

Obituary



Leslie Colin Woods
6 December 1922 – 15 April 2007

Leslie Colin Woodhead was born on 6 December 1922 at Reporoa, a small settlement between Rotorua and Taupo in New Zealand. When Leslie was four years old his father became a fisherman at Mercury Bay, with the family living in an isolated tent by the mouth of Purangi Creek, 5 km from Whitianga. His father had to take the fish which he caught to Auckland in order to sell them, and so when Leslie was nine years old the family moved to Auckland.

In 1934 and 1935 he attended Brixton Road Primary School, where he received top marks in the Standard 6 examination (Year 8 today). His teachers urged him to go to a grammar school, but in 1936 Leslie's father instead sent him to Seddon Memorial Technical College to train as a mechanic. The boys in the engineering classes were taught some mathematics, by rote. Cyril Maloy taught those classes, where he recognised Leslie's potential, and in 1937 he suggested that Leslie should transfer to accountancy and prepare for the Matriculation examination. Leslie had no objection, and his father was not consulted.

In 1938 he easily passed the Matriculation examination and he hoped to enroll at Auckland University College the following year, but his father refused to pay the fees. Cyril Maloy then suggested that he return to Seddon Tech for a year and try for one of the 30 entrance scholarships, and Leslie's father agreed reluctantly. He sat the Entrance Scholarship examination in December 1939 and came 26th on the list of 30 winners — the first ever winner from Seddon Tech. He was jubilant and so were his teachers, and he looked forward eagerly to starting university study — but then his father refused to provide board for him. Thereupon Cyril Maloy declared that *he* would pay Leslie's board, and that noble offer shamed Leslie's father into agreeing to provide board for his exasperating son.

Leslie enrolled in 1940 to study engineering. He enjoyed the mathematics lectures by Professor Henry Forder and by Cecil Segedin, but was bored by Keith

Bullen's lectures. Leslie's home life became increasingly miserable, and in 1941 he told his father that he was going to leave home. Leslie became reconciled with his parents only when they had grown old.

Leslie resigned his scholarship, and volunteered to join the RNZAF. He trained at Ardmore Airfield, on Tiger Moth biplanes. At a dance in Ashburton he met Betty, and they married on 21 August 1943. He decided to resume extramural study for a BSc; and Cecil Segedin gave him very helpful advice. In November 1943 he went to Auckland University College and passed examinations in Pure and Applied Mathematics, giving him seven of the eight units required for BSc. A few months later he was invited to apply for a BSc immediately, under special regulations for servicemen, and so he gained his first degree. In December 1943 Leslie applied successfully for active service in the Pacific War, where RNZAF pilots flew American aircraft under US command. In three tours of duty at Bougainville, Flying Officer Leslie Woodhead flew 76 missions, with many dive-bombing raids on the Japanese fortress at Rabaul. Nine of his close friends were killed during that period, mostly in flying accidents. During home leave after his first tour of duty, with his first child due in three months, Leslie Woodhead changed his surname to Woods, to spite his father. On his second leave Leslie Woods saw his first daughter — eventually he had a family of five daughters. He sat his examinations and gained second-class Honours in Mathematics for his MSc, and he passed Philosophy 1. The Government announced generous provisions for rehabilitation of servicemen, and he decided to study for a BE, which he was qualified to complete in two years. In November 1945 he sat further examinations (at Christchurch) for his BA; and he was discharged from the RNZAF on 17 November 1945.

In 1946 Leslie resumed studying at Auckland University College School of Engineering, in the 'temporary' tin shed built in 1908. (It was finally demolished in 1979.) He augmented his income by teaching some evening classes at Seddon Tech. He applied for a Rhodes Scholarship to undertake research at Oxford for a DPhil in Engineering Science, and on 25 November 1947 he was awarded that prestigious scholarship. At the end of 1947 he completed his BE, and Professor Leech appointed him as Temporary Junior Lecturer to teach Fluid Dynamics and Aeronautics. The tin shed had ceased to be useable, and Professor Leech abruptly shifted the School of Engineering to the RNZAF base at Ardmore Airfield. Leslie lectured there until August 1948, initially traveling by motorbike 50 miles each day.

In August 1948 the Woods family flew from Auckland to Sydney on a Sunderland flying-boat, taking eight and a half hours for the flight. After a week in Sydney the family boarded the SS *Orion* for a five-week journey to London. Leslie had been accepted by Merton College, where the Secretary provided a room for him, but was bewildered by his request for accommodation for his family. Food was still rationed in the UK, and accommodation was desperately short around Oxford. In desperation, he took his wife and daughters to stay temporarily with a cousin of hers in West Bromwich. His encounter with the English class system, manifested in the hideous slums of the Black Country, was a startling experience for anyone coming from a tent by Purangi

Creek. Eventually his family joined him in a semi-detached house in Upper Wolvercote, and he splurged his funds to buy a motorcar.

Leslie joined the University Air Squadron, after negotiating the obstacles of his interview by a panel of RAF officers, one of whom surprised Leslie by asking what his father did. The answer 'He was a fisherman' nonplussed the officers, and so Leslie explained that 'He owns his boat'. 'Ah, a fishing manager', one of them said, smiling! The Wing Commander asked Leslie about the games that he played, and he replied that he had played football in NZ and now played for Merton College. 'Football?'. 'Yes'. 'He means rugger, Sir!'. More smiles of approval, and he was accepted in December 1948. Initially he flew Tiger Moths, but on 13 July 1950 he flew a Meteor jet. The next day he gave instruction on a Harvard, on his final flight as a pilot of powered aircraft. He had joined the New Zealand Defence Corps, which supported his further study and research, but he had to resign from the University Air Squadron.

At the Engineering Laboratory, Leslie studied under Alexander Thom and worked on transonic flow around a two-dimensional aerofoil, laboriously solving finite-difference equations with the aid of a Brunsviga calculator. He earned some much-needed money by teaching Mechanics at Oxford Technical College. In 1950 he was awarded a DPhil for his thesis *The flow of a compressible fluid about a body*, which resulted in seven publications and an auspicious start for his academic career. In preparation for the degree ceremony he met the Dean of Degrees, who asked Leslie whether he had a degree. He explained that he had a Master of Science and a Bachelor of Engineering from the University of New Zealand; to which the Merton Dean responded flatly 'You have no degree'! Leslie then created something of a precedent by taking an Oxford BA after gaining his DPhil — the First Class which he gained in 1951 obscured his Second-Class MSc (NZ). After the farce of his unearned MA (Oxon) he gained a DSc (NZ) and DSc (Oxon), and in 1983 the University of Auckland awarded him an honorary DSc at its centennial celebrations.

In 1951 the NZDC seconded Leslie to the National Physical Laboratory at Teddington, where he worked on aerofoil theory and published many papers. He applied for a Senior Lectureship in Applied Mathematics at Sydney University, and he was appointed to start in February 1954. Only after he had accepted did he learn of the internecine warfare in that Mathematics Department, between the Professor of Pure Mathematics T.G. Room and the Professor of Applied Mathematics Keith Bullen. The Woods family greatly enjoyed living in Sydney, but the fraught conditions within the Department made working there very difficult. The relations between Leslie and Keith Bullen steadily deteriorated, culminating in March 1956 in a blazing row in Bullen's office. Leslie finished by telling Bullen that he would take the first available university post at whatever level, to leave this petty domination. In May 1956, at the age of 33, Leslie became the second Nuffield Research Professor of Mechanical Engineering at the University of Technology at Sydney. When the Australian Mathematical Society was founded in 1956 he was elected a member of the first Council, and in 1958–1959 he became the vice-president. His extensive research

on aerofoil theory was summarised in his treatise *The Theory of Subsonic Plane Flow* (CUP, 1961), which remained in print for 25 years. In 1958 he became acquainted with plasma physics, and he gave some lectures on controlled thermonuclear fusion in his nuclear engineering course. His lecture notes on reactor physics got published as the Methuen monograph *An Introduction to Neutron Distribution Theory*.

At the end of 1959 the Woods family sailed cheaply to England, where he was to become an associate of the 'Controlled Thermonuclear Reaction Division of the Atomic Energy Research Establishment' at Harwell, for 1960. Enormous sums of money have been spent since 1950 by many governments on attempts to generate power by controlled thermonuclear fusion, with plasma confined by magnetic fields. Leslie started work at Harwell on investigating the basic magnetoplasma problem of why, in all attempts to confine plasma, it escaped across the magnetic field at *thousands* of times the rate predicted. The early optimistic forecasts of the imminence of power production by controlled thermonuclear reactions looked increasingly improbable, as physicists failed to cope with that fundamental problem. Then Balliol College invited him to become their Foundation Fellow in Engineering. That provided the opportunity to continue in plasma physics research, perhaps with a consultancy at Harwell; and so he accepted the invitation. Leslie returned to Sydney to make the (very difficult) arrangements for his departure, and then visited his parents and friends in Auckland. *The New Zealand Herald* published a story (30 November 1960), in which he estimated that 'It might be 50 years before the enormous energy in the hydrogen bomb can be brought under control'. In 2000, he described that as an underestimate.

Leslie began his duties as Balliol Tutor in January 1961, and he was appointed as a consultant in plasma physics for Harwell. Until 1977 he spent one day a week at the Laboratory (situated at Culham from 1963), studying mostly instabilities in plasmas. In 1965 he was promoted to Reader in Applied Mathematics, and in 1969 he was appointed as Professor of the Mathematics of Plasma. From 1953 Leslie had attended some international conferences, and the frequency with which he attended conferences increased steadily from 1960 to 1980. Also he accepted many visiting professorships and visiting fellowships at universities around the world, including visits to NZ.

The marriage of Leslie and Betty had mostly been happy, but he had persistent difficulties with her mother. In 1973 those problems escalated and the marriage broke down, with an expensive divorce in 1977. And two later marriages also ended in divorce for Leslie Colin Woods.

Leslie worked in the tradition of British applied mathematics, devoted to the solution of real problems arising in physical or technological contexts. His writings are distinguished by critical care and independence in the mathematical formulation, and in his interpretation of the results. He could employ an impressive mastery of technique, where that was appropriate. He clearly presented his views on applications of mathematics in his articles 'Beware of Axiomatics in Applied Mathematics' (*Bulletin of the IMA* **9**, 40–44), and 'The Bogus Axioms of Continuum Mechanics' (*Bulletin of the IMA* **17**, 98–102),

both of which stimulated intense discussion. Leslie was a vigorous participant in scientific controversy.

The favourite device for fusion research is the Tokamak, with the Joint European Tokamak (JET) at Culham being the largest, looking like a set designed for an extravagant science-fiction film. It was designed to generate power by heating deuterium and tritium to 300 million K and confining that plasma for 25 minutes, so that the nuclei would react to produce helium and neutrons. The use of radioactive tritium introduced significant radiation hazards, since all isotopes of hydrogen diffuse through iron and other metals. If that D-T reaction ever did occur, then it would produce a flux of neutrons at least as dangerous as that from a fission reactor of comparable power. But, after several European governments have provided several hundred million pounds over nearly 50 years, only in recent years has JET succeeded in confining plasma for a period approaching 1 second. Many types of instability have been discovered by Leslie and others, and attempts were made to patch up the apparatus to cope with them.

Leslie wrote *The Thermodynamics of Fluid Systems* (OUP, 1975). In 1979 he found that a basic equation used by plasma physicists is incorrect — the pressure used in that formula does not correspond to the collision of particles. He explained that to the Director of Culham Laboratory, who told Leslie that he was wrong and refused to renew Leslie's consultancy. Leslie then wrote three major texts on plasma physics: *Magnetoplasma Dynamics* (OUP, 1987), *Kinetic Theory of Gases and Magnetoplasmas* (OUP, 1993) and *Thermodynamic Inequalities with Applications to Gases and Magnetoplasmas* (Wiley, 1996). Those texts were reviewed dismissively by the thermonuclear establishment, but many other physicists have appreciated them. Leslie commented that

The evident failure of the fusion programme will never be admitted by those whose careers and livelihoods depend on maintaining the myth of 'steady progress'.

In 1984, Leslie became Chairman of the Mathematical Institute at Oxford University — he described that as simply being his turn, as the most senior professor available. In 1985 and 1986 he was in Muscat to create a mathematics department, as the Foundation Professor of Mathematics for the Sultan Qaboos University. He resigned as Chairman of the Mathematical Institute in October 1989, and his Professorial Fellowship in Balliol terminated in 1990. He continued with some consultancy work and with visiting appointments at various universities. He resumed playing his clarinet, and in 1996 (aged 73) he took up gliding as a hobby. And he continued research into solar physics.

In 1990, *The New Zealand Mathematical Society Newsletter* 48 published a Centrefold article *Leslie Colin Woods*, by Brian Woods. In 1998 Leslie was the New Zealand Mathematical Society Lecturer at the Mathematics Colloquium at the Victoria University of Wellington, where his memorable lecture on *The Tokamak disaster* was much appreciated. He then gave lectures at other universities in NZ. Auckland Institute of Technology (which later became the Auckland University

of Technology) was a successor to Seddon Memorial Technical College, and in 1998 the AIT fêted Leslie as *their* Rhodes Scholar. He gave there a seminar on the philosophy of science, and he was delighted to be able to pay tribute to his patron Cyril Maloy, who had recognised Leslie's potential 62 years previously, and who was there in the audience.

When Leslie's eldest daughter Coral was dying of cancer at the age of 49, he wrote for her a brief account of his early life in New Zealand. She urged him to continue writing the story of his life, and he dedicated that autobiography to her memory. It was published as *Against the tide: An autobiographical account of a professional outsider*, Institute of Physics Publishing, Bristol & Philadelphia, 2000.

On a visit to Auckland in 2003 Leslie visited the aerodrome at Ardmore, where he was delighted to find one of the Tiger Moth biplanes on which he had trained in 1941, revving on the tarmac, ready to take him for a spin.

Leslie summarised his experience with Tokamak in his treatise on *Theory of Tokamak Transport: New Aspects for Nuclear Fusion Reactor Design* (Wiley, 2006).

On 15 April 2007, Leslie Woods died in his sleep at Oxford, aged 84.

Garry J. Tee¹ and Graeme C. Wake²

Graeme first met Leslie in 1970 when he went to Oxford as a post-doctoral scholar. Leslie treasured his ANZ roots and took many of us Aussies and Kiwis under his wing. They became close friends and met frequently after Graeme returned to NZ in late 1971. Graeme last dined with Leslie in July 2006 when revisiting Oxford. In March 2007 Leslie gave an invited lecture on the tokamaks at the University of Western Ontario in Canada, which was well received.

Garry was nine years after Leslie as a student at Brixton Road Primary School, Seddon Memorial Technical College and Auckland University College. Like Leslie, he is an alumnus and retired faculty member of the University of Auckland, and is a leading writer on science and mathematics history.

¹Department of Mathematics, University of Auckland, Private Bag 92019, Auckland, New Zealand. E-mail: tee@math.auckland.ac.nz

²Institute of Information and Mathematical Sciences, Massey University at Albany, PB 102904, North Shore MC, Auckland, New Zealand. E-mail: g.c.wake@massey.ac.nz