

Leslie C. Woods, **Against The Tide**

An autobiographical account of a professional outsider,

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Leslie Colin Woodhead was born on 1922 December 6 at Reporoa, a small settlement between Rotorua and Taupo. As Les Woods he became Chairman of the Oxford University Mathematical Institute from 1984 to 1989. When his 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 has dedicated this autobiography to her memory .

When Leslie was 4 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 younger brother soon died and he met no other children, his clothes were made by his mother and he had few toys. But there was much to interest a small boy by the creek and along the beach, and the family always had fish to eat. After a year the family moved to Whitianga so that Leslie could attend school – he was disconcerted by the bustling hubbub of Whitianga, with 400 people. Sometimes he went on fishing trips with his father, as far away as the Aldermen Islands 46km from Whitianga, and lasting 3 days. His father had to take the fish which he caught to Auckland in order to sell them, and so when Leslie was 9 years old the family moved to Auckland.

The family lived briefly in Parnell and then at Panmure Basin, where Leslie did well at school, despite frequent bullying by other boys. His bare feet felt cold in winter, but he spent much time in solitary walking through the bush, swimming, cycling and reading. The family moved to Dominion Road, and in 1934 and 1935 he attended Brixton Road Primary School, where he began wearing boots. He began a paper round, distributing newspapers to earn some pocket money. At the end of 1935 he got top marks in the Standard 6 examination, and his teachers urged him to go to a grammar school. But his father had attended Auckland Grammar School, and "he used to boast that he was the only fisherman in Auckland with a knowledge of Latin and Greek, and he was

certainly not going to let his son waste time learning such useless dead languages!" (p.24). Accordingly, Leslie's father sensibly sent him to Seddon Memorial Technical College in 1936, to train as a mechanic. The boys in the engineering classes were taught some mathematics, by rote. Cyril Maloy taught those classes, where he recognized 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.

Leslie enjoyed scouting, and he became a troop leader in the Boy Scouts. In Whitianga and Auckland he attended a succession of Bible Classes, but his experience of a revivalist Easter Camp at Ngaruawahia made him a confirmed atheist.

In 1938 he easily passed the Matriculation examination and he hoped to enrol 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. Leslie's father agreed reluctantly, on condition that Leslie increase the amount of family work that he did, including assisting on some fishing trips. He gave up his paper round, but he took on various odd jobs. He sat the Entrance Scholarship examination in December 1939 and came 26th on the list of 30 winners – the first 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 to study engineering, and when he found that he was familiar with the material in first-year Pure and Applied Mathematics and in Physics he attended some second-year classes in mathematics. He devoted much time to music and to sport, and in each vacation he worked at various labouring jobs. At the end of 1940 he failed the Chemistry examination: he was permitted to enter the engineering course but had to repeat Chemistry 1. 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. His father responded "Don't slam the door after you" (p.48). Leslie became reconciled with his parents only when they had grown old.

Leslie resigned his scholarship, and volunteered to join the RNZAF. Ordinarily, parental consent was required in writing for volunteers under 21, but he explained his family circumstances and he was accepted at the age of 18. He underwent flight training at RNZAF bases at Levin, Taieri and Woodbourne, starting on the Tiger Moth biplane and progressing to the Harvard II monoplane. He was deeply disappointed to be kept in NZ as an instructor on Tiger Moths, at Tauranga and Ashburton. At a dance in Ashburton he met Betty, and they married on 1943 August 21. He decided to resume extramural study for a B.Sc; and Cecil Segedin gave him very helpful advice. An embarrassing minor accident on a training flight on 1943 May 2 ended his career as an instructor on Tiger Moths, and he was demoted to flying obsolete Vickers Vincent biplanes at Woodbourne, towing drogue targets. In November 1943 he went to Auckland and passed examinations in Pure and Applied Mathematics, giving him 7 of the 8 units required for B.Sc. A few months later he was invited to apply for a B.Sc. 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. He was trained on Kittyhawks at Ohakea for 2 months, and then on leave in Auckland he enrolled as an extramural student for M.Sc. in Mathematics and also for B.A. On 1944 March 7 his Kittyhawk squadron flew from Whenuapai, and arrived at Guadalcanal after 5 one-day flights. On 1944 March 26 his squadron flew to Bougainville Island, part of which had been captured by Americans, but most of that island was still occupied by Japanese troops. By then the Japanese had few aircraft left in the Southwest Pacific, and so the Kittyhawk fighters were used mainly as dive-bombers. The major Japanese stronghold was at Rabaul, heavily protected by anti-aircraft guns. In 3 tours of duty, Flying Officer Leslie Woodhead flew 76 missions, with many dive-bombing raids from Bougainville on 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 3 months, Leslie Woodhead changed his surname to Woods, to spite his father.

On his second leave Les Woods saw his first daughter – eventually he had a family of 5 daughters. He sat his examinations and gained second-class Honours in Mathematics for his M.Sc., and he passed Philosophy 1. Thus, he could look forward to a

career as a teacher of mathematics. He had flown Corsair fighters on his second and third tours of duty. He transferred to Whenuapai as a trainer on Corsairs in March 1945, and he was promoted to Flight Lieutenant in May 1945. He was able to attend some lectures at Auckland University College. His unit transferred to Ohakea, where his wife and daughter joined him at Marton. The Government announced generous provisions for rehabilitation of servicemen, and he decided to study for a B.E., which he was qualified to complete in 2 years. In November 1945 he sat further examinations (at Christchurch) for his B.A; and he was discharged from the RNZAF on 1945 November 17.

In 1946 Woods resumed studying at Auckland University College School of Engineering, in the "temporary" tin shed built in 1908. (It was finally demolished in 1979.) He got a small house built in Hillsborough Road, and his family were able to settle there late in 1947. 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 D. Phil. in Engineering Science, and on 1947 November 25 he was awarded that prestigious scholarship. At the end of 1947 he completed his B.E., and Professor Leech appointed him as Temporary Junior Lecturer to teach Fluid Dynamics and Aeronautics. The tin shed had ceased to be usable, and Professor Leech abruptly shifted the School of Engineering to the RNZAF base at Ardmore Airfield. Woods lectured there until August 1948, initially travelling by motorbike 50 miles each day. In July his wife and 2 daughters went to stay with her parents in Ashburton, while he camped in the barracks at Ardmore.

In August 1948 the Woods family flew from Auckland to Sydney on a Sunderland flying-boat, taking $8\frac{1}{2}$ hours for the flight. After a week in Sydney the family boarded the SS *Orion* for a 5-week journey to London, travelling with Cecil Segedin who was going to Cambridge on study leave.

Woods 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 U.K., 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.

Woods joined the University Air Squadron, after negotiating the obstacles of his interview by a panel of RAF officers, one of whom surprised Woods by asking what his father did. The answer "He was a fisherman" nonplussed the officers, and so Woods explained that "He owns his boat". "Ah, a fishing *manager*", one them said smiling! The Wing Commander asked Woods 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 1950 July 13 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, Woods worked on transonic flow around a 2-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 D.Phil. for his thesis on *The flow of a compressible fluid about a body*, which resulted in 7 publications and an auspicious start for his academic career. In preparation for the degree ceremony he met the Dean of Degrees, who asked Woods 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"! (p.169). Woods then created something of a precedent by taking an Oxford B.A. *after* gaining his D.Phil – the First Class which he gained in 1951 obscured his Second-Class M.Sc. (N.Z.). After the farce of his unearned M.A. (Oxon) he gained a D.Sc. (N.Z.) and D.Sc. (Oxon), and in 1983 the University of Auckland awarded him an honorary D.Sc. at its centennial celebrations.

In 1951 the NZDC seconded Woods 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 Woods and Keith Bullen steadily deteriorated, culminating in March 1956 in a blazing row in Bullen's office. Woods finished by telling Bullen that he would take the first available university post at whatever level, to leave his petty domination.

In May 1956, at the age of 33, Woods 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 summarized 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 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. Woods 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. There were then 3 other New Zealand Fellows of Balliol: Dan Davin (Assistant Secretary of OUP), Don Harris (Law) and the philosopher Arthur Prior.

Woods 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 (1960 November 30), in which Woods estimated that "It might be 50

years before the enormous energy in the hydrogen bomb can be brought under control". He now considers that to be an underestimate.

Woods 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 Woods 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 Les 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 2 later marriages also ended in divorce for Woods.

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 $3 \times 10^8 \text{K}$ and confining it for 25 minutes, so that the nuclei would react to produce helium and neutrons. The use of 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 40 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 Woods and others, and attempts were made to patch up the apparatus to cope with them.

Woods 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 Woods that he was wrong, and refused to renew Woods' consultancy. Woods then wrote 3 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. Woods comments (p.296) 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, Woods became Chairman of the Mathematical Institute at Oxford University – he describes 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 has 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. He continues research into solar physics.

In 1998 Woods was the NZMS Lecturer at the Mathematics Colloquium at 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 Woods 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 was in the audience. This candid memoir is illustrated with many interesting photographs – the most touching shows Cyril Maloy (p.311) with Les Woods, whose potential he had realized 62 years previously.

Nothing quite like this book had been published previously.

Every library in New Zealand should get this book.

Garry J. Tee

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