population of the country was less than five million, with "about one million and a half" in each of New South Wales and Victoria. In each state, government departments administered educational matters but were predominantly concerned with primary education. It had been only a few years before then that they developed an interest also in secondary education, which had previously been largely the province of private schools.

As a consequence, the universities played a very large role in the determination of standards and in examinations within the secondary schools, most of which were private, whether or not the pupils intended to enter a university. Carslaw saw this as not educationally sound, since it led to too much emphasis being placed on teaching to the syllabus with success in the examinations the only target, and educationalists have of course echoed the thought in succeeding decades. There was a particularly bad corollary for mathematics: "[As] separate papers are set in the different mathematical subjects of the school course, it has sometimes happened that pupils have taken up one or other of these subjects by itself instead of getting a suitable general training in all."

As the first example, the University of Sydney administered a junior examination "to cover the first two or three years' work of a Secondary School" and a senior examination "usually taken from one and a half to two and a half years after the Junior". These were about to be superseded by Intermediate and Leaving Certificate examinations under the control of the Department of Public Instruction. About 1100 candidates at the time sat for the junior examination, and for matriculation to the university students had to pass all three mathematical papers, in arithmetic, algebra and geometry, or some equivalent examination. Between 70 and 80 per cent of candidates passed the various subjects in June 1912, according to an extensive table included by Carslaw.

For the senior examination, there were papers in algebra, geometry, plane trigonometry, mechanics, and "Elementary Analytical Geometry of the Straight Line and Circle, and the Elements of the Differential Calculus". No syllabus details were given for the last of these, and it is the only mention of calculus in this chapter of Carslaw's report. There were "additional papers or separate questions" for honours candidates in the various papers. It was apparently

not mandatory, but was customary, for "those taking mathematics classes in their University course" to pass the senior examination "in mathematics" (without specifying the actual papers), while students intending to study engineering were required to pass in the first four papers of the senior. Fewer than 200 candidates sat for the senior in November 1912, and pass rates in the mathematics subjects, as in most subjects, generally exceeded 80 per cent.

The public examinations of the University of Melbourne included junior and senior examinations, and junior and senior commercial examinations. A certain amount of mathematics was required for entry into all the faculties of the University, "except Laws and Music", but the subjects could be taken at either junior or senior level. There were more candidates at the time than in New South Wales: "about 2000 for the Junior, of whom about 50 would be Junior Commercial candidates; and about 400 for the Senior", with a "negligible" number for the senior commercial. All of the senior mathematics papers could also be taken at an honours level. Standards were to remain comparable with those in England, with the papers being set "in general accordance with the recommendations contained in 'The Teaching of Elementary Mathematics: a Report of the Committee appointed by the Mathematical Association'". Pass rates between 70 and 80 per cent were usual in the junior mathematics papers, with lower pass rates apparent in the senior.

Carslaw included syllabus details for each university's public examinations in mathematics. As an example, they are reproduced here for the senior at the University of Melbourne. The fifth of these is for the senior Commercial examination.

> *Algebra.* More advanced treatment of work prescribed for the Junior Public Examination, together with the remainder theorem; quadratic equations of two unknown quantities; ratio, proportion; variation; permutations and combinations; binomial theorem for positive integral exponent; logarithms. — *Honours:* More advanced treatment of work prescribed for the Pass Examination, together with the elements of the theory of partial fractions; the elements of the theory of equations and determinants; exponential and logarithmic series.
>
> *Geometry.* The Pass paper contains questions on the subject matter of Euclid, Books IV., VI. and XI., as now usually taught, and on the properties of the Parabola. — *Honours:* More advanced treatment of work prescribed for the Pass Examination, together with harmonic ranges, inversion, and the elementary geometry of the parallelopiped, pyramid, cone, cylinder and sphere. Elementary analytical geometry so far as relates to the point, line, circle, parabola and ellipse, referred to rectangular axes. Radical axis. Pole and polar; centres of similitudes.
>
> *Trigonometry.* More advanced treatment of work prescribed for the Junior Public Examination, together with heights and distances and the general solution of simple trigonometrical equations. The simple treatment of circumscribed, inscribed and escribed circles. — *Honours:* More advanced treatment of work prescribed for the Pass Examination, together with de Moivre's theorem and its simpler applications; summation of simple finite trigonometrical series; fundamental formulae connecting sines and cosines of the sides and angles of spherical triangles.
>
> *Elementary Mechanics*. Rectilinear motion with uniform acceleration; composition and resolution of velocities and accelerations; Newton's laws of motion; composition and resolution of forces in one plane; projectiles; uniform motion in a circle; momentum and impact; principle of work; equilibrium of a particle and a rigid body under forces in one plane; inclined plane; lever; pulley; centroids. — *Honours:* Simple harmonic motion, together with more advanced treatment of the work prescribed for the Pass Examination.
>
> *Commercial Arithmetic.* The work prescribed for the Junior Public Examination in Arithmetic, together with the following:—Freights; rates of exchange and transactions with home

and foreign Bills; the coinages, weights and measures of the principal commercial countries of the world. Debentures, preference stock, ordinary stock, profits and dividends; liabilities, insolvency and liquidation. Bankers' interest. The use of logarithms, more particularly for problems on compound interest, insurance and annuities. Methods of calculating rates and taxes. Compound interest with special reference to repayment of loans.

The University of Adelaide conducted a primary examination, marking the completion of work at primary school, as well as junior, junior commercial, senior and senior commercial examinations, and a higher examination. "The Junior, Senior and Higher Examinations cover much the same ground as the Junior and Senior Examinations in New South Wales and Victoria, but the programmes in mathematics . . . do not include the work prescribed there for Honours." The senior mathematics papers were in arithmetic and algebra (one paper), geometry and trigonometry. Entry requirements for the various faculties differed. In Arts, for example: "The Senior Examination must be passed in Arithmetic and Algebra, and Geometry, or candidates must satisfy the Faculty of their fitness to enter upon the course of study chosen for the degree. All candidates must pass in these subjects before taking their degree." There were about 800 candidates for the junior examination, 400 for the senior and another 100 for the higher, in 1912.

These examinations catered also for students in Western Australia. The university there had only just opened, and Carslaw wrote: "Next year the University of Western Australia will hold two School Examinations—the Junior, for those about 15 or 16, and the Leaving Certificate, for those about 17 or 18. The examinations are to be under the control of a Board consisting of three members of the University staff, two representatives of the Education Department, and two representatives of the Private Secondary Schools."

Until 1910, pupils in Queensland sat for the University of Sydney papers at centres in northern New South Wales. The University of Queensland then adopted its own system of public examinations, but in mathematics followed very closely the Sydney syllabuses. In 1912, there were about 450 candidates for the junior examination and fewer than 100 for the senior.

The University of Tasmania also largely followed the Sydney scheme in its public examinations, but the Education Department was more open in expressing dissatisfaction with the private secondary schools for "working towards these examinations". It was moving more quickly than New South Wales towards adopting its own curricula and examinations. About 450 candidates sat for the junior examination in 1912 and about 150 for the senior.

The state high schools and the Leaving Certificate system

It was only around the time when Carslaw was producing his report that state high schools were being established around the country.

In Victoria, for example, acts of parliament were passed in 1906 requiring the registration of teachers (for which they needed to possess "the Diploma in Education of the University of Melbourne or some equivalent qualification") and in 1910 "authorising the establishment of State High Schools and Higher Elementary Schools". By 1914 there were 40 such schools in existence but only eight of those prepared their pupils beyond the junior examination. Fees were payable for children over 14 years of age "but free places and scholarships are provided on a moderate scale."

The standard four-year course was divided into two parts, Part 1 being two years common to all pupils and Part 2 then allowing a choice of the "Preparatory Professional (Secondary) Course", a domestic arts course, an agricultural course or a commercial course. The second of these was

"meant for girls who do not take Course (a)", and contained no mathematics subjects. Carslaw gave timetable allocations for all subjects and some indication of mathematics syllabuses. The agricultural course is of interest in supplying a subject called Practical Mathematics for Farm Students, which included extensive work in mensuration ("application . . . to the measurement of the area of fields, to computing the contents of tanks, drains, embankments, dams, silos, haystacks, timber, bricks, etc.") and elementary surveying:

> The construction, adjustment and use of the prismatic compass, clinometer, theodolite and optical square (where supplied). Survey and subdivision of land, including plane-table sketching, prismatic-compass sketching, and rough contour maps of the locality. Use of the clinometer in estimating heights. Field notes of a simple survey. Computation of areas from dimensions given in a field-book. Copying, reducing and enlarging maps.

In New South Wales, four state high schools were opened in 1903 and by 1913 there were 15 such with a total enrolment over 3200. Fees were abolished in 1911. The course of study was over four years, shortly to be converted to five years, and led to the standard of the senior examination. The courses available, though not all within any one school, were the general course; the commercial course; the industrial course; and the "Domestic Arts and Science Course for Girls". The number of 45-minute periods devoted to mathematics in the domestic arts and science course was about the same as in the commercial course (six, six, four and four a week in the four years, respectively), compared to eight periods a week each year in the other courses.

Carslaw concluded this chapter by describing the Intermediate and Leaving Certificates in New South Wales, the first examinations for which took place in November 1913. Their introduction was accompanied by a new system of inspection of secondary schools and the awarding of exhibitions allowing exemption from fees for university study.

The Intermediate Certificate was awarded after two years of study. In the geometry syllabus there was a "noticeable departure . . . from the practice recommended by the English Board of Education and followed by a large number of English schools". This referred to a stricter adherence to Euclid's treatment of theorems on the congruence of triangles and parallels, rather than an approach in which "the earlier practical or experimental investigation of these theorems—and of the angle-sum of a triangle—be taken as sufficient, and that they be accepted as facts which are as obvious and real to the pupil as the difference between white and black." Carslaw's own qualms regarding the parallel postulate, as described in Chapter 4, are evident in this.

The third and fourth years' work, leading to the Leaving Certificate, was divided into pass and honours sections, as for the senior examination. All pupils had to satisfy the examiners in one of the mathematics pass papers, at least, in order to have their Leaving Certificate accepted for matriculation into the University.

Mathematics at the technical colleges

Technical education cannot be developed on the basis of an elementary education alone, Carslaw wrote, although that had been "the foundation upon which the work of most of our institutions which claim the title of Technical College has been built." Consequently, Carslaw felt that technical instruction "has not yet attained a proper footing in our educational system in Australia". His survey dealt only with those technical colleges that offered courses with a substantial component of mathematics.

In New South Wales, there had been a technical instruction branch of the Department of Public Instruction since 1890 and the "most important institution under its control" was the

Sydney Technical College. The departments of mechanical and electrical engineering offered a diploma course with three years of mathematics instruction. This and other colleges "in the chief towns throughout the State" also taught evening classes over two years, and these included mathematics. Carslaw included the syllabuses for both courses.

Carslaw had some praise for technical instruction in Victoria: there are "several largely attended Technical Colleges and Schools of Mines; notably, the Working Men's College in Melbourne, founded in 1887, the School of Mines at Ballarat, and the School of Mines at Bendigo. These two Schools of Mines were established in 1870–2, and, in the days when Victoria had a monopoly of such work, their students passed quickly into positions of importance in this great industry of Australia." However, at the time of his report, "they do not flourish so vigorously," he wrote. Carslaw gave syllabuses for the mathematics subjects in certificate courses taught in Victorian colleges, on behalf of the Education Department. They show a depth of treatment of differential and integral calculus, for example, at least equivalent to first-year university courses at the time.

South Australia had given "a considerable amount of attention" to technical education, particularly in connection with mining, and the School of Mines in Adelaide was closely connected with the "scientific departments" of the University of Adelaide. It awarded an associateship and a fellowship, the work for the latter being carried out in part in the University.

In Queensland, only the Central Technical College in Brisbane and the Charters Towers School of Mines gave mathematics instruction at a relatively advanced level. At Charters Towers, for example, there were classes in Preparatory Mathematics, Mathematics I and Mathematics II, the last of which included some differential and integral calculus and spherical trigonometry.

The situation in Western Australia was unique:

> A Technical College was established in Perth in 1900 under the Department of Public Instruction. It progressed rapidly and did much to prepare the way, at any rate on the technical side, for the new University of Western Australia. There are also branch institutions in Kalgoorlie and other important mining centres.

The Perth Technical School at the time was conducting its own course in engineering as well as offering the subjects within the university course, so that mathematics was taught at considerable depth: calculus in third year included "elementary differential equations, elements of elliptic functions, harmonic analysis, definite integrals, frequency curve, applications to statistics".

In Tasmania, there were five technical schools. One of these ran a course based on a syllabus issued by the English Board of Education, which retained responsibility for examining the course. Otherwise, all the schools taught only towards the junior and senior examinations of the University.

Mathematics at the teachers colleges

It is worthwhile to quote Carslaw's opening paragraphs in full:

> Up to about 1900 the teachers in the Primary Schools throughout Australia almost without exception obtained their training on the pupil teacher system. After serving for four years in this capacity, a limited number of the pupil teachers would be admitted to courses of training in a Central Teachers' College; but many of the teachers would start their work without further training. Teachers appointed to schools in the University towns were, and still are, in the habit of attending the Evening Classes in Arts, which some of the Universities have arranged, chiefly for their benefit, and there is a strong and persistent demand from them for fuller provision of Science Classes and Laboratory Instruction in the evening . . . The system of pupil teachers is

now practically abolished in almost all the States, and the candidates for positions as teachers in the schools are entering the Teachers' Colleges of the Education Departments better prepared to undergo the courses of training there provided.

For teachers in the Secondary Schools—public or private—a University degree has been in the past, and still remains, an almost indispensable qualification. In addition to the regular University curriculum in Arts or Science that may be taken, it is in all cases recognised to be desirable, and in some cases insisted upon by the Regulations for Registration, that special training in the Theory and Practice of Education be included in the preparation for the work of the school.

In New South Wales, the Sydney Teachers College was founded in 1906 for the training of state school teachers, following the final abolition of the pupil-teacher system. The main offerings were a two-year course for primary school teachers and a fourth year diploma course for secondary school teachers, after they had obtained their degree in Arts or Science. The requirement for entry into the two-year course was three years of study at secondary school, though it was intended that the Leaving Certificate become the normal standard. The mathematics studied in that course included compulsory arithmetic, algebra, geometry and trigonometry in the first year and optional further work in algebra and trigonometry, as well as some differential and integral calculus and mechanics, in the second year. Again, Carslaw's perceptions were apparent in the geometry syllabus:

Geometry. Brief historical sketch of the development of Geometry; Egyptian Geometry; Greek Geometry; The work of Euclid; The reform movement in the teaching of Geometry; The present attitude towards the subject; The nature and place of definition, axiom, postulate, proof; Experimental and demonstrational Geometry; . . .

In Victoria, most secondary school teachers had completed their BA or BSc before embarking on the University's Diploma in Education, but it was allowable to have only two years prior university study. The Melbourne Teachers' College offered a one-year course for the Primary Certificate, which included instruction in methods of teaching elementary mathematics, and a two-year course for the Infant Teachers' Certificate, which required the Intermediate Certificate for entry and contained only "extremely elementary" work in mathematics.

The South Australian system was the most demanding, although that in Tasmania was not too dissimilar. The former will be described here. All future teachers had to decide their vocation at age 14 and enter the Adelaide High School to work towards the University's senior public examination. Those who were successful embarked on one or two years teaching in primary schools before entering the Teachers' Training College where they undertook university studies in subjects of their choice and college classes on teaching principles. Students could leave after one year to become infant and primary school teachers; others completed one or two years further study to become secondary school teachers. Mathematics teachers had to have at least two years of university mathematics.

In Queensland, on the other hand, there was not yet a teachers' college and the pupil-teacher system was still in effect for primary school teachers. Future secondary school teachers sought one of 20 scholarships available for study at the University of Queensland, and their work was supervised by the lecturer in education at the University. Satisfactory completion of the degree course was usually the sole requirement for subsequent teaching.

The pupil-teacher system was also still evident in country schools within Western Australia but a two-year college training course was available in Perth for future primary school teachers. All students took the mathematics classes in the first year, but the second-year course was

optional. However, "in practice it is taken by almost all the men students, and by about 25 per cent. of the women students."

Mathematics at the Royal Australian Military and Naval Colleges

Cadets entering the Royal Australian Military College at Duntroon, "in the Federal Territory and close to the site of the new Capital", were aged 16 to 19. Their four-year course included studies in civil subjects, namely mathematics, physics, chemistry, English, history and modern languages. Entry into the college required satisfactory completion of five papers, including one on arithmetic, algebra and geometry, at roughly the level of the junior examination; there were other optional papers, including one with further algebra and geometry, and some trigonometry. Mathematics was then studied in the first three years, with a choice of topics that led either to surveying and astronomy, or mechanical applications. The general range of topics and level of treatment suggested a second-year university standard, with some especially relevant work such as "maximum range of a projectile on an inclined plane", "applications of the theory of errors, particularly to gunnery", "effect of air resistance on a bullet" and "stresses in a gun".

The Royal Australian Naval College opened towards the end of 1913, at Geelong in Victoria. Within two years it would move to Jervis Bay. Candidates had to be just 13 in the year in which they applied for entry and the entrance examination, in English, history, geography, arithmetic and geometry, reflected this young age. First year studies in mathematics were extensive but also necessarily elementary. Carslaw gave the syllabus in detail, requiring two pages; later year syllabuses had not been determined at that stage.

Mathematics at the Australian universities

In the final chapter of his report, Carslaw again went around the states, this time describing the work of each university mathematics department. In a very brief introductory history, which included total annual revenue of each university, the only professors that warranted mention by name were Horace Lamb and William Bragg.

At the University of Sydney, mathematics was no longer compulsory for an Arts degree; nor was it compulsory in the Faculty of Science. Engineering students were required to take the subject for two years, except for mining engineering students, who took only the first-year course. There was a new two-year course in "Insurance-Mathematics", designed "chiefly for actuarial students and others who desire instruction in the mathematics of statistics". The main course was given as Mathematics I, II and III over the three years and there were three levels of instruction: A, for honours, and B and C, much as when Gurney was professor, and as described in Chapter 2. The numbers of students in each year were given as roughly 120, 65 and 16, respectively, with six of the 16 in Mathematics III in Class A.

Insurance mathematics was separate:

> The class in Insurance-Mathematics ranks as a First and Second Year Class, and is an alternative to Mathematics I. and II.
>
> The programme for the First Year Course is as follows:—
>
> Arithmetic and Algebra, Elements of the Theory of Probability, Elements of Analytical Geometry of Two Dimensions and the Calculus, Compound Interest and Annuities Certain, The Construction and Use of Tables, and Graphical Methods.
>
> The programme for the Second Year Course is as follows:—

The Theory of Probability (more advanced), The Theory of Least Squares and Errors, The Theory of Life Contingencies and Calculating Machines.

Mathematics in the University of Melbourne was "divided between the Professor of Mathematics and the Independent Lecturer in Applied Mathematics". Mathematics had been a compulsory subject for all candidates for a BA, but this requirement was abolished only in 1913. In the science and engineering faculties the overall schedule was similar to that in Sydney, with the mathematics courses in each of the three years labelled as Pure Mathematics I, II and III, and Applied Mathematics I, II and III, and each given at either pass or honours level.

Honours for Pure Mathematics III included functions of a complex variable, Fourier's series and integrals, differential equations and calculus of variations; honours for Applied Mathematics III involved more advanced work in the pass topics, namely analytical statics and dynamics, potential theory, hydrodynamics, elasticity and electricity. The final honours examination was in both pure and applied mathematics. However: "Very few students in Melbourne take a Three-year Course in Mathematics, and the number who graduate with Honours in Mathematics is small." Carslaw indicated that about 120 students took Pure Mathematics I at the pass level and ten at honours level; the corresponding numbers for Pure Mathematics II, Applied Mathematics I and Applied Mathematics II were 40 and 5, 40 and 10, and 10 and 5.

Mathematics at the University of Adelaide consisted of the following courses: First, Second and Third Year Pure Mathematics (average attendance 25, 25 and 6, respectively); Applied Mathematics (average attendance 20); Spherical Trigonometry and Astronomy ("not given every year"); and Honours Mathematics (for "one or two" students). The topics covered in the final honours examination were selected from: analytical geometry, infinitesimal calculus, harmonic analysis "including Fourier's series and Laplace's Functions", analytical statics, dynamics of a particle, elementary rigid dynamics and hydrodynamics.

In the University of Tasmania there was a mathematics class for first-year Arts students designed to bring them to the standard of the University's senior examination for secondary schools. This was followed by a class for first-year Science and second-year Arts students, followed in turn by one for second-year Science and third-year Arts students, and then one for third-year Science students. The syllabus for the latter consisted of differential equations, spherical trigonometry and astronomy, and elementary particle and rigid body dynamics. In addition, "better students [were] advised also to read Fourier's Series and Spherical and Cylindrical Harmonics." The first three classes had roughly 18, 12 and 12 students, with "one or two" in the others.

Mathematics at the University of Queensland was similar to that in Melbourne for the first two years, with a third-year course ("Higher Analytic Geometry, Analysis, Theory of Attractions, Rigid Dynamics, and Hydrodynamics") offered only to honours students. According to Carslaw: "The tendency, both in Brisbane and Perth, is to develop [the universities] more as Technical Universities than was the case in the earlier days of Sydney, Melbourne and Adelaide." Consequently, a relatively large number of students took the mathematics courses at Queensland University; for example, in 1913, 33 and 15 students took the second-year pure and applied subjects, respectively.

In Western Australia, the University was just one year old and Carslaw gave only an indication of likely mathematics courses.

Appendix 2

The Spirit of Applied Mathematics*

By K. E. Bullen

(An address delivered at the inaugural meeting of the Australian Mathematical Society on August 17, 1956.)

The giving of this address has come upon me somewhat as a Nemesis. Some twelve months ago, I was asked to express an opinion on the desirability of founding this new Mathematical Society. I raised the question, from the applied mathematical point of view, as to how far it is wise to link applied mathematics with pure mathematics in this middle twentieth century. As you of course know, it has been decided to form a Society which aims to be comprehensive in its coverage of Australian pure mathematics, applied mathematics and mathematical statistics. It is in this context that I have been asked to give this address on Applied Mathematics.

The emergence of a body of learning, sometimes called Applied Mathematics, sometimes called Natural Philosophy, sometimes carrying other labels, is one of the things that have come with the latter-day division of Science into a number of branches. The branch called Applied Mathematics of course has affinities with Pure Mathematics, and it overlaps with Pure Mathematics. It also has close affinities with other branches of science such as Experimental Physics, Mechanical and Aeronautical Engineering, Astronomy, Geophysics, Chemistry, Geology, and so on. And it overlaps with all these branches, just as it does with pure mathematics.

Because of the various overlaps, it is foolish to try to define Applied Mathematics in any precise sense or to seek to describe Applied Mathematics too literally in terms of the words 'applied' and 'mathematics', or to try to parcel up applied mathematics into watertight compartments. A British professor has in fact lately commented on the misunderstandings that arise from the very name of applied mathematics. There are of course many types of applied mathematicians, including those who are nearly pure mathematicians, and those whom some people would classify as physicists, engineers, astronomers, geologists, etc. And, which is not quite the same thing, there are applied mathematicians who are also pure mathematicians, just as there are applied mathematicians who are also experimental physicists, experimental chemists, linguists, painters or poets.

Like other branches of learning, applied mathematics has the properties of an organism, developing with the passage of time in ways which cannot be closely predicted. Applied mathematics is therefore best described in terms of what applied mathematicians do. It would of course be foolish to try to formalise this description. Any such attempt might, to begin with, conjure up something like a distribution function of many variables in many-dimensional space, even if one ignored the attendant uncertainties and nebulosities.

** Four corrigenda attached to the original have been incorporated into this reprint and a few other typing errors have been corrected.*

But it is reasonable to enquire as to whether, amid the swirl of a very vigorous round of activities, there can be discerned some semblance of distinctive spirit which illumines the work of the majority who may be reasonably called applied mathematicians. I think such a spirit is discernible, and my purpose today is to try to indicate, necessarily imperfectly in the space of one hour, where that spirit lies in relation to pure mathematics and where it lies in relation to things that are not pure mathematics.

For most of scientific history, applied mathematics has been closely associated with physics. Early examples of applied mathematics are the work of Thales on Egyptian surveying, carried out in close conjunction with practical measurement; and the work of Archimedes on density, the lever, the screw and the pulley, all inspired by observation and experiment. Most of Greek mathematics was not applied mathematics because of the limited appeal to experiment, but the spirit of applied mathematics was discernible in the ancient world.

In the millennium and more following Christ, when test by experiment became a heresy in many countries, the spirit of applied mathematics almost vanished from the face of the Earth. After the long darkness, a rejuvenation of all Science through the appeal to observation and experiment once more came with the Renaissance.

Up to the early nineteenth century, applied mathematics remained largely unseparated from physics. Many famous applied mathematicians, for example Galileo, indeed bore the title of Professor of Mathematics, but they were all interested in physical experiment, and nearly all designed and carried out experiments with their own hands. The word Physics itself has had an interesting history. At the time of the Greeks, it included the study of the whole of nature, organic and inorganic. In the writings of Locke, God and angels were included as well. Then in the eighteenth century, the term became limited to inorganic nature. As late as 1800, the British Medical Journal referred to medicine as "a principal department of physics". Some time after 1800, a dividing line was drawn between Physics and Chemistry.

There were round about this time great applied mathematicians like Fourier who were imbued with the notion that all Nature is ultimately describable in terms of simple mathematical laws, and that mathematical analysis is the supreme tool for bringing this about. In his famous 'Analytical Theory of Heat', Fourier writes that the "chief attribute (of mathematical analysis) is clearness. It has no marks to express confused notions. It brings together phenomena the most diverse, and discovers the hidden analogies which unite them." He further declares that it interprets the various laws of Nature "by the same language, as if to attest the unity and simplicity of the plan of the Universe, and to make still more evident the unchangeable order which presides over all natural causes".

To most modern applied mathematicians this is too simple a philosophy, for they have learned that when mathematical analysis 'takes charge', and rides over the uncertainties latent in postulates about the natural world, the result can be sterility. That did not apply to Fourier, for he was dealing with a field which happened to be ready for analysis to make a cardinal contribution. Fourier's work is indeed a great example of early nineteenth century applied mathematics which raised mathematical analysis to its fitting place in the investigation of natural phenomena.

In Britain a formal separation was made between Mathematics and Experimental Physics when in 1871 the University of Cambridge established the Cavendish Chair of experimental physics. In spite of this formal separation, and in spite of the inclusion of the word 'experimental', the two first holders of the Chair were Clerk Maxwell and Rayleigh, men who at the present time

would be regarded as among the world's greatest nineteenth century applied mathematicians, quite apart from their other accomplishments.

Following this, in Britain and some other countries, departments or faculties of mathematics grew up in which pure and applied mathematics were linked together in some measure of separation from physics. In other countries again, for example the United States, many departments of mathematics, there interpreted as pure mathematics, came to be largely separated from departments of physics and applied mathematics. Latterly there has been the rise of departments of applied mathematics, and, at the same time, a swing towards improved balance between the use of pure mathematics and observational data.

If one looks at the giants in applied mathematics who were brought up in the Cambridge mathematical school near the beginning of the present century, one finds that their greatness was linked with other activities. For example, Fowler was a professor in the Cavendish Laboratory, Eddington directed the astronomical observatory, G. I. Taylor worked in one of the engineering laboratories, Jeffreys was a reader in geophysics; and so on.

My purpose in making these preliminary remarks has been to show that the spirit of applied mathematics cannot be appreciated simply by examining what pure mathematicians and others may envisage as mathematics—that it is necessary to look at the broader field of Science.

Science itself is a great human adventure which makes use of observation, experiment and reasoning. Every scientist who concerns himself with observation and experiment cannot help but also concern himself with reasoning, to greater or less degree. There was a time when the scientist sought to *explain* what he thought he observed. Today, in somewhat humbler vein, he seeks rather to *describe* his observations as succinctly as possible.

Now description involves language in some form, and there are many forms of language. There are the language of music, the language of art, the language of poetry, the English prose language, the French language, the language or languages of pure mathematics, and so on. According to the context, any one language may have its strengths and its limitations as a means of description, and there are degrees of elegance of expression in all of them.

Where the context is complicated or is shadowed by uncertainty, the English or similar language may be the best medium of description. Part of the beauty and strength of the English language lies in its flexibility whereby an uncertain context can be saved from being strait-jacketed into inappropriate precision. Where the fringes of uncertainty are sufficiently narrow, and where the context is sufficiently simple, in the pure mathematician's sense of the word 'simple', use, and sometimes superb use, may be made of pure mathematical language. In many contexts, description needs more than one type of language.

Scientists, including applied mathematicians, ordinarily use both English and pure mathematical language. To all but the pure mathematician, the use of a language like English is indispensable since there is no context in the natural sciences which is free from non-measurable uncertainty.

In using the pure mathematical language, the applied mathematician concerns himself with, and indeed avails himself of, rigour. In elementary mechanics classes, for example, the applied mathematical teacher is usually at pains to stress the mathematically deductive aspect to students who have been introduced to the subject experimentally. But there are many contexts where an attempt to achieve the highest standard of rigour would be a foolish waste of time. For example, Heaviside's calculus led to progress in geophysics and elsewhere long before all questions of rigour had been examined. A more sophisticated example is Dirac's delta-function, lately rendered rigorous in Schwartz's theory of distributions.

Any scientist may throw rigour to the winds in an early attack on a problem, but the pure mathematician is in a special class in that he aims relentlessly at ultimate total rigour. The applied mathematician bears the label 'mathematician' because he does have some considerable concern with rigour. One of the lesser rôles of the applied mathematical teacher is in fact to interpret mathematical methods to students of other subjects. At the same time the applied mathematician has this in common with other natural scientists that he puts context ahead of rigour, where by context I here mean the relevant experimental and observational data. If he fails to do this, his work runs the risk of being unrealistic and sterile and falling between two stools. After consideration of this context, comes judgment on the appropriate level of rigour—judgment also on how far the description should be in English, and how far symbolism and abstraction should be introduced. If two sentences of English prose will convey a meaning to sufficient precision for a context, the applied mathematician does not normally trouble his reader with a longer, more precise, pure mathematical, account.

The context forces the applied mathematician to develop an indefinable sense of proportion on rigour. He learns to leap gaps in deductive argument, though he exposes himself to criticism if he does not indicate where he stands on rigour, or if he makes his leaps unwisely. And, like all scientists, he must (or should) give thought to questions of elegance whatever the language he uses.

When he represents a field of observations by a pure mathematical structure, he has, moreover, to realize that this is but a 'mathematical model', simpler than the real context. Many are the occasions when both mathematicians and physicists have confused a mathematical model with reality, the mathematicians intoxicated and the physicists dazzled, by the beauty of the pure mathematics involved. The frequent result is either futile metaphysical controversy or downright acrimonious controversy.

An example of the former is the discussion on determinism which followed Heisenberg's formulation of his principle of uncertainty. An example of the latter is Kelvin's application of that same beautiful theory of heat conduction of Fourier, without adequate allowance for background uncertainties, in calculating the age of the Earth. Kelvin's mathematical model included the representation of all physical knowledge prior to 1850, and prior to the discovery of radioactivity. On obtaining, by a formally valid argument, a value for the Earth's age radically smaller than geological estimates, he demanded what he called "a great reform in geological speculation". The mathematical model, however, turned out to deviate very far from reality on the crucial matter of radioactivity, a fact which geologists keep reminding geophysicists of to this day.

I would now like to draw some illustrations of the spirit of applied mathematics from the history of Mechanics. Following work of Archimedes and a few others, there was a notable step in 1586 when Stevinus published an account of the composition of forces. In keeping with the times, his book describes an imagined, not an actual, experiment, though as a professional engineer he had probably carried out relevant actual experiments. He considers an endless uniform chain hanging over a smooth wedge, and then by a mixed deductive-intuitive argument, including appeal to the impossibility of perpetual motion, arrives essentially at the parallelogram law. He does, however, describe the actual experiment of Grotius and himself which showed that heavy and lighter objects fall to the ground in about the same time, contrary to an Aristotelian dictum that had been argued on for nearly 1900 years without appeal to simple experimental test. A little later, the archer Baliani drew attention to the significance of air-friction on the times of fall.

The stage was now set for Galileo's work on falling bodies which exhibits the spirit of

applied mathematics particularly well. After conjecturing the speed v to vary as the distance s, and quickly seeing this to be unsatisfactory, Galileo considered the possibility of v varying as the elapsed time t. His first step was to use pure mathematics to deduce from the new hypothesis that s would vary as t^2. His motive in making the deduction was to obtain a suitable test against experiment. In spite of much experimental research, however, he did not succeed in devising a direct test because of the smallness of the times in vertical falls. He then took the bold inductive step of assuming that he could substitute a roll down a gentle slope for a vertical fall. In this case he was able to measure the times to suitable precision, and it transpired that the results agreed with the proportionality of s and t^2. So emerged the law that bodies fall near the Earth with roughly constant acceleration. There was a gap in the deductive logic; the dynamics of rolling spheres had not been worked out. But Galileo put context ahead of rigour and leapt across the gap, thereby supplying the principal key to the classical connection between force, mass and change of motion.

Subsequently, Newton set down his laws of motion. Newton brought out the proportionality of mass and weight by his observations of pendulums. He regarded it as surprising that the force of gravity depends not on a body's surface but on what he called its 'quantity of solid matter', and he inferred that gravity must penetrate to the centres of the Sun and the planets. Like Huyghens, he was led in due course to the inverse square law of gravitation. And again this was achieved not as an isolated deductive process, but in relation to the detailed observational context of Kepler and others.

Newton, however, was still concerned with explaining rather than describing. He writes: "All these things being considered, it seems probable to me that God in the Beginning formed matter in solid, massy, hard, impenetrable particles". (But he does say 'probable' rather than 'certain'.)

Following Newton, a great and elegant mathematical structure was erected on his laws, at the hands of d'Alembert, Laplace, Lagrange, Hamilton, Jacobi and Poincaré, to name only a few. And great were the applications in astronomy, physics and engineering. But in due course, there came the stage when this very success blinded many followers of Newton to the limitations of the laws, and the fringe of uncertainty in contexts came to be forgotten. The Newtonian particle came to be conceived as certain physical reality, and late into the nineteenth century, rigid materialist philosophies were built on a formal mechanistic interpretation of Nature. The pattern was held to have been discovered by Newton, and what pure mathematicians built on it was held to be inviolate.

In many of the world's mathematical departments, a sterility set in, and Mechanics became a dead subject, taught after the style of Euclidean geometry. Indeed some questions in the Mathematical Tripos today, however well they may test the wrangler, still exhibit this deadness. And I imagine that some of the older ones in this audience must remember, as I do, being brought up on statements such as that "it is inconceivable that the original laws on which Mechanics is based could be erroneous".

It was experimental evidence from fresh quarters that led to Newton's laws being put in their proper setting. First came the revolutionary postulates of Einstein in 1905 which provided a new mathematical model consistent with a larger field of observations than Newton's laws.

Einstein's 1905 paper is an interesting exercise of the spirit of applied mathematics. Although the pure mathematics in that paper is by no means elegant, the argument is firmly tied to the Michelson-Morley experiment, the essential result of which is brought to bear again and again

in the derivation of the Lorentz transformation. There are features of Einstein's 1905 account of Special Relativity which make it more satisfying as natural philosophy than some later more pure mathematically elegant approaches which conceal the essential link with experiment.

Moreover, with the elegant use of tensors in General Relativity, there has since arisen a tendency to deify Relativity, just as Newton's laws were once deified, and to forget that Relativity is still only a mathematical model.

The rise of Quantum Mechanics was another factor in putting Newtonian Mechanics into proper perspective. And again the inspiration came from experiment. In Newtonian mechanics, the particle is a one-parameter mathematical model, specified by the measure of its mass regarded as concentrated at a point. The new experimental results revealed contexts in which this model gave too simple a description. Some two decades of pure and applied mathematical thinking, guided by further experiments, led in due course to a more serviceable model called Quantum Mechanics. In the new model, there is no longer a simple one-parameter particle, absolutely tied to a geometrical point. Yet such was the lingering confusion between the Newtonian particle and reality, that quite an upset was caused when Heisenberg deduced that the representation of an electron in the new model theory precluded simultaneous measurement of position and momentum to absolute precision.

These changes in models bring out the need for appreciating that no set of so-called laws in nature is ever more than one among infinitely many mathematical model descriptions of a set of data. Suppose, for example, that Galileo's experiment on rolling spheres had yielded the data:

t	0	1	2	3	4
s	0	2	8	18	32

Then all the observations would be compatible, not merely with the 'law' $s = 2t^2$, but with any of the 'laws'

$$s = 2t^2 + t(t-1)(t-2)(t-3)(t-4)\phi(t)$$

where ϕ is any one among the infinite set of bounded functions of t. Thus it cannot be said that the observations yield the 'law' $s = 2t^2$ in any absolute sense. Similarly, the entire set of observations made by the human race in its entire history, being yet infinite, can yield no absolute law. The real principles determining so-called laws are of course the expediency principles of scientific economy and mathematical simplicity.

There is a result in one theory of probability that helps further to put laws in good perspective. Suppose that a hypothesis or mathematical model p entails the independent deductive inferences $q_1, q_2, \ldots, q_n, q_{n+1}, \ldots$, and suppose that $q_1, q_2, \ldots, q_n$ have all been in some sense verified. Then the theorem is that, as $n \to \infty$, the probability approaches unity that q_{n+1}, and thence also an indefinite number of further consequences of p, will be verified, and this *independently of the truth of the hypothesis* p (provided only that p is not a priori impossible).

Suppose for example that p stands for Newton's laws. Of the many formal consequences of p, all those tested up to late last century were held to have been verified. Hence, according to the theorem, it became almost, but not quite, certain that many more consequences would be verified, in spite of uncertainties attaching to the model itself.

The important thing here is the attention directed to the observational results. There is no question of the model being 'right'. Mathematical models are seen in their proper light as temporary expedients, serving to coordinate the fruits of fields of observation, and to lead to the prediction of new results with greater or less probability.

There can indeed be more permanence in observations than in so-called laws. Observations of some ancient eclipses are for example more important to astronomical research today than are many early astronomical model theories.

My next illustrations will be taken from the early development of elasticity theory, which provides a ready elementary instance of the significance of parameters in applied mathematics.

Hooke had in 1676 announced his 'ut tensio sic vis' anagram, which came later to be generalized to the form

$$p_{ij} = \sum\sum A_{ijkl} e_{kl} \tag{1}$$

where p_{ij} and e_{ij} denote components of stress and strain. The 81 coefficients A_{ijkl} in (1) are reducible to 36 through symmetry, thence to 21 in certain commonly assumed thermodynamical conditions, and, further, to 2 in isotropic conditions, for which case the relations may be written as

$$P = k\theta; \qquad P_{ij} = 2\mu E_{ij}. \tag{2}$$

In (2), P is the mean of the principal stresses, θ is the dilatation, P_{ij} and E_{ij} are the stress and strain deviators, and k and μ are the two parameters, expressing the incompressibility and rigidity, respectively.

Important whole text-books on solid elasticity are based essentially on the mathematical model given by Newton's laws and (2), and books on classical hydrodynamics on the particular case $\mu = 0$. (Rigid dynamics is the case $k = \mu = \infty$.)

These mathematical models differ from reality in at least four respects. They involve differentiable functions; they assume that the stress of a given material is fully determined by the strain; they assume that stress is a linear function of strain; and they assume absolutely isotropic behaviour. It is virtually certain that no actual material conforms with pure mathematical precision to any one of these four requirements. So an applied mathematical judgment on relevance is required. It happens that there do exist quite a number of materials whose observed behaviour in certain contexts agrees so closely with the form (2) that the working out of deductive consequences of (2), in various boundary conditions and other settings, has become an important part of applied mathematics.

But (2) are far from universal in their relevance both to solid elasticity and to hydrodynamics. In hydrodynamics, a hypothetical material to which (2) applies, with μ put equal to zero, is called a perfect fluid. There was a time last century when hydrodynamical contexts were dominated by beautifully simple streamlines and the like, so that this simple model led to useful progress. In other contexts, the less simple set of equations

$$P = k\theta; \qquad P_{ij} = 2\nu \frac{dE_{ij}}{dt}, \tag{3}$$

containing the new parameter ν is used. The viscous fluid relations (3) are often said to define a 'real' fluid, in contrast to the perfect fluid case, but such usage ignores the vital point that (3) still have the limitations of a mathematical model.

Similarly, the replacement of (2) by the less simple equations

$$P = k\theta; \qquad P_{ij} = 2\left(\mu + \nu \frac{d}{dt}\right) E_{ij} \tag{4}$$

can be of service in some contexts of imperfect solid elasticity, though many experimental contexts of today appear to demand the introduction of considerably more than three parameters.

In all these contexts, an important applied mathematical task is that of judging the suitable

number of parameters needed. There is the problem of compromise between pure mathematical simplicity and adequate representation of the observations. This is not always easy, especially in contexts where the field of observations or the attendant uncertainties are changing fairly rapidly.

It is part of the fortune or misfortune of living in the twentieth century that knowledge has advanced to the point where more and more parameters seem to be needed in describing nature. It may or may not be that we shall pass through to a stage where some giants among us will make a new synthesis and produce simpler yet adequate models. But the very complexity of the present situation demands close contact with experimental work in the meantime, and adventurous research into new fields not necessarily pure mathematical.

I should now like to turn to some first-hand experience in geophysics of the spirit of applied mathematics. In 1932 I had the privilege of joining Jeffreys in work in seismology. I may remark in passing that Jeffreys had had the genius to see that important progress in knowledge of the planet Earth could come about by fresh analysis of the records of many widely-recorded earthquakes. And he thought fit to devote nearly one whole decade of his distinguished applied mathematical career in closest contact with literally mundane observational data.

One of the tasks set me by him was to examine the effect of the Earth's ellipticity on seismic transmission times. This required knowledge not merely of the Earth's outside surface ellipticity, but also of the ellipticities of internal surfaces of constant seismic velocity. And I quickly found that for this purpose I needed to know the Earth's density distribution to better precision than was available in existing models such as Laplace's, Roche's and Wiechert's.

I decided to use an equation for the density gradient $d\rho/dz$, where z denotes depth below the outside surface. Strictly, the density ρ depends on the entity P I have defined earlier, the temperature T, and an indefinite number of parameters n_i relating to other things such as chemical composition. Correspondingly,

$$\frac{d\rho}{dz} = \frac{\partial\rho}{\partial P}\frac{dP}{dz} + \frac{\partial\rho}{\partial T}\frac{dT}{dz} + \sum \frac{\partial\rho}{\partial n_i}\frac{dn_i}{dz}\,. \tag{5}$$

In the absence of even moderately precise knowledge of the temperature and composition in the Earth's deep interior, I had originally little choice to do other than (in effect) ignore the second and third terms on the right side of (5). The first term, however, with the help of elasticity and attraction theory, and with the use of simplifications such as the assumption of spherical symmetry, led to a formula which enabled $d\rho/dz$ to be formally calculated from certain seismic and related observational data.

On applying the formula to the Earth's mantle, i.e. the solid part of the Earth extending down to a depth of 2900km, I had the good luck to make a test which led to a serious clash with observation. The clash was that my results, when combined with numerical data on the Earth's moment of inertia, implied, in the Earth's core, i.e. the region of radius 3470km below the mantle, an unstable distribution of mass. The good luck—though I did not immediately see it that way—was that I had shown a mathematical model to be inadequate, and had stumbled across a means of improving it.

An exhaustion of the likely causes of the clash indicated that the third term in (5) was significant in the outermost few hundred km of the Earth, which meant that this region was, on the then available knowledge, highly probably chemically inhomogeneous. This illustrates how applied mathematical work can overlap not merely with physics, but beyond. Here was a

calculation ostensibly based on mechanics, attraction and elasticity theory, which yet led to an inference involving chemistry.

The test also led to severe limitations on allowable density distributions, and enabled greatly improved values of the density, pressure and elastic parameters to be determined in the Earth's deep interior. An incidental result was that g is nearly constant, being equal to 990cm/sec^2 within 1 per cent., down to a depth of 2500km. This result, amusingly enough, is essentially simpler for this part of the Earth than the law quoted, often without reference to any underlying assumptions, in many dynamical text-books. Which illustrates again the unrealism of applied mathematics when out of touch with observational evidence.

Another aspect is worth mentioning. The calculations in question showed a surprisingly smooth variation of the incompressibility k with the pressure, even in parts of the Earth where the variation of the density ρ and the rigidity μ were far from smooth. This led to the setting up, ten years ago, of a hypothesis on the compressibility of materials at pressures of the order of a million atmospheres. The hypothesis has since been linked with certain calculations in theoretical physics, has given some insight into the behaviour of matter at these high pressures, and has led to restrictions on the likely representative atomic numbers of materials deep in the Earth's interior. It has led to the inference that the Earth's inner core (of radius about 1200km) is most probably solid, and has aroused new discussions on the internal constitutions of the terrestrial planets.

The method of making the inferences has been a mixed deductive-inductive process. Part of the procedure is to set up several competing mathematical models, each model being plausibly based on one section of evidence, and then to confront the models with all possible observational tests. When a model becomes too badly battered in the process, it is either modified or withdrawn in favour of those models which are less scathed. Whenever this happens the gap between mathematical representation and elusive physical reality is narrowed to greater or less degree, and, every now and then, an inference emerges with strong probability. The inferences are of course all subject to probability considerations; but that is in keeping with the spirit of applied mathematics which recognizes no inference about the external world as certain.

In all my illustrations so far, I have made much reference to the applied mathematician's use of experimental data. I want now to show how the spirit of applied mathematics can be found right in the midst of experiment itself. And my illustration will be taken from seismology again.

The last few years have seen the development in several centres of what are called seismic model experiments. The models here are not mathematical ones, but physical. The aim is to simulate an earthquake in the model in order to throw light on features of actual seismograms which have so far eluded mathematical interpretation. The procedure is to apply an impulse at a point of the model and have a device which records on an oscilloscope the ensuing displacements at other points. There is all the elegance of modern experimental technique: the scale of the model is such that the impulses can be repeated at the rate of 1000 per second, resulting in a steady picture like a seismogram being shown on the oscilloscope.

To be useful to seismology, a first requirement is that the model, with appropriate scale corrections, should reasonably represent conditions in the Earth. It was on this point that Dr. Leon Knopoff of California was working when I visited his laboratory in 1954. He was then testing a model against Lamb's solution for the displacements in an infinite half-space of perfectly elastic material arising from an impulse applied at a surface point. The oscilloscope picture, however, deviated from the Lamb solution in a way which could be attributed only to an accentuation

of the effects of imperfect elasticity in the experimental set-up, to a degree that forbade simple application in seismology.

When I visited Dr. Knopoff again in May of this year, there had been an interesting change. He had discontinued using the Lamb case as being too involved for the present early stage of the model development. He had now tested his set-up by applying an impulse at a point, O say, on one of the surfaces of a plate of finite thickness, and observing the disturbances recorded at the immediately opposite point O', and he had succeeded in using the known mathematical solution for this case to reduce to insignificance the effects of imperfect elasticity in his set-up.

But what was really intriguing was the sequel. Instead of returning immediately to the seismological context which had inspired the work, he was now running off solutions for the disturbances at points other than O', for which no purely mathematical solution is available. He saw in fact that he had developed a new analogue method for solving a variety of partial differential equation boundary problems. He now aims to use his experimental method to guide him to a deeper understanding of the mathematics of boundary problems, irrespective of their application to seismology. Such is the independence of the spirit of applied mathematics.

This is of course just one of many illustrations which might be given to show how applied mathematics can be directly advanced in the laboratory itself, or even in the field. On the latter, I will simply mention that Professor J. A. Jacobs, a brilliant young English applied mathematician who went to Toronto, finds it worth while to participate in field work on Canadian ice to help him in a mathematical attack on visco-elasticity.

In the somewhat random selection of illustrations I have given this morning, I cannot hope to have drawn more than an impressionist picture of what I conceive to be the spirit of applied mathematics. There are many branches of applied mathematics that I have not found time to even mention, for example Electromagnetism and the new and lively branch of Hydromagnetism which has arisen from studies of the Earth's magnetic field.

I have been at pains to emphasize the need for applied mathematicians in general to keep contact with observational data. I hope that I have not too badly understated the important part that mathematical analysis plays in applied mathematics. Moreover, had my audience included experimentalists, I should have been at pains to amplify, in a way not needed in this room, certain words of Professor C. A. Coulson of Oxford, in an address bearing the same title as this one. The words are: "Just as (applied mathematics) may degenerate into a bastard form of pure mathematics, so it may degenerate into becoming an appendage of experiment."

And this brings me to the essential point which I have tried to make this morning, namely that the spirit of applied mathematics does not thrive if it is tied too closely to any one of its many neighbours. It has a rôle to play in this modern world which in one sense is a very independent one, and in another sense may demand close attention to all of pure mathematics, physics, chemistry, astronomy, geology, etc.

Hence my message to this new Society is to suggest that due cautions be taken to see that the pure mathematical aspects of applied mathematics, important as they are, do not distract the young applied mathematician from other vital aspects of his subject. Otherwise those applied mathematicians who work in non-mathematical departments may be the ones who will chiefly benefit from the Society.

Having said this, I should like to express my thanks for having been given the opportunity to present a point of view, and to wish the Society a prosperous future.

Appendix 3

Lists

First members of the Australian Mathematical Society

The following lists are presented as close copies of the original circulated lists. The first is a list of the foundation members of the Society.

Prof. F. V. ATKINSON, Maths. Dept., Canberra Univ. College.
Prof. V. A. BAILEY, Physics Dept., Univ. of Sydney.
Mr. F. K. BALL, C.S.I.R.O. Met. Physics, Aspendale, Vic.
Dr. E. S. BARNES, Pure Maths. Dept., Univ. of Sydney.
Mr. J. C. BARTON, Maths. Dept., Univ. of Melbourne.
Assoc. Prof. F. A. BEHREND, Maths. Dept., Univ. of Melbourne.
Prof. M. H. BELZ, Statistics Dept., Univ. of Melbourne.
Dr. O. BERAN, Patent Office, Canberra.
Mr. C. E. BILLIGHEIMER, Royal Military College, Duntroon.
Dr. F. E. BINET, C.S.I.R.O. Poultry Research Centre, Werribee, Vic.
Prof. A. L. BLAKERS, Maths. Dept., Univ. of W.A.
Prof. G. BOSSON, Maths. Dept., N.S.W. Univ. of Technology.
Mr. E. W. BOWEN, Maths. Dept., Univ. of W.A.
Mr. M. N. BREARLEY, Maths. Dept., Univ. of Adelaide.
Dr. H. BRINER, Perth Technical College, W.A.
Dr. A. BROWN, Maths. Dept., Univ. of Melbourne.
Dr. H. A. BUCHDAHL, Physics Dept., Univ. of Tasmania.
Prof. T. M. CHERRY, Maths. Dept., Univ. of Melbourne.
Prof. F. C. CHONG, Auckland Univ. College, N.Z.
Mr. A. P. CLARKE, W.R.E. Math. Services Group, Salisbury, S.A.
Mr. G. G. COOTE, C.S.I.R.O. Food Preservation, Homebush, N.S.W.
Mr. B. D. CRAVEN, Physicist, A.P.M., Alphington, Vic.
Dr. H. A. DAVID, Statistics Dept., Univ. of Melbourne.
Prof. C. S. DAVIS, Maths. Dept., Univ. of Qld.
Miss A. DOIG, Statistics Dept., Univ. of Melbourne.
Dr. F. H. DORMAN, C.S.I.R.O. Industrial Chemistry, Melbourne.
Mr. J. B. DOUGLAS, Maths. Dept., N.S.W. Univ. of Technology.
Mr. I. A. EVANS, Maths. Dept., Univ. of Qld.
Mr. H. M. FINUCAN, Maths. Dept., Univ. of Qld.
Mr. D. FORD, A.R.L., Fishermen's Bend, Vic.
Mr. F. GAMBLEN, Maths. Dept., Univ. of W.A.

Dr. J. M. GANI, Maths. Dept., Univ. of W.A.
Mr. P. N. L. GODDARD, W.R.E. Math. Services Group, Salisbury, S.A.
Prof. H. S. GREEN, Math. Physics Dept., Univ. of Adelaide.
Mrs. D. J. GREIG, Maths. Dept., Univ. of Melbourne.
Dr. J. B. GRIFFING, C.S.I.R.O. Plant Industry, Canberra.
Mr. J. L. GRIFFITH, Maths. Dept., N.S.W. Univ. of Technology.
Mr. W. D. HARDY, R.A.A.F. College, Point Cook, Vic.
Mr. W. M. HARPER, D.S.L., Maribyrnong, Vic.
Mr. C. R. HEATHCOTE, Statistics Dept., Univ. of Melbourne.
Mr. G. W. HILL, C.S.I.R.O. Math. Statistics, Univ. of Adelaide.
Mr. P. W. HUGHES, Maths. & Physics Dept., Hobart Technical College.
Dr. C. A. HURST, Math. Physics Dept., Univ. of Adelaide.
Mrs E. S. HUTTON, Maths. Dept., Univ. of Melbourne.
Dr. A. T. JAMES, C.S.I.R.O., Math. Statistics, Univ. of Adelaide.
Mr. A. JONES, Research Student, Maths. Dept., Univ. of Melbourne.
Mr. A. KEANE, Maths. Dept., N.S.W. Univ. of Technology.
Mr. R. G. KEATS, W.R.E., G.W.R.D., Salisbury, S.A.
Mr. C. B. KIRKPATRICK, Maths. Dept., N.S.W. Univ. of Technology.
Dr. H. S. KONIJN, Economics Dept., Univ. of Sydney.
Dr. H. O. LANCASTER, School of Public Health, Univ. of Sydney.
Mr. R. T. LESLIE, Statistics Dept., Univ. of Melbourne.
Miss M. LESTER, Maths. Dept., Univ. of Melbourne.
Dr. H. C. LEVEY, A.R.L., Fishermen's Bend, Vic.
Mr. R. D. LEWIS, W.R.E. Math. Services Group, Salisbury, S.A.
Mr. H. LINDGREN, Patent Office, Canberra.
Prof. E. R. LOVE, Maths. Dept., Univ. of Melbourne.
Dr. H. F. J. LOWIG, Maths. Dept., Univ. of Tasmania.
Dr. P. E. LUSH, Secondary Teachers College, Melbourne.
Assoc. Prof. J. P. McCARTHY, Maths. Dept., Univ. of Qld.
Mr. J. A. MACDONALD, D.S.L., Maribyrnong, Vic.
Mr. G. A. McINTYRE, C.S.I.R.O., Box 109, Canberra.
Mr. M. H. McKAY, Maths. Dept., N.S.W. Univ. of Technology.
Mr. J. K. MACKENZIE, C.S.I.R.O. Tribophysics, Univ. of Melbourne.
Dr. J. J. MAHONY, A.R.L., Fishermen's Bend, Vic.
Mr. B. F. MARROWS, Engineer, P.M.G. Dept., Melbourne.
Mr. H. K. MESSERLE, Elec. Engineering Dept., Univ. of Sydney.
Dr. R. E. MEYER, G.D.A.M., Brown Univ., Providence, U.S.A.
Mr. J. B. MILLER, Maths. Dept., Univ. of New England.
Dr. C. F. MOPPERT, Maths. Dept., Univ. of Tasmania.
Prof. P. A. MORAN, Statistics Dept., A.N.U., Canberra.
Mr. R. D. MUNRO, Operational Research Group, Army H.Q., Melbourne.
Mr. E. H. PALFREYMAN, Inspector, Public Service Bd., Melbourne.
Mr. T. PEARCEY, C.S.I.R.O., Radiophysics, Sydney.
Mr. N. J. C. PERES, C.S.I.R.O. Metrology [*sic*], Sydney.
Dr. B. J. PETTIS, Tulane Univ., New Orleans, U.S.A.

Dr. A. F. PILLOW, Maths. Dept., Univ. of Melbourne.
Prof. E. J. G. PITMAN, Maths. Dept., Univ. of Tasmania.
Miss J. PITMAN, Pure Maths. Dept., Univ. of Sydney.
Dr. A. H. POLLARD, M.L.C. Assurance Co., Sydney.
Miss M. A. POPPLE, External Studies Dept., Univ. of Qld.
Dr. R. B. POTTS, Maths. Dept., Univ. of Adelaide.
Mr. H. K. POWELL, Maths. Dept., Univ. of Qld.
Dr. B. C. RENNIE, Maths. Dept., Univ. of Adelaide.
Mr. D. J. RICHARDSON, W.R.E., P.D., Salisbury, S.A.
Mr. G. W. ROGERSON, I.C.I.A.N.Z. Research Lab., Ascot Vale, Vic.
Prof. T. G. ROOM, Pure Maths. Dept., Univ. of Sydney.
Mr. J. L. ROUSE, Physics Dept., Univ. of Melbourne.
Mr. R. W. RUTLEDGE, Colonial Sugar Refining Co., Sydney.
Mr. J. P. RYAN, Maths. Dept., Univ. of Melbourne.
Prof. H. W. SANDERS, Maths. Dept., Univ. of Adelaide.
Mr. J. G. SANDERSON, W.R.E., Salisbury, S.A.
Mr. D. B. SAWYER, Maths. Dept., Univ. of Otago, Dunedin, N.Z.
Dr. H. SCHWERDTFEGER, Maths. Dept., Univ. of Melbourne.
Mr. D. A. SECOMB, A.R.L., Fishermen's Bend, Vic.
Dr. J. P. O. SILBERSTEIN, A.R.L., Fishermen's Bend, Vic.
Mr. P. SPRENT, Maths. Dept., Univ. of Tasmania.
Mr. R. J. STORER, Maths. Dept., Univ. of W.A.
Mr. J. K. STRACHAN, A.R.L., Fishermen's Bend, Vic.
Mr. J. A. W. STRATH, W.R.E. Telecommunications, Salisbury, S.A.
Mr. I. M. STUART, C.S.I.R.O. Wool Textile Lab., Ryde, N.S.W.
Mr. F. J. D. SYER, Maths. Dept., Univ. of Melbourne.
Mr. G. SZEKERES, Maths. Dept., Univ. of Adelaide.
Mr. J. C. TAYLOR, Maths. Dept., Univ. of Melbourne.
Mrs J. V. TAYLOR, Maths. Dept., Univ. of Melbourne.
Mr. N. W. TAYLOR, Maths. Dept., New England Univ.
Prof. A. W. TUCKER, Maths. Dept., Princeton, New Jersey, U.S.A.
Mr. C. J. F. UPTON, Research Student, Maths. Dept., Univ. of Melbourne.
Mr. M. L. URQUHART, Maths. Dept., Univ. of Tasmania.
Mr. A. M. W. VERHAGEN, C.S.I.R.O. McMaster Lab., Univ. of Sydney.
Dr. G. E. WALL, Pure Maths. Dept., Univ. of Sydney.
Mr. G. A. WATTERSON, C.S.I.R.O. Building Research, Highett, Vic.
Mr. E. K. WEBB, C.S.I.R.O. Met. Physics, Aspendale, Vic.
Mr. H. WEILER, C.S.I.R.O. Sheep Biology Lab., Prospect, N.S.W.
Dr. K. C. WESTFOLD, Applied Maths. Dept., Univ. of Sydney.
Mr. G. L. WHITE, D.S.L., Maribyrnong, Vic.
Mr. W. C. J. WHITE, W.R.E., Salisbury, S.A.
Dr. E. J. WILLIAMS, C.S.I.R.O. Forest Products, Sth. Melbourne, Vic.
Mr. L. C. WITCHARD, W.R.E., Salisbury, S.A.
Mr. H. W. WOOD, Sydney Observatory, Sydney.
Prof. L. C. WOODS, Mech. Engineering Dept., N.S.W. Univ. of Technology.

A second list of members was circulated. It contained two additional foundation members:

Dr. J. A. OVENSTONE, W.R.E. Math. Services Group, Salisbury, S.A.
Dr. G. S. WATSON, Statistics Dept., A.N.U., Canberra.

Then there were "Other Members (as at 3.8.57)":

Dr. J. M. BENNETT, Computing Lab., Physics Dept., Univ. of Sydney.
Mr. B. A. BOLT, Applied Maths. Dept., Univ. of Sydney.
Mr. W. BRISLEY, Maths. Dept., Newcastle Univ. College.
Dr. P. J. CLARINGBOLD, Vet. Physiology Dept., Univ. of Sydney.
Dr. E. A. CORNISH, C.S.I.R.O., Math. Statistics Div., Univ. of Adelaide.
Mr. D. G. HURLEY, A.R.L., Fishermen's Bend, Vic.
Mr. B. E. JOHNSON, Student, Maths. Dept., Univ. of Tasmania.
Mr. J. A. LAMBERT, Maths. Dept., Newcastle Univ. College.
Prof. K. J. LE COUTEUR, Theoretical Physics Dept., A.N.U., Canberra.
Mr. R. F. MATLAK, Maths. Dept., Newcastle Univ. College.
Dr. G. R. MORRIS, Maths. Dept., Univ. of Qld.
Mr. K. W. MORRIS, Maths. Dept., Univ. of Adelaide.
Dr. H. MULHALL, Applied Maths. Dept., Univ. of Sydney.
Assoc. Prof. R. C. T. SMITH, Maths. Dept., Univ. of New England.
Dr. R. C. THORNE, Applied Maths. Dept., Univ. of Sydney.
Mr. S. M. TROTT, Engineering Board of Management, Univ. of Tasmania.
Dr. W. A. O'N. WAUGH, Maths. Dept., Canberra Univ. College.
Dr. P. WHITTLE, Statistics Dept., A.N.U., Canberra.
Dr. W. W. WOOD, A.R.L., Fishermen's Bend, Vic.

Lastly here, there was the "Third List of members (at 1-12-57)":

Mr. B. E. CLANCY, Maths. Dept., N.S.W. University of Technology.
Dr. E. J. HANNAN, Statistics Dept., A.N.U., Canberra.
Dr. A. C. HURLEY, C.S.I.R.O. Industrial Chemistry, Melbourne.
Dr. G. M. KELLY, Pure Maths. Dept., Univ. of Sydney.
Mr. M. LABALETTE, 71 Hunter Street, Sydney.
Dr. D. G. LAMPARD, C.S.I.R.O. Electrotechnology, Sydney.
Mr. P. MAJSTRENKO, Maths. Dept., Univ. of New England.
Prof. H. MESSEL, Physics Dept., Univ. of Sydney.
Mr. J. F. NICHOLAS, C.S.I.R.O. Tribophysics, Melbourne.
Mr. S. J. PROKHOVNIK, Maths. Dept., N.S.W. Univ. of Technology.
Mr. W. B. SMITH-WHITE, Pure Maths. Dept., Univ. of Sydney.

Office holders of the Australian Mathematical Society, not including ANZIAM

More extensive lists, including some corresponding lists for the New Zealand Mathematical Society, are contained in the *Administrative Directory of Mathematical Sciences in Australasia*, Australian Mathematical Society Inc. (June 2003). The lists given here are mostly adapted from that source.

Presidents

T. M. Cherry	1956 – 1958	G. B. Preston	1982 – 1984
E. J. G. Pitman	1958 – 1960	R. S. Anderssen	1984 – 1986
T. G. Room	1960 – 1962	N. S. Trudinger	1986 – 1988
E. S. Barnes	1962 – 1964	G. I. Gaudry	1988 – 1990
B. H. Neumann	1964 – 1966	J. H. Rubinstein	1990 – 1992
H. O. Lancaster	1966 – 1968	C. E. Praeger	1992 – 1994
C. S. Davis	1968 – 1970	D. W. Robinson	1994 – 1996
G. E. Wall	1970 – 1972	A. J. van der Poorten	1996 – 1998
G. Szekeres	1972 – 1974	I. H. Sloan	1998 – 2000
H. S. Green	1974 – 1976	A. L. Carey	2000 – 2002
P. A. P. Moran	1976 – 1978	A. J. Guttmann	2002 – 2004
J. M. Gani	1978 – 1980	M. G. Cowling	2004 – 2006
A. L. Blakers	1980 – 1982		

Secretaries

J. P. Ryan	1956 – 1959
H. O. Lancaster	1959 – 1963
C. F. J. Upton	1963 – 1967
W. Pye	1967 – 1977
D. G. Hurley	1977 – 1979
W. R. Bloom	1980 – 1990
D. Elliott	1990 – 2001
E. J. Billington	2001 –

Treasurers

C. S. Davis	1956 – 1968
V. G. Hart	1968 – 1983
B. D. Jones	1983 – 1993
A. Howe	1993 –

Office holders of ANZIAM

Chairs

V. T. Buchwald	1974 – 1976	I. H. Sloan	1989 – 1990
S. Rosenblat	1977	R. J. Hosking	1991 – 1992
R. B. Potts	1978 – 1979	N. G. Barton	1993 – 1994
C. J. Thompson	1980 – 1981	G. C. Wake	1995 – 1996
R. S. Anderssen	1982 – 1983	E. O. Tuck	1997 – 1998
J. R. Blake	1984	J. M. Hill	1999 – 2000
R. H. J. Grimshaw	1985 – 1986	N. J. de Mestre	2001 – 2003
J. R. Blake	1987 – 1988	R. McKibbin	2004 –

Secretaries

E. D. Fackerell	1974 – 1975
J. R. Blake	1976 – 1978
R. D. Braddock	1979 – 1983
W. C. Summerfield	1984 –

Treasurers

D. Elliott	1974 – 1979
J. D. Donaldson	1980 – 1988
D. F. Paget	1989 – 1996
J. D. Donaldson	1997 – 2001
M. Randall	2001 – 2004
P. R. Johnston	2005 –

Honorary members of the Australian Mathematical Society

N. G. Barton AM
W. R. Bloom
C. S. Davis DFC
J. B. Douglas
D. Elliott
J. M. Gani AM
J. R. J. Groves
T. E. Hall
V. G. Hart
B. D. Jones
S. A. Morris
M. F. Newman
G. B. Preston
W. Pye
W. C. Summerfield
G. E. Wall

The deceased honorary members of the Society are E. S. Barnes, A. L. Blakers AM, H. S. Green, H. O. Lancaster AM, E. R. Love, K. Mahler, P. A. P. Moran, B. H. Neumann AO, E. J. G. Pitman, R. B. Potts AO, T. G. Room and G. Szekeres AM.

Medallists and prize winners of the Australian Mathematical Society, not including ANZIAM

Australian Mathematical Society Medal

The medal is awarded to a member of the Society, under the age of forty years, for distinguished research in the mathematical sciences.

1981	N. S. Trudinger
1982	G. Brown
1983	L. M. Simon
1984	R. P. Brent
1985	No award
1986	P. G. Hall
1987	J. H. Rubinstein
1988	F. R. de Hoog
1989	M. G. Cowling
1990	B. D. McKay
1991	G. Huiskin
1992	M. G. Eastwood
1993	P. J. Forrester and N. C. Wormald
1994	No award
1995	A. J. Baddeley
1996	I. Shparlinski
1997	M. K. Murray
1998	M. T. Batchelor
1999	J. I. E. Urbas
2000	C. M. O'Keefe and M. Varghese
2001	P. G. Bouwknegt, A. I. Molev and H. P. Possingham
2002	X.-J. Wang
2003	B. H. Andrews and A. W. Hassell
2004	No award
2005	Terence Tao

George Szekeres Medal

The award is for a sustained and outstanding contribution to research in the mathematical sciences in the fifteen years prior to the year of the award. The candidate should have been resident in Australia when the bulk of the work was completed.

2002 I. H. Sloan and A. J. van der Poorten
2004 R. S. Anderssen

B. H. Neumann Prize Winners

The prize is for the most outstanding talk by a student (postgraduate or undergraduate) at the annual general meeting of the Society.

1985 Derek Ward (University of New South Wales)
1986 Anis A. Inayat-Hussain (University of Western Australia), Robert L. McIntosh (Australian National University)
1987 Eamonn O'Brien (Australian National University)
1988 No award
1989 Ian S. Barnes (Australian National University)
1990 X. T. Dong (Macquarie University)
1991 Michael Hartley (University of Western Australia), S. O. Warnaar (Australian National University)
1992 Jacqui Ramagge (University of New South Wales)
1993 Maureen Edwards (University of Wollongong)
1994 Ljljana Brankovic (University of Newcastle)
1995 May Nilsen (University of Newcastle)
1996 Ian Wanless (Australian National University)
1997 Marcel Jackson (University of Tasmania)
1998 Ruth Corran (University of Sydney)
1999 Csaba Schneider (Australian National University)
2000 Andrew Scott (University of Queensland)
2001 Mark Aarons (Monash University), Stephan Tillman (University of Melbourne)
2002 Sivah Somasundaram (University of Waikato)
2003 Benjamin A. Burton (University of Melbourne), William B. Hart (Macquarie University)
2004 Jonathan A. Cohen (University of Western Australia)
2005 Geoffrey Pearce (University of Western Australia)

Medallists and prize winners of ANZIAM

The ANZIAM Medal

The medal is awarded on the basis of research achievements and activities enhancing applied or industrial mathematics and for contributions to ANZIAM.

1995 Renfrey Burnard Potts
1997 Ian Hugh Sloan
1999 Ernie Oliver Tuck
2001 Charles E. M. Pearce
2004 Roger Grimshaw

The J. H. Michell Medal

At most one award is made annually, where merited, to a researcher within ten years of conferral of a PhD who has carried out distinguished research in applied and/or industrial mathematics, a significant proportion of which has been carried out in Australia and/or New Zealand.

1999	Harvinder Singh Sidhu	2003	No award
2000	Antoinette Tordesillas	2004	Mark Ian Nelson
2001	Nigel Bean	2005	No award
2002	Stephen Lucas		

T. M. Cherry Prize Winners

The prize is for the best student paper at the annual ANZIAM conference.

1969 Rhys Jones (University of Adelaide)
1970 John A. Rickard (University of London)
1971 Janet Jones (Mt Stromlo, Australian National University)
1972 Not offered
1973 Not offered
1974 Richard P. Oertel (University of Adelaide)
1975 E. Robinson (University of Sydney)
1976 J. P. Abbott (Australian National University)
1977 John Finnigan (CSIRO), Sita Bhaskaran (University of Adelaide)
1978 Barry D. Hughes (Australian National University), P. Robinson (University of Queensland)
1979 John R. Coleby (University of Adelaide), Barry D. Hughes (Australian National University)
1980 Mark Lukas (Australian National University)
1981 Ashley W. Plank (University of New South Wales)
1982 Glen Fulford (University of Wollongong), John Gear (University of Melbourne)
1983 P. Korvest (University of Western Australia)
1984 Adam Kucera (University of Wollongong), S. Wright (University of Queensland)
1985 Glen Fulford (University of Wollongong), Fraser Murrell (University of Melbourne)
1986 A. Becker (Monash University), Kym Thalassoudis (University of Adelaide)
1987 Michael Rumsewicz (University of Adelaide)
1988 Wanda M. Henry (Australian National University)
1989 Mary R. Myerscough (University of Oxford), John A. G. Roberts (University of Melbourne)
1990 John P. Best (University of Wollongong)
1991 Steve K. Lucas (University of Sydney), Antoinette Tordesillas (University of Wollongong)
1992 Stephen F. Brown (University of Sydney)
1993 David Standingford (University of Adelaide)
1994 Belinda Barnes (Monash University)
1995 A. V. Buryak (Australian National University)
1996 A. Gore (University of Newcastle), David C. Scullen (University of Adelaide)
1997 Sharon Cummins (Monash University)

1998 John Clark (University of Sydney), Tim P. Gourlay (University of Adelaide)
1999 Elena Ostrovskaya (Australian National University)
2000 C. Reid (Massey University)
2001 Peter M. Haese (University of Adelaide)
2002 William Megill (University of Wollongong), Vladimir Gubernov (ADFA)
2003 Not offered
2004 Kassem Mustapha (University of New South Wales)
2005 Jason Looker (University of Melbourne)

Mahler Lecturers

1991 John Henry Coates (University of Cambridge)
1993 Don B. Zagier (Max Planck Institute, Bonn)
1995 Michel Mendes-France (Université de Bordeaux)
1997 Peter J. Hilton (State University of New York at Binghamton)
1999 John Horton Conway (Princeton University)
2001 Robin Thomas (Georgia Institute of Technology)
2003 Hendrik W. Lenstra (University of California, Berkeley)
2005 Bruce C. Berndt (University of Illinois at Urbana-Champaign)

Editors of the publications of the Australian Mathematical Society

The Journal and the Journal (Series A)

T. G. Room	1960 – 1965	H. Lausch	1980 – 1982
G. B. Preston	1965 – 1969	T. E. Hall	1983 – 1991
B. Mond	1969 – 1975	J. R. J. Groves	1992 – 1997
J. N. Crossley	1975 – 1977	C. F. Miller III	1998 –
J. B. Miller	1977 – 1979		

The Journal (Series B) and the ANZIAM Journal

J. J. Mahony	1975 – 1978	E. O. Tuck	1985 – 1992
I. H. Sloan	1978 – 1982	C. E. M. Pearce	1993 –
W. E. Smith	1983 – 1984		

The ANZIAM Journal: Electronic Supplement

A. J. Roberts	1997 –

The Bulletin

B. H. Neumann	1969 – 1979	A. S. Jones	1990 – 1996
S. A. Morris	1979 – 1984	M. G. Cowling	1996 – 2002
S. Oates-Williams	1985 – 1989	A. S. Jones	2002 –

Chairs of the Editorial Board of the Australian Mathematical Society Lecture Series

S. A. Morris	1984 – 1994
J. H. Loxton	1995 – 2000
M. K. Murray	2001 –

The Gazette

A. J. van der Poorten	1974 – 1977	T. M. Mills	1994 – 1997
D. C. Hunt	1977 – 1981	B. R. Benjamin	1997 – 2000
J. D. Gray	1981 – 1984	W. P. Galvin and J. R. Giles	2001 – 2003
G. L. Cohen	1985 – 1990	J. de Gier and S. O. Warnaar	2003 –
B. Sims	1991 – 1993		

The Electronic Site

D. C. Hunt	1994 – 1996
I. R. Doust	1997 – 2003
R. R. Moore	2003 –

Presidents of the Australian Mathematical Sciences Council

Garth Gaudry	1989 – 1992	Helen MacGillivray	1999 – 2000
Richard Jarrett	1993 – 1994	Judy Mousley	2001 – 2002
Jan Thomas	1995 – 1996	Alan Carey	2003 – 2004
Noel Barton	1997 – 1998	Louis Caccetta	2005 – 2006

Fellows of the Australian Academy of Science

This information is mostly adapted from the Academy's website and from F. Fenner (editor), *The First Forty Years*, Australian Academy of Science, Canberra (1995). See also *The Australian Academy of Science: Directory 2003–2004*, Australian Academy of Science, Canberra (2004). Most of the more recent information has been kindly supplied by the archivist of the Basser Library, Australian Academy of Science.

Current fellows of the Australian Academy of Science (in November 2005) who are now or have been involved in the mathematical sciences in Australia, with their year of election to the Academy, offices held and honours received, include the following.

Brian David Outram Anderson AO FRS, 1974; *Council 1980–1983, 1998–2002, President 1998–2002, Matthew Flinders Lecturer 1992*
Adrian John Baddeley, 2000; *Hannan Medal 2001*
Michael Newton Barber, 1992; *Council 1997–2000, 2001–2005, Secretary (Science Policy) 2001–2005*
Robert Andrzej Bartnik, 2004
Rodney James Baxter FRS, 1977; *Pawsey Medal 1975, Lyle Medal 1983*
Richard Peirce Brent, 1982; *Hannan Medal 2005*
Gavin Brown AO, 1981; *Council 1992–1995, Vice-President 1993–1995*
Hans Adolph Buchdahl, 1968; *Lyle Medal 1972*
Michael George Cowling, 1993

Edward Norman Dancer, 1996
Robert Leith Dewar, 1992
Peter Drummond, 2003
Michael George Eastwood, 2005
Denis James Evans, 1994; *Frederick White Prize 1990*
Warren John Ewens FRS, 1981
Victor Vilevich Flambaum, 2000
Peter Forrester, 2004
Jorgen Segerlund Frederiksen, 2005
Joseph Mark Gani AM, 1976
Graham Clifford Goodwin FRS, 1997; *Council 2002–*
Ross William Griffiths, 2001
Roger Hamilton James Grimshaw, 1990
Anthony John Guttmann, 2002; *Hannan Medal 1998, Lyle Medal 2005*
Peter Gavin Hall FRS, 1987; *Council, 2003– , Lyle Medal 1989, Hannan Medal 1994, Matthew Flinders Lecturer 2006*
Alan Kenneth Head AO FRS, 1971
Christopher Charles Heyde AM, 1977; *Council 1986–1993, Vice-President 1988–1989, Treasurer 1989–1993, Hannan Medal 1994, Lyle Medal 1995*
Charles Angas Hurst AM, 1972; *Council 1983–1986, Vice-President 1984–1985*
John Edward Hutchinson, 2002
Stephen Timothy Hyde, 2005; *Pawsey Medal 1993*
Jörg Imberger AM, 1993
Jacob Nissim Israelachvili FRS, 1982; *Pawsey Medal 1977, Matthew Flinders Lecturer 1986*
Gregory Maxwell Kelly, 1972
Yuri S. Kivshar, 2002; *Pawsey Medal 1998*
Kenneth James Le Couteur, 1960
Gustav Issac Lehrer, 1998
Stjepan Marcelja, 1991
Oliver Mayo, 1996
Alan Gaius Ramsay McIntosh, 1986
Brendan Damian McKay, 1997
Bruce Harold John McKellar, 1987; *Council 1995–1998, 1999, 2000– , Vice-President 1997–1998, 2000– , Secretary (Physical Sciences) 1999, 2000– , Pawsey Medal 1973, Lyle Medal 1991*
Richard Ernst Meyer, 1956
Gerard James Milburn, 1999
John Barratt Moore, 1994
William Moran, 1984
Amnon Neeman, 2005
Barry William Ninham, 1978; *Pawsey Medal 1971*
Michael Robert Osborne, 1983
Hugh Philip Possingham, 2005
Cheryl Elisabeth Praeger AM, 1996; *Council 2000–2003*
Derek William Robinson, 1980; *Council 1989–1992, Lyle Medal 1981*

Colin Rogers, 1999
Joachim Hyam Rubinstein, 2003; *Hannan Medal 2003*
Eugene Seneta, 1985
Igor Shparlinski, 2006
Leon Melvyn Simon FRS, 1983
Ian Hugh Sloan, 1993; *Council 1995–1998, Lyle Medal 2001*
Allan Whitenack Snyder FRS, 1985; *Lyle Medal 1985*
Terence Paul Speed, 2001
Mandyam Veerambudi Srinivasan FRS, 1995
Ross Howard Street, 1989
Colin John Thompson, 1995
Neil Sidney Trudinger FRS, 1978; *Hannan Medal 1996*
Ernest Oliver Tuck, 1988, *Lyle Medal 1999*
John Stewart Turner, 1979; *Matthew Flinders Lecturer 1990*
Gordon Elliott Wall, 1971; *Council 1977–1980*
Geoffrey Anton Watterson, 1991 (resigned 1994)
Robert Oliver Watts, 1999; *Council 2003–*

The following are "Corresponding Members" of the Academy. They are persons who are eminent in respect of scientific discoveries and attainments but are not normally resident in Australia. No more than two corresponding members can be elected in any one year.
Sir Michael Francis Atiyah FRS, 1992
Vaughan Frederick Randal Jones FRS, 1992
Lord Robert May FRS, 1991
Edwin Ernest Salpeter, 1988
Terence Tao, 2006
George Keith Batchelor, Richard Henry Dalitz, Sir Harrie Massey and Paul Erdős, all now deceased, were also corresponding members.

The following, all associated with the mathematical sciences, are deceased fellows of the Academy:
Christopher John Ash, 1994; 5 January 1945 – 16 February 1995
Victor Albert Bailey, 1955; 18 December 1895 – 7 December 1964
John Adair Barker FRS, 1967; 27 March 1925 – 22 October 1995
Eric Stephen Barnes, 1954; 16 January 1924 – 16 October 2000; *Council 1962–1964, 1972–1976, Secretary (Physical Sciences) 1972–1976, Lyle Medal 1959*
John Markus Blatt, 1966 (resigned 1982); 23 November 1921 – 16 March 1990
John Robert Booker, 1995; 24 July 1942 – 13 January 1998
Keith Edward Bullen FRS, Foundation Fellow; 29 June 1906 – 23 September 1976; *Council 1955–1957, Matthew Flinders Lecturer 1969*
Stuart Thomas Butler, 1969; 4 July 1926 – 15 May 1982; *Council 1970–1973*
Sir Thomas MacFarland Cherry FRS, Foundation Fellow; 21 May 1898 – 21 November 1966; *Council 1954–1959, 1961–1965, Vice-President 1955, Secretary (Physical Sciences) 1955–1959, President 1961–1965*
Edmund Alfred Cornish, 1954; 7 January 1909 – 31 January 1973

Robert Edmund Edwards, 1968 (resigned 1975); 15 March 1926 – 5 August 2000
Ronald Gordon Giovanelli, 1962; 30 April 1915 – 27 January 1984
Herbert Sydney Green, 1954; 17 December 1920 – 16 February 1999
Edward James Hannan, 1970; 29 January 1929 – 7 January 1994; *Lyle Medal 1979*
Andrew Crowther Hurley, 1972; 11 July 1926 – 14 October 1988
John Conrad Jaeger FRS, 1954; 30 July 1907 – 15 May 1979; *Council 1957–1959, Vice-President 1958–1959*
Douglas Geoffrey Lampard, 1977; 4 May 1927 – 1 September 1994
Henry Oliver Lancaster AO, 1961; 1 February 1913 – 2 December 2001; *Lyle Medal 1961*
Sir John Percival Vissing Madsen, 1954; 24 March 1879 – 4 October 1969
Kurt Mahler FRS, 1965; 26 July 1903 – 25 February 1988
John Joseph Mahony, 1974; 15 July 1929 – 30 June 1992
James Henry Michael, 1973; 3 April 1920 – 17 April 2001
Patrick Alfred Pierce Moran FRS, 1962; 14 July 1917 – 19 September 1988; *Council 1971–1974*
Bernhard Hermann Neumann AC FRS, 1964, 15 October 1909 – 21 October 2002; *Council 1968–1971, Vice-President 1969–1971, Matthews Flinders Lecturer 1984*
Hanna Neumann, 1969; 12 February 1914 – 14 November 1971
John Robert Philip FRS, 1967; 18 January 1927 – 26 June 1999; *Council 1972–1978, Secretary (Biological Sciences) 1974–1978, Lyle Medal 1981*
Edwin James George Pitman, 1954; 29 October 1897 – 21 July 1993; *Council 1959–1961, Vice-President 1960–1961*
Renfrey Burnard Potts AO, 1975; 4 October 1925 – 9 August 2005; *Council 1980–1983*
Charles Henry Brian Priestley AO FRS, 1954; 8 July 1915 – 18 May 1998; *Council 1958–1960, Vice-President 1959–1960, Matthew Flinders Lecturer 1976*
Roger Wolcott Richardson, 1990; 30 May 1930 – 15 June 1993
Thomas Gerald Room FRS, Foundation Fellow; 10 November 1902 – 1 April 1986; *Council 1960–1962*
George Szekeres AM, 1963; 29 May 1911 – 28 August 2005; *Lyle Medal 1968*

Endnotes

Chapter 1

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4 J. Stokes, "A description of the mathematical concepts of Groote Eylandt Aborigines", in Hargrave, ibid., pp. 33–152.
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Chapter 2

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Chapter 3

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Chapter 10

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