General Introduction

By Roger Tanner and John Kent

Early days

In the beginning there was no Engineering at the new University of Sydney as it began as a 'liberal arts' college in 1850, but in 1882 Mr. William H. Warren was appointed as Lecturer in Engineering. Warren was thirty years old when appointed. He had been a railway engineer in Britain and had studied at Owen's College in Manchester, at a time when engineering was under the direction of the famous Professor Osborne Reynolds, and before the college became Manchester University.

It is clear from the University of Sydney history that things did not go smoothly for the new lecturer [Turney et al 1991]. Although only three undergraduate students and seven non-matriculated students were in the 1883 class, there were complaints from staff and students that accommodation in the Main Building was inadequate. (Figure 1) It was only in 1909 that this issue was finally resolved when the new P. N. Russell engineering building was opened (Figure 2).

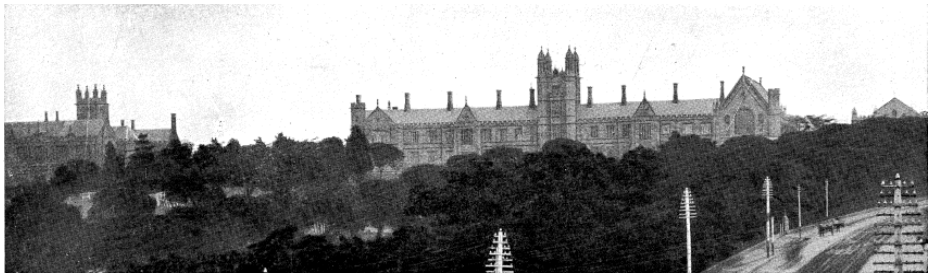

Figure 1 University Main Building (The Engineering Yearbook, University of Sydney, 1926)

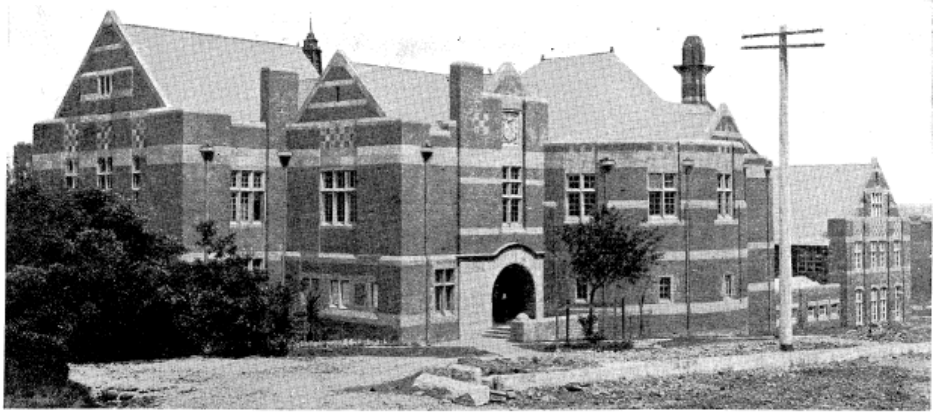

Figure 2 The first P.N. Russell Engineering Building, opened in 1909. (The Engineering Yearbook, University of Sydney 1926).

In 1884 Warren and attendant/factotum John Hufton were the total engineering staff. However, the three-year B.E. course was economically organised:

First Year: First Year Arts (Latin, Greek, Natural Philosophy);

Second Year: Mathematics, Chemistry, Physics, Physical Geography and Geology, Surveying, Applied Mechanics and Mechanical Drawing;

Third Year: Mechanical Engineering and Machine Construction (or Civil or Mining options).

The instruction in engineering led to certificates in the civil, mining and mechanical branches, so in this sense Warren, who was swiftly promoted to Professor in 1884, was essentially the de facto first Professor of Mechanical Engineering.

The first mechanical engineering certificate was given in 1887. In that year, Warren wanted changes and by 1890 he had reduced the Arts component to a single course. Students in Engineering were busy; they were in class 9am-5pm five days a week and on Saturday mornings. It was reported that some employers thought the curriculum was too theoretical, which has been a recurring theme even in recent times.

In 1891 the Civil and Mechanical courses were combined, only to separate again later. Four year degrees in Engineering were approved in 1900; at this time the Mechanical and Electrical courses were combined.

The Challis and Russell Bequests

The budget of the University was never large in these early days and named bequests were vital to the University's development. One such bequest came from John Henry Challis, (1806-1880), a merchant and grazier whose statue stands in the Great Hall. The promise of the magnificent Challis bequest of a quarter of a million pounds (worth about fifteen million today) was instrumental in leveraging the NSW Government to increase the University's annual endowment, so that the new areas of Medicine and Engineering could be established in 1883 [Turney et al 1991]. Warren was the first Challis Professor of Engineering, and there is still a Challis Chair in Civil Engineering.

In 1895, while on leave in London, Professor Warren had a fortunate meeting with Peter Russell, which led ultimately to the magnificent endowments totalling £100,000 for Engineering at the University. In 1896, Russell endowed the Department of Engineering with a gift of £50,000, including in the deed of gift a provision that the department should thereafter be styled 'The Peter Nicol Russell School of Engineering'. In 1904 this gift was followed by a second

benefaction of £50,000 as an extension of the first amount, where Sir Peter Russell stipulated that the Government of New South Wales should undertake to hand to the University, within three years, a sum of £25,000 to provide an extension of the buildings of the School of Engineering or to erect new buildings. This the Government agreed to do and a building was erected from designs prepared by the Government Architect Walter L. Vernon.

Thus was founded the Peter Nicol Russell School of Engineering, the new building for which was opened in 1909 (Figure 2).This building on Science Road now houses the English Department and has been renamed the Woolley Building. The present Faculty building in the Darlington engineering precinct retains the name of its benefactor, thus preserving for future generations the P. N. R. tradition. A statue of Russell is also to be seen in the engineering precinct near the present Chemical Engineering building; over the years it has frequently been subject to undergraduate 'improvements' (see Figure 8).

The Gradual Separate Development of Mechanical Engineering

With the Russell endowments, Professor Warren was able to appoint some new staff members in the late 1890s. In 1895 Henry Barraclough (later, Professor Sir Henry) was appointed as Assistant Lecturer in Mechanical Engineering and Drawing. The second Russell bequest in 1904 enabled a new Lecturer and a new demonstrator in Mechanical Engineering to be advertised. Barraclough was appointed as Lecturer, then in 1908 he became Assistant Professor, and finally in 1915 he became the first P. N. Russell Professor of Mechanical Engineering.

Barraclough published numerous articles, often connected with steam engines and boilers, in the engineering journals and the Journal and Proceedings of the Royal Society of New South Wales. Fisher Library has three items by him: the Mathematical Tables; an essay entitled 'The Engineer in the Ages'; and a book, 'Engineering the State', published in 1940. His *Abridged Mathematical Tables ... (1907)* was republished several times. All Sydney Engineering students were issued with a copy of these Tables at examinations until at least the 1970s. He was an interesting teacher and a good administrator. Dignified and immaculately dressed in spats, gloves, with a cane and a bowler hat, he was careful of speech, cheerful and kindly. Barraclough clearly had a large influence on engineering education in New South Wales. He retired as Professor in 1941, but continued as a fellow of Senate until 1956.

Barraclough had an infectious enthusiasm for research and worked hard to improve laboratories and equipment. The Metrology laboratory was initially the standard for New South Wales, and one of the measuring machines is still on display on the third floor of the current Mechanical Engineering building (J07), near room S342. He also fostered travelling scholarships. During his tenure the Kolling Bequest endowed the Charles Kolling Research Laboratory and the

Kolling Travelling Scholarships. A portrait of Charles Kolling, who was an American-born mechanical engineer, hangs on the wall in the third floor of the present Mechanical Engineering Building (J07). Mrs Eva Kolling knitted a pair of thick woolen socks for each Scholar to help combat the European winters; these socks were on display in the Department at least until 1966. A further endowment was made in 1942 upon the death of Mrs. Kolling.

Barraclough was also active in setting up engineering workshops [Turney et al 1991]. A notable feature of the Department was the engine laboratory, shown in Figure 3 as it was in 1926. The very large Mirrlees, Bickerton and Day engine in the left foreground was still there in 1961; soon after that the laboratory was cleared out so the space could be used for other purposes.

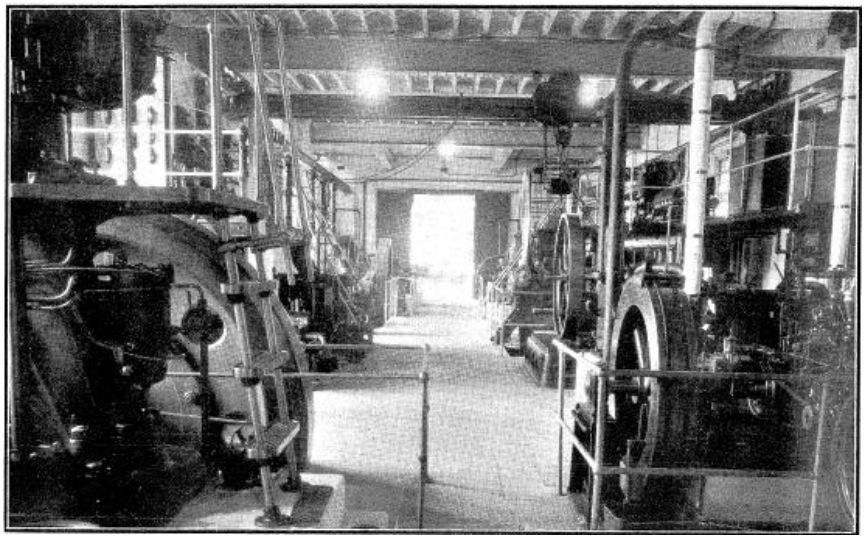

Figure 3 The Engine Laboratory in 1926. (The Engineering Yearbook, University of Sydney, 1926).

In 1920 the University Senate removed Engineering from the Science Faculty, where it had been since 1883, and created a new Faculty of Engineering with Departments of Civil, Mining, Electrical and Mechanical Engineering. This essentially represents the beginning point of our School.

Administrative arrangements in Engineering remained unchanged until 1926 when Engineering Technology was added as a fourth branch. With the decision of the Senate to introduce teaching in Aeronautical Engineering in 1939, Aeronautical Engineering became the fifth branch. The first two years were common across the Faculty and the Electrical/Mechanical joint curriculum in 1939 was as follows:

First Year: Chemistry I, Physics I, Mathematics I, Descriptive Geometry, Engineering Design and Drawing I, Building Construction, Workshop Practice.

Second Year: Mathematics II, Engineering Construction, Mechanical Engineering I, Physics II, Engineering Technology I, Engineering Design and Drawing II.

Third Year: Mechanical Engineering II, Electrical Engineering I, Surveying I, Engineering Design and Drawing III.

Fourth Year: Mechanical Engineering III, Electrical Engineering II, Engineering Design and Drawing IV.

Many of these courses included laboratory practice or field work, and in addition six months of practical workshop practice between third and fourth year were required. Details of the courses of study given in the 1939 University Calendar show a great preoccupation with engines and their operation and testing, and with boiler explosions. A thesis was required. Evidently students were kept very busy, and clearly there was a marked change from the 1883 curriculum to a more professionally oriented course.

The McDonald Years (1942-1959)

Professor George G. McDonald was appointed as the second P.N. Russell Professor in 1942, arriving from Britain in spite of the Second World War. He was a University of Glasgow graduate, had worked as a marine engineer and then as a Lecturer at Glasgow University. He was interested in fluid flow and may have been an attractive academic appointment given the nascent hydrodynamics laboratory and ship tank which had been planned in the late 1930s [Halliday 1957]. No funds were available at that time to provide a towing carriage, drive or track, and it was only in the period 1952 onward that the towing tank became operational, largely due to McDonald's impetus. By 1962 one could see many old aircraft engine superchargers and other ex-Services equipment pieces that he had collected, hidden in the dark basement of the old P. N. R. school (presently the Woolley building).

McDonald began to hire research-oriented people, and as such, an important addition in early 1961 was R. E. (Sam) Luxton, a fluid mechanicist who eventually left to become Professor at Adelaide University in 1974. One of McDonald's most significant contributions to the School's welfare was made, just before he died, when he hired Miss Jean Bennett as departmental secretary in November 1959. She remained from January 1960 until September 1990 as de facto manager and mother figure to the School. She devoted a total of nearly forty years service to the University, including her early employment in Accounting. On Friday September 21, 1990 she retired, got married on Saturday to Sam Luxton, and went to live with him in Adelaide.

Figure 4 Jean Bennett/Luxton c.1980.

During McDonald's seventeen years as Professor, the Department experienced a post-war expansion followed by a decline in student numbers in the early 1950s, with a subsequent rise in the 1960s. Until 1957 students in both Electrical and Mechanical Engineering followed the same four-year curriculum, but after that the courses began to diverge. After the separation of the two degree streams in 1957, one finds in the 1960 Calendar the following Mechanical Engineering curriculum:

First Year: Chemistry I, Physics I, Mathematics I, Engineering I.

Second Year: Physics II, Mathematics II, Engineering II.

Third Year: Mechanical Engineering I, Mechanical Engineering Design I, Electrical Engineering.

Fourth Year (Pass degree): Mechanical Engineering II, Mechanical Engineering Design II.

A thesis and six months of practical experience were also required.

Honours students took an extra year, doing a substantial research project; there were few takers. There was still an emphasis on engines and the Design II course always focused on the design of a small air compressor. As noted, from 1939 there had been a Hydrodynamics laboratory and ship tank, which were later to play a part in America's Cup challenger preparations.

Fisher Library has twenty items by McDonald; they are mainly manuscripts although some items were published on centrifugal pump and blower performance. No documents later than 1951 are in this collection.

It is noteworthy that McDonald took a great interest in the curriculum and teaching methods and read widely about developments overseas in these areas; he also originated the series of biennial conferences of heads of Mechanical Engineering Schools in Australia and New Zealand which continues to this day.

The Fink Revival (1960-1968)

At the death of George McDonald the research performance of the Department was far inferior to that of the Electrical and Aeronautical Departments. Because McDonald appeared to be trying to save money, there were a number of vacancies in 1960. After the appointment of Tom Fink in mid-1960 the other staff at mid-1961 included:

Senior Lecturers: D. R. (Bob) Axelrad, K. R. (Keith) Mann Hart, V. R. (Roy) Peterson and G. B. (Gordon) Vonwiller;

Lecturers: H. G. (Harold) Bayley, Max Boomsma, R.F. (Bob) Halliday, R. E. (Sam) Luxton and A. A. (Arthur) Sherwood.

Jean Bennett was Secretary and Janet Black assisted her. F. K. (Keith) Fraser and Les Sarvas were Technical Officers.

Mr W. H. H. Gibson, Reader, who had done research on photoelasticity, retired in 1958; his son Dr. Don Gibson (B.E. 1962) is a Fellow of the Australian Academy of Technological Sciences and Engineering (FTSE) and is one of our distinguished graduates. Two staff, Eric Hemingway and H. C. O'Connor, were only on staff for one or two years. Dr. O'Connor met Roger Tanner in Bristol before Tanner left for his appointment at Sydney, and O'Connor's news about the Department's research profile was depressing.

Of the staff listed above, Bob Axelrad worked on high-temperature creep but he eventually left Sydney in 1963 and had a long career at McGill University in Canada.

Sam Luxton was a committed researcher who made advances in experimental fluid mechanics, especially in turbulent flows; as mentioned he went to Adelaide University as Professor, in 1974.

Arthur Sherwood was extremely well-known for his miniature model railway working steam models - some of which are still on display in our entrance lobby (Figure 5) - and he was also engaged in research. His best-known work was with Professor Tom Taylor at the Royal North Shore Hospital. Arthur Sherwood made the screws and plates which were used to straighten the spines of scoliosis sufferers, and so he was our original biomedical engineer [d'Alpuget 1965].

Figure 5 This working steam locomotive was a typical product of Arthur Sherwood: very small, but made to emulate the full-size train as far as was possible. The School has a number of these models on display in the entrance foyer of the Mechanical Engineering Building (J07).

Keith Mann Hart and Bob Halliday continued to develop the Hydrodynamics lab, and the others seemed to be mostly engaged in teaching.

To improve the research activity situation, Fink set about filling vacancies by recruiting research-oriented staff. These appointments included: Roger Tanner (November 1961); Roy Henderson (January 1962); Brian Cotterell (March 1962); Hugh Nelson (March 1962); Jack Phillips (December 1963); Bob Bilger (December 1964); Bryan Roberts (1965); Ralph Scrutton (1965) and Peter Morgan (1967). Raj Huilgol and John Atkinson were made temporary lecturers in 1966 and 1968 respectively.

The effect of these appointments on the research profile of the Department was dramatic, as can be seen from the subsequent annual reports. Fink had made many innovative changes to the curriculum by 1968. The fifth year for honours had disappeared, core and elective course segments had appeared, and there were honours and pass level courses in the third and fourth years. 'Research and Development' and 'Industrial' streams of instruction had emerged, both leading potentially to honours after four years. Under Fink's influence course contents were changed greatly and made more modern and mathematical overall. Lectures in industrial organisation and management were added, and the first PhD in the department was awarded to L. F. (Roy: short for Leroy) Henderson in 1964, soon to be followed by others.

J. H. (John) Kent was a student during Tom Fink's time. He recalls being called in to the Professor's office before the start of fourth year to be told: "Your marks are quite good and we were considering allowing you to do the Honours course, but I was concerned that you might be a bit of a good-time boy!" John was permitted to do the course and he did achieve Honours. One of the Honours

courses, Potential Flow, was conducted by Fink in his nicely furnished Head's office. John remembers the class of only about eight students being a little overawed by the proximity of the Professor who was a little formal, yet was a sympathetic teacher with a twinkle in his eye.

At that time Sydney University still made do with part-time Deans seconded from the academic staff. Fink left the School to move to the University of NSW in 1968, where he became full-time Dean. Tom's influence on the School's development is unparalleled.

The George Interregnum (1969-1974)

Following the resignation of Tom Fink, Don George was appointed as the fourth P. N. Russell Professor of Mechanical Engineering in July 1969. Don was an Electrical and Mechanical graduate (1948) with interests in conduction in plasmas and in atomic energy. He soon became Chair of the Professorial Board with a consequent large investment of time and energy in general University business. Following this successful time in administration, he became Vice-Chancellor of the University of Newcastle (NSW) in 1974.

He made comparatively few appointments in the Department. In 1969 Ken Fisher was appointed as temporary Lecturer, in 1974 Dr A.M. (Arnie) Brichta was appointed as Senior Lecturer in design, and J. H. (John) Kent was appointed as Lecturer. Don presided over changes to the curriculum for the B.E., which continued to contain both 'core' and 'elective' units.

A major occurrence in this period was the construction of the new building which was occupied by the Mechanical and Aeronautical Engineering Departments in January 1974 (Figure 6). The flat roof leaked laughably and this was only cured much later when a 'tin' roof was built over the existing flat concrete roof.

Figure 6 The new Mechanical-Aeronautical Engineering Building, occupied in January 1974. Due to the glass frontage, the upper (fifth) floor gets very hot in summer.

The Beginning of the Multi-professor School (1975)

R. I. (Roger) Tanner was appointed as the fifth P. N. Russell Professor of Mechanical Engineering in 1975 and he began his duties on July 15 of that year. The staff in 1975 was not much changed from 1968. Ken Fisher had departed, R. A. (Bob) Antonia and John Kent were new Lecturers, Arnie Brichta had arrived, Keith Mann Hart had retired, Gordon Vonwiller was part-time, Ralph Scrutton had gone to Waterloo University in Canada and Raj Huilgol was, after a spell in the USA, at Flinders University in Adelaide.

In 1976, Bob Bilger said that he had an offer to go to the University of Queensland as Professor. Roger asked him not to accept until he had explored the possibility of filling the second chair in the Department. He went to see Vice-Chancellor Bruce Williams and explained the situation. After some passionate pleading and discussion Bruce Williams agreed we could have a second chair on condition that we did not fill the vacant Lectureship. The advertisement, letters of reference and committee proceedings were all completed in about six weeks (!) and Bob Bilger was appointed out of a strong field of candidates. He has since led a noted research team and has gathered many honours.

Thus the single-professorial pattern which had persisted in the Department since 1915 disappeared, much to the benefit of the overall research performance.

It is generally not a good idea to have lone researchers in a subject branch, and it was clear in 1975 that in the solid mechanics/materials research area Brian Cotterell needed a companion. Following advertisement we offered a Lectureship to Dr. Isherwood of Imperial College, London. After several months, since we had had no reply, Roger telephoned the head of Mechanical Engineering at Imperial College (Prof J. Gordon Williams, now an annual visiting Professor at the School) to find out what was going on.

Professor Williams informed Roger that he had hired Isherwood himself. Roger said ‘Do you have anyone else in the solids area looking for a job?’ He replied ‘Well, there is this chap Mai, who speaks good English’. Mai sent us a CV, was admitted as a ‘late applicant’ (a now forbidden procedure) and he arrived in 1976. Roger went to meet him at the airport where there was a colossal delay before he came out of Customs, because some of his documents were spelt ‘Mi’ and some were spelt ‘Mai’, which had upset Immigration. He was an immediate success, reviving solids/materials research, and after we spent some money on the Lab, he settled in, and soon became Associate Professor.

In 1987 he received an offer of a chair at the University of Michigan. Again Roger hastened to see the Vice-Chancellor (John Ward) to see if Mai could be awarded a Personal Chair. There were only two or three such chairs in the whole University at that time, so it was a difficult ask. After a while Professor

Ward agreed there was a strong case, and we were able to retain Mai, who eventually became a Fellow of four Academies (FTSE 1992, FAA 2001, Fellow of the Royal Society of London (FRS) 2008, and Fellow of the British Engineering Academy (FREng) 2011).

We had not succeeded in retaining R.A. (Bob) Antonia, who went in 1977 to the University of Newcastle as Professor; he has had a distinguished career in turbulence research (FAA 2004). With his departure turbulence research in the Department essentially ceased, and we sold Sam Luxton's 'quiet' wind tunnel to the Australian Defence Force Academy in Canberra.

By 1976, the curriculum had been thoroughly reorganized. There were many choices for the students and occasionally it became necessary to reduce the number of elective offerings so as to maintain viable class sizes.

The PhD degree had not become available at Sydney University until 1948. Prof W. H. Wittrick, of Aeronautics, was the first person in the Engineering Faculty to be awarded this degree (1951). In Mechanical Engineering the first PhD was Roy Henderson (1964). The first female PhD was Sydney Lynne Hall (1976) whose supervisor was Roy Henderson. She subsequently became an academic at the University of Technology, Sydney and later at the Australian National University in Canberra.

There were occasional D.Sc. in Engineering degrees- appropriately the first one was awarded to J. J. C. Bradfield in 1924. The first award of the Master of Engineering (M.E.) degree was to James Vicars in 1894. Since then the M.Sc. either by research only or by coursework and thesis appeared (1964), and other varieties of this degree are now available (MPhil, MPE).

Around 1988, while Roger Tanner was admiring a copying machine, it became clear to him that the future of innovative design lay in combining mechanical and electrical technology. The process of setting up this new Mechatronics course stream, initially termed Industrial Automation, was finalized by John H. Kent when he was Head of Department in 1990. The first Mechatronics appointee was Dr. David Rye.

Finally, a Biomedical Engineering group was begun, and from this point on the story diverges into separate streams with their own personnel: these branches and their staff will be treated in the following Chapters. The areas of concern are solid mechanics/materials, combustion, design, mechatronics, biomedical and rheology. The important joining with Aeronautics to form the present School of Aerospace, Mechanical and Mechatronic Engineering is discussed below.

Whilst these developments were internally motivated, Engineers Australia was pressing via the accreditation process for more management material to be

included in the curriculum. Roy Peterson, who had four undergraduate degrees and an M.B.A. (B.A., B. Ec., B.Sc. , B.E., MBA (UNSW)) taught in this area until he retired in 1981. J. L. (John) Fullagar (B.E. 1963, M.B.A (Chicago)) was appointed as Senior Lecturer in the subject in 1977; he left the School in 1988 to go to the University of Western Sydney. Since then the subject area has been taught externally to the School. Currently it is handled by members of Prof. Ron Johnston's Australian Centre for Innovation and International Competitiveness.

The Nineties and Beyond

From the time of Bob Bilger's appointment as second Professor of Mechanical Engineering in 1976 until the late eighties, the Headship in Mechanical Engineering alternated between Roger Tanner and Bob Bilger, except for brief periods when an acting head was needed (see Table 1). Subsequently, Heads were selected by a consensus process generally from the ranks of Professor or Associate Professor and they typically served terms of two to four years. During the late eighties and most of the nineties, a period of great expansion, John Kent was Head of Mechanical Engineering.

In 1988 there were two Departments (Mechanical and Aeronautical) with three Professors, two degree streams and typically a total of about fifty to sixty graduates. By 2001 we were a School, merged with Aeronautical Engineering, and we had six Professors (Tanner, Bilger, Mai, Phan-Thien, Durrant-Whyte, Steven). There were five degree streams, Aeronautical, Space, Mechanical, Mechatronics, Biomedical Engineering and we had one hundred graduates. Later Space Engineering specializations were also added to the Mechanical and Mechatronic programs. In 2010 the graduating class size was one hundred and eighty-seven.

A partial record of the times comes from Departmental meetings. In early years Staff Meetings were held several times a year, attended only by academics and recorded on a rotating basis by academics. At one memorable meeting our recorder, coming from a good lunch, had difficulty following the gist of proceedings. At some point he slipped quietly from his chair and disappeared under the table. To give him credit next day he interviewed each member and dutifully completed the minutes. In 1985 the University determined that these meetings were to become formal Departmental Board Meetings which were to include student and non-academic staff members. Thereafter, decorum prevailed.

Mechatronics

During the 1980's the computer revolution had made programs such as Computer Science and Electrical Engineering very popular and almost half the student intake in Engineering opted for Electrical. Mechanical Engineering represented about a fifth of the Faculty intake and student numbers seemed to be

stagnating, which was a matter of some concern. We needed to be part of the revolution, or face the consequences. Computer-controlled mechanical equipment, robotics, intelligent vehicles were all seen as exciting new frontiers. This was the origin of the Mechatronics program, but it took some years, much laboratory investment and several good academic appointments to achieve a successful degree program and strong research activity. Ultimately our *Australian Centre for Field Robotics* achieved international status, ranked second in the world for its expertise.

Key appointments of the initial team in this program were David Rye (one of our PhD graduates) who returned from the University of Newcastle in 1987, Gamini Dissanayake who came from the National University of Singapore in 1988 and Eduardo Nebot from the Universidad Nacional del Sur, Argentina, who joined us in 1992. The feeling of this young group was that a research leader was needed and in 1994 Hugh Durrant-Whyte from the University of Oxford was appointed as Professor of Mechatronics. The new degree program offered courses from 1990 and was initially called Industrial Automation with the name change to Mechatronics as it gained recognition (Bob Bilger had brought the word back from Japan in 1985). In 1993 we also decided to rename ourselves *Department of Mechanical and Mechatronic Engineering*, a change which was considered a very big step at the time.

Introductory discussions with Hugh Durrant-Whyte took place on Manly beach during his flying visit here in 1994. He liked to remind everybody over ensuing years how John Kent had warned him about the difficulty of attracting research support from industry in Australia. He proved this warning very wrong. Mechatronics became a group of one hundred and twenty with enormous support from mining, aerospace and other industries far surpassing any previous levels of support obtained in the Department, or in the Faculty.

At one stage the group seemed too successful to some. While the Mechatronics group were developing underwater robot technology, a company which was importing similar equipment from overseas, (instead of supporting local innovation) complained to a Member of Parliament that government-subsidised activity was undermining capitalistic endeavour. Our Vice-Chancellor, the late Gavin Brown, had to appear before an enquiry in Canberra. Gavin was Scottish and because of his Edinburgh accent it was reported that he was speaking about the development of an “underwater rowboat”. There was little concern that such a product would constitute a commercial threat.

Biomedical Engineering

There is a curious statistic that the proportion of women students in Mechanical Engineering hovers between about seven to fifteen percent. This seems to be true not only in English-speaking, but also other European countries. Despite our efforts with attractive presentations to school students, a professionally

produced video and with scholarships for women students (possibly considered discriminatory today) we had only limited success in raising the number of women, sometimes to about twenty percent. By contrast, Chemical Engineering enjoyed a balanced male, female intake for many years, maybe related to female preferences for Chemistry and Biology over Physics and Mathematics at school.

The Biomedical Engineering program overcame the problem. Australia has a significant and very successful Biomedical Engineering industry engaged in active research and development. Our objective was to allow students to specialize in this field and yet retain enough elements of the general Mechanical Engineering course to be readily employable in any other field. Women came to represent thirty to forty percent of the intake to this program and the cut-off qualification for entry was higher than for our other degrees.

We started our lectures with Robin Higgs, an eminent orthopaedic surgeon who offered his services as an honorary Adjunct Professor from 1993-2002. He took our students to hip-replacement operations where several students fainted, but they all appreciated his dedication to teaching and his experience. Lynne Bilston, appointed 1994 – 2002, developed the early Biomedical Engineering curriculum followed by Dennis Bobbin in 2001 – 2002. Mike Swain shared an appointment between Mechanical Engineering and Dentistry 1998-2003 teaching and researching in the area of dental biomaterials. Andrew Ruys, who started as a Research Fellow in 1997 and was appointed to the academic staff in 2003, greatly expanded the program with total Biomedical enrolments rising from about fifty in 2003 to two hundred and forty in 2011. More recent appointments to the current Biomedical staff were Qing Li (2006) Hala Zreiqat (2006), and Colin Dunstan (2008).

Formation of School of AMME

The academic relationship between Aeronautical and Mechanical Engineering has always been close. The Departments were geographic neighbours in the old P. N. R. building as well as in the present building. Students in Mechanical and Aeronautical shared common courses in the first two years and also some in their third years. Consequently there was cross-teaching between Departments and curriculum content was designed to suit both degrees. Nevertheless a cultural difference existed between the Departments in the Nineties. Mechanical Engineering focused heavily on academic research whilst the Aeronautical group had a higher proportion of staff who invested in teaching.

University administrators always believe in merging small units on the basis that this leads to smaller overheads and less duplication. The pressure from above to merge Aeronautical with Mechanical had been present for some years. An earlier attempt at a merger failed, when Graeme Bird was Lawrence Hargrave Professor of Aeronautical Engineering. The move was strongly

resisted by Aeronautical staff, as it was seen by them as a loss of autonomy. Mechanical Engineering favoured the merger believing it would lead to more flexible teaching arrangements, larger coherent research groups in certain areas, more flexible programs for students and a combined greater impact in the Faculty. The merger finally took place in 2001. Assaad Masri became the first Head of the renamed *School of Aerospace, Mechanical and Mechatronic Engineering (AMME).*

The rise of the Computer Era

The many arithmetic operations of engineering were for many years carried out by using log tables, slide rules and mechanical calculators. (The last slide rule purchased by Roger Tanner, for example, was bought in 1960 when he was preparing his PhD thesis.) In industry at that time there were still rooms full of men and women doing computations with electric calculating machines, of which the Marchant was perhaps the best example. Upon arrival in the Department in 1961, Roger was assigned an office next to Roy Henderson, who was engaged on a project that required many operations with the Marchant. Multiplication was quick with the machine but division was slow, taking about ten seconds; at the end of each division Roy emitted a tremendous belch of satisfaction, which could easily be heard in the next offices.

The University's first digital computer, named SILLIAC, was copied from a University of Illinois original (ILLIAC). It was built on site and located in the Physics School and was operational in the early 1960s, used for research by members of our School. All programs were entered on paper tape and the researchers themselves operated the machine. Later it was replaced by a commercially available machine (English Electric KDF9) and successive larger and faster machines were installed in what became the central computing facility. The last central facility machine was a CDC machine, installed in the mid 1980s.

Eventually the Faculty of Engineering installed its own system based on IBM VAX machines and this was very successful largely because K. R. (Kevin) Rosolen was able to maintain and service the VAX machines himself. The first computer purchased in 1977 by the Department of Mechanical Engineering for general use was based on PDP8 technology and it was expensive and slow. Research groups purchased their own machines, which gradually became more powerful, and eventually, by 1995, a 'farm' of several dozen interlinked small computers was put together by Nhan Phan-Thien for research use. Eventually nationally accessible systems became available and the local 'farms' died. Another aspect of computing was the installation of a computerized drafting system and this story is continued by Dr Andrei Lozzi.

For undergraduates the advent of electronic hand calculators was revolutionary; the first machine of this type was the Hewlett-Packard HP400 which appeared

around 1970. It was expensive but prices soon came down, so that every student could have their own calculator. The calculators with memory soon posed a dilemma to examiners.

Thus computing has had an impact on teaching and research; some research applications are described in the following Chapters.

Principal Research Areas

Over the years there have been a great number and variety of research projects. Some areas of research rise and fall with the driving force of particular academics. Technological progress also dictates change and therefore research directions change with time. The current principal research areas with leaders are:

- Fluid mechanics, Computational fluid dynamics, Aerodynamics (CFD)
- Combustion
- Materials and smart structures
- Rheology
- Robotics, Autonomous Systems, unmanned vehicles
- Biomedical Engineering

Some of these research areas have become prominent large groups which attract very significant funding.

The Workshops

The workshops in the Mechanical and Aeronautical Departments underpin teaching and research and remain an integral part of our activities even in the computer age. The Departments had separate workshops which were not combined into a single unit until the merger in 2001. Mechanical Engineering typically had up to ten technical officers whereas Aeronautical was smaller. There was also an electronics workshop for many years, but it has not continued to the present day.

The workshops are responsible for building laboratory equipment for undergraduate experiments, equipment for undergraduate student theses, research equipment for academics and postgraduate students and also maintaining the extensive laboratories in good working order. Equipment from the finest probes up to complex machines and large wind tunnels has been built and even aeroplane kits (Jabiru) are assembled (by students, under guidance.) Projects such as the SAE competition (where final year students build a racing car which is entered in a national competition against other institutions) would not be possible without the close relationship between academics, students and technical staff.

In past years the Engineering Faculty also ran a general workshop and even a pattern shop, which amongst other things produced wooden yacht models for the America's Cup ship tank testing. These workshops shut down over the years as teaching and research directions changed. In fact workshops throughout the University declined in size or were closed. Our two Departments, however, maintained the quality technical expertise and the workshops were (and still are) mainly supported from general recurrent funds. We now also attract work from other parts of the University (the principle being that the last one to blink remains standing).

The School has had (and has now) good heads of the workshop. From the 1960's on the workshop heads in Mechanical Engineering were: Harry Pond; Alec Laws; Chris O'Sullivan; Hasso Nibbe; and for the combined School, Greg Cumberland and now Duncan Stenger. Competition between academics for workshop resources has always been intense as have complaints about delays. Good management is needed to allocate jobs on the basis of urgency (e.g. student theses) and size of job. An important management advance occurred when a technical officer (TO) was allocated to each research group with the remaining in the "pool". This allowed groups to allocate their own priorities and the system has survived to the present day. John Kent as Head of Department urged academics to add a budget line to contribute to workshop usage on grant applications. This was resisted at first for fear that the additional expenses would disadvantage the applications. However, they were successful and those concerned were delighted with the extra funds, which they refused to hand over as tax for the workshop!

Selected Memoirs of John Kent

'Auntie and Uncle'

Before the advent of e-mail, communications in the University were written using memoranda. The Head wrote a note in handwriting, the secretary typed it, the Head checked and signed it and then it was sent by internal mail. When the University took over responsibility for other campuses and institutions there was a sudden large increase in staff to be added to the system. The result was that the University was quite unprepared and we had new staff in our Department who did not receive any pay for many weeks because of the administrative backlog. I drafted a blunter than usual message to the Staff Office, (the content of which would in politically-correct times have definitely landed me in trouble) and gave it to Jean Bennett. Later I heard quite a bit of mumbling coming from her office, adjoining mine. Presently Jean and Ian Crumpton (our accountant) stood together in front of my desk. "Auntie and Uncle think you should not send this memo". It wasn't sent.

RDO's

The University introduced Rostered Days Off (RDO's) allowing staff a nine-day fortnight, (for extra hours per day) if the Head of Department approved. I hated RDO's because urgent matters invariably came up when the relevant person was on RDO, but of course it was very popular with staff. After I had repeatedly resisted the call, one morning Vinita Martin (Jean's replacement as secretary) and Karen (administrative officer) came into the Head's office, Vinita through one door and Karen through the other, in what was a pre-planned pincer movement. They pleaded their case for RDO's with the sweetest of smiles. At a later date Vinita revealed to me that they were quite surprised at how quickly I had just nodded and agreed with them.

The Petrol Thief

At one time we suffered a series of serious thefts. Wallets, portable computer equipment and petty cash were disappearing on a weekly basis. Celia our accountant was reduced to tears. Being a public place, the building is open and we first suspected local teenagers. The University security service was alerted and in true Inspector Clouseau style they set up surveillance with binoculars from an adjacent building.

One day Greg Elder, technical officer in our workshop, came to me in some concern. It was the job of the attendant to fill a jerrycan with petrol from the University store and bring it to our student laboratories to run the engines. Greg noted that the jerrycan should have contained a substantial amount of petrol, but it was empty. When the attendant was asked to explain, he said that he had tipped the rest of the petrol into the University vehicle driven by Bob Bilger. Now it so happened that Bob was one of the few people who religiously maintained his car logbook and when inspected, together with the fuel gauge reading and mileage, it was obvious that the attendant's story was not true. I spoke with the attendant and told him that in view of all the other thefts that had occurred we would really need to call the police. He resigned immediately. The thefts also ceased.

It Droppeth As The Gentle Rain From Heaven ...

A concern for any laboratory-based discipline is the possibility of an accident involving students. We did have a spectacular incident, but nobody would have foreseen it. The undergraduate R. F. Halliday Laboratory has sloping skylight glass windows. Some students had found their way onto the flat concrete roof above the laboratory to practise with their skateboards. One student (not one of ours as it turned out) apparently attempted a bunny-hop onto the sloping glass, smashed through and dropped with skateboard some seven metres onto the concrete floor of the laboratory. When I arrived he had already been taken to hospital, thanks to first-aid efforts by technical officer Bruce Crundwell. All that

was left to see was the blood stain on the concrete. That evening I visited Royal Prince Alfred Hospital in trepidation. The student had mercifully not sustained serious injuries. I expressed my sympathy to his mother at the bedside. She cheerfully assured me not to worry: "He is always doing things like that"!

BIOGRAPHICAL NOTES

William Henry Warren

Warren was born in Bristol, England in 1852 and trained as a civil engineer in the London and Northwestern Railway Works; he had previously studied at the Royal College of Science in Dublin and at Owen's College (now Manchester University) where he was awarded a prestigious Whitworth Scholarship. According to Gourlay [1999] Warren never earned a University degree because he could not pass Latin and French. The only degree awarded to him was the honorary LL.D degree from Glasgow University (1912) (Figure 7).

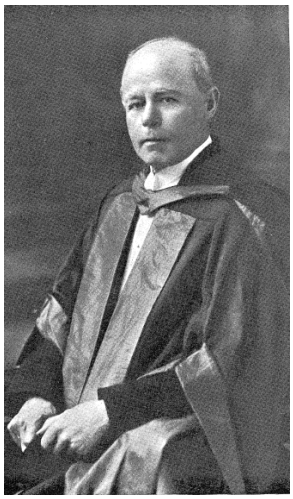

Figure 7 Professor William H. Warren about 1920. (The Engineering Yearbook, University of Sydney, 1926).

Warren arrived in Sydney in 1881 and he was employed in the New South Wales Public Works Department. He began his duties as Lecturer in Engineering at the University on 1 March 1883, and was made Professor in 1884. His career at the University lasted an amazing forty-two years, until 1925. Apparently he was well-liked by students [Turney et al 1991; Gourlay 1999]; H.H. Dare [1933] attests to the interest that Warren's partner Annie Warren took in the students in the 1880s, including arranging visits for them to the Warren home. It seems doubtful that Annie and "Bill", as he was called by his students, were married [Gourlay 1999]. Warren was married in England to Albertine King in 1875 and they had three children, but they separated before he came to Sydney in 1881. In early 1882 he was joined by Ann Jefferson who was henceforth known as Annie Warren. Apparently it was she who urged Warren to

apply for the University Lectureship in 1883; she died in 1895 while Albertine was still living.

One of Warren's students, the famous J. J. C. Bradfield, (the engineer responsible for the Sydney Harbour Bridge, much of our road system and the city rail loop), said of Warren:

> The Professor, hirsute, with ruddy brown side levers, often rode an old kangaroo bike to lectures... He was a connoisseur in cigars and whisky... As we students were the prime cause of the Professorship, we had no misgivings as to who were his real friends, particularly if we desired a drink, when spending our afternoons making an extensive series of tests on various Australian timbers for the book he was writing.
>
> [Bradfield 1932]

Some of Warren's books and reports are available in the Fisher Library: there are several books on Australian timber dating from 1887, 1892 and 1911; a paper on the destruction of garbage for the Royal Society of New South Wales; a book on Engineering Construction (3rd edition 1921); and a Presidential address to the Royal Society of NSW in 1903. Gourlay [1999] has a more complete list of his papers.

In the 1890s he sought the opinion of the Colonial Sugar Refining Company (forerunner of today's CSR Company) as to what should be included in the curriculum for Mechanical Engineering. In reply he was told that it would be useful if mechanical engineers knew how to manage the fires in locomotive boilers. Fortunately Professor Warren did not take this too seriously. He was involved in the negotiations which led to the important Russell bequest.

Numerous honours were awarded to him. Besides being President of the Royal Society of NSW in 1892 and 1902 he was also the first President of the Institution of Engineers, Australia (now Engineers Australia) in 1919, and the first recipient of the Peter Nicol Russell Medal from that institution (1923). His most notable project was the Northbridge suspension bridge (1891), the first suspension bridge in NSW. For leisure, he enjoyed opera and golf.

He died in early 1926, nine days after retiring on 31 December 1925. His name is perpetuated in the Warren Centre, a 'think-tank' associated with the University that was founded in 1983 as part of the Centenary of Engineering celebrations (Professor R.W. Bilger was the first Director of the Centre). The Warren Centre assembles teams of eminent people to consider projects and write influential reports. It is a fitting memorial to Warren's distinguished career.

Peter Nicol Russell

Peter Nicol Russell was born in Scotland in 1816. He came to Australia in 1832 where, with his brothers Robert and John, he helped his father establish a general engineering and foundry business in Hobart. In 1838 they moved the business to Sydney.

Peter Russell left the family firm in 1842 and commenced a new operation under the name 'The Sydney Foundry and Engineering Works', which later became P. N. Russell and Co. This business quickly flourished and during the next twenty years the firm grew to such a size that the works extended over a large area at Darling Harbour with a big warehouse in George Street. Ornamental architectural iron work executed by P.N. Russell & Co.'s foundry can still be seen around the balconies of many old Sydney buildings.

Peter Nicol Russell returned to London in 1864 and retired as an active member of the firm, but for many years continued to act as overseas representative. He showed sound judgement and foresight by his anticipation of possible future labour troubles in the colony. On 30 October 1873 the workmen at the Sydney foundry made a demand for ten hours of pay for eight hours of work, and went on strike. No satisfactory arrangements for the settlement of the strike were reached and the engineering works and warehouses were closed in June 1875, never to be opened again. When Peter Russell revisited Sydney after the closing of the firm which had been his life's work, it is said that he was so distressed that he immediately returned to London; there he lived in retirement, was knighted in 1904, and died in 1905 at the age of eighty-nine. The University website has a history of Engineering which provides a fuller description of Russell; see also Nicholas and Eridiweera (2011).

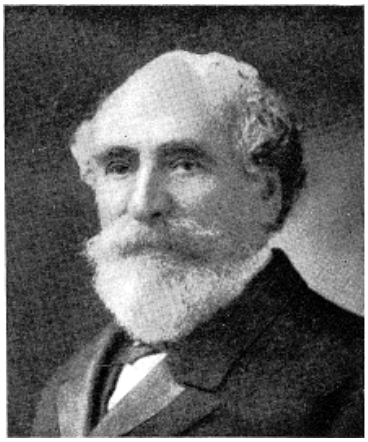

Figure 8 (Sir) Peter Nicol Russell. ***Left*** The statue which now stands near the Chemical Engineering building (J01). ***Right*** Portrait of Sir Peter Russell around 1900 (Engineering Yearbook, University of Sydney, 1926.)

Samuel Henry Egerton Barraclough

Samuel Henry Egerton Barraclough (1871-1958) was born on 25 October 1871 in Sydney [Antill 1979]. He was educated at Sydney Boys' High School and the University of Sydney (B.E., 1892). Awarded an 1851 Exhibition travelling scholarship, he attended the Sibley College of Engineering at Cornell University in Ithaca, New York, where he was awarded a Master's degree in Mechanical Engineering in 1894. After travelling in North America, he returned to Sydney in 1895 and became lecturer-in-charge of the department of (applied) physics at the Sydney Technical College, and also taught physics at Sydney High School.

He thoroughly reorganized his College department and introduced a more modern syllabus, and also helped to edit the *Australian Technical Journal*. In 1897 he was appointed Assistant Lecturer in mechanical engineering under Professor W. H. Warren in the Peter Nicol Russell School of Engineering at the University; he also lectured in the Department of Military Science.

In 1901-02 he was founding president of the Sydney University Engineering Society. Lawrence Hargrave consulted him in 1908 about a suitable engine for his planned 'lightest and most compact' flying machine. Despite being granted the right of private practice in 1904 and promotion to Assistant Professor in 1908, he applied unsuccessfully in 1909 for the chair of engineering at the University of Melbourne. He was president of the Engineering Association of New South Wales in 1914-15.

In October 1899 Barraclough had been commissioned in the Corps of Australian Engineers; in 1908 he transferred as captain to the Australian Intelligence Corps. Promoted to major in 1914, he served with Intelligence as senior assistant censor until the end of 1915 when he visited India, Egypt, France and Great Britain on behalf of the Commonwealth government. At the end of 1916 he returned to London as honorary lieutenant-colonel in charge of the Australian munitions workers in England and France. Barraclough was appointed C.B.E. (Military Division) in 1919 and the next year was promoted to Knight of the British Empire (K.B.E.); he was also awarded the Volunteer Officers' Decoration. He remained in England until 1920.

Barraclough had been appointed P. N. Russell Professor of Mechanical Engineering in the University of Sydney in 1915. He was Dean of the Faculty of Engineering in 1924-33 and 1936-41, and a fellow of the Senate in 1925-33 and 1938-56. He retired as Professor in 1941. For twenty years he was chairman of the Australian Student Christian Movement.

His wife, Mona Edith Rossiter, and he were married at Bishopscourt, Melbourne, on 22 August 1927, when Barraclough was fifty-six years old.

Figure 9 Professor Sir Henry Barraclough. (Engineering Yearbook, University of Sydney, 1926) A different portrait, dated 1941, hangs in the office of the Head of School.

Sir Henry was a councillor of the Royal Society of New South Wales, and President of its engineering section, and President of Section H of the Australian and New Zealand Association for the Advancement of Science in 1937. As a Councillor and President in 1935 of the Institution of Engineers, Australia, he helped to obtain the grant of its royal charter in 1938 and in the next year was awarded its Peter Nicol Russell Memorial Medal. He also served on the Australian National Research Council, the council of the Standards Association of Australia and on various local advisory committees. He was a member of the Australian Club, Sydney, the Atheneum in London, and the Royal Sydney Golf Club.

Barraclough died at Sydney Hospital on 30 August 1958 and was cremated with Congregational rites. He was survived by his wife.

George Gilmour McDonald

McDonald was born in Glasgow on 15 May 1903. Following high school (he was the dux of his class) he was apprenticed to the Glasgow engineering firm of G. and J. Weir Ltd between 1918 and 1924. He then entered Glasgow University, where he finished his training in March 1928, and at age twenty-five, he graduated B. Sc with first class honours from the University of Glasgow.

Clearly he had a good intellect plus considerable industrial experience, and he collected several prizes on his way to graduation. The B.Sc. was followed in 1939 by a PhD from Glasgow; the degree was earned while he was a member of the lecturing staff there.

Figure 10 Professor G. G. McDonald in 1942. (Engineering Yearbook, University of Sydney, 1942)

In 1937 while at the University of Glasgow he published a paper in the Philosophical Magazine (vol. 23 1937, pp.302-306), entitled 'The effect of variable specific heats on the conditions at the throat of a convergent-divergent nozzle'. While it seems never to have been cited, it helped to direct his research towards the fluid mechanics and thermodynamics of machines, especially gas turbines, which were a novelty in those days.

The Sydney Morning Herald noted in February 1941 that the Institution of Engineers and Shipbuilders in Scotland had awarded a gold medal to Dr. G. G. McDonald, and that he would come to Sydney in February 1942. He duly arrived in Sydney to become the second P.N. Russell Professor of Mechanical Engineering.

According to Ken Seale (BE 1952) and Graham Grant (BE 1956) McDonald was a tall man with a strong Scottish accent. He gave a few final year lectures to undergraduates but was evidently not very visible to students.

He had a wide range of interests and wrote on naval architecture and gas turbines among other subjects; he was able to secure the donation of various items of equipment for the laboratories. It was during his tour of duty as Dean that he died on 3 December 1959 at the early age of fifty-six, leaving a widow, a son and a daughter. According to Keith Mann Hart [1960], 'he was one of the very nicest of our professors.'

Peter Thomas Fink

Tom Fink was born in Frankfurt, Germany on October 12 1922, and his parents sent him to England for his high school education [Rourke 1994], presumably because of Hitler's appointment as German Chancellor in 1933. He then came to Sydney University where he studied Aeronautical Engineering (BE 1944). After graduation he spent the period until August 1947 as a research student and later as a teaching fellow in the Aeronautics Department. Then he went to England as an Assistant Lecturer in the Aeronautics Department at Imperial

College; in 1956 he became Reader there. He returned in October 1957 to take up appointment as Reader in Aeronautical Engineering at the University of Sydney. He applied for the vacant P. N. Russell professorship, but the first choice of the Committee was L. C. (Les) Woods, who did not accept the offer. The University then appointed Tom Fink as the third P. N. Russell Professor of Mechanical Engineering in mid-1960.

During his undergraduate days he met Averil Collins, whom he married after being received into the Roman Catholic Church. They had four children, Thomas, Elizabeth, Averil and Jerome.

Tom and Averil lived at Middle Cove in the 1960s and a feature of the summers was the annual gathering for all academic and administrative staff at their house (named 'Trefontane'). This admirable garden party tradition was continued by his successors until the 1980s.

Tom Fink was not a tall man, but, when walking with the head of the Workshop (H. R. (Harry) Pond, also a short man) they walked so fast one would have thought that they were rocket-assisted. The Finks were frequent Opera House attendees and one night during the interval in 'Lucia di Lammermoor', when Joan Sutherland was singing the lead role, Roger Tanner said 'I think Joan's performance is tremendous' and Tom replied 'Yes, but she is so big!' Roger suggested that he reverse his opera glasses to correct this problem. Tom had a wristwatch with an alarm and this would frequently interrupt a conversation and cause his abrupt departure to his next appointment; it could be very annoying.

Figure 11 Professor Tom Fink about 1965.

Tom was an enthusiastic fluid mechanicist. He supervised Roy Henderson's PhD and saw one other PhD student to completion during his tenure as P. N. Russell Professor. This was W. T. F. (Bill) Lau, who subsequently went to Newcastle University. Tom was a co-author on the Bathtub in the Southern Hemisphere paper. After his move to the University of NSW as Dean in 1968, he worked with W. K. Soh, a medallist from our School who is now at Wollongong University. This work, which deals with the rolling up of vortex

sheets, was published in the Proceedings A of the Royal Society of London (1978, vol. 362, p.192) and it has been cited forty-four times.

Some of Tom's fondest memories were in his connection with Donald Campbell's land and water speed record attempts. In the late 1970s he helped Sydney motorboat builder and driver Ken Warby capture the world water speed record with a jet-propelled hydroplane on the Blowering Dam in the Snowy Mountains. Initially the boat was too slow, but Tom did an on-the-spot slide rule calculation to show that cropping the rudder would enable nearly 300 knots to be reached; this modification was done at the lakeside and the record was broken.

In research not everything is successful. Tom supervised the building of a hovercraft, which began as a student fourth year project. It was about 4m (11 feet) in diameter, according to the Sydney Morning Herald [Moffitt 1961]. It was supposed to hover 45cm (18 inches) off the ground. Because the fan could not be driven fast enough for fear of its disintegration, the hovercraft actually lifted only 5mm or so and the project was abandoned.

In 1978 Tom left UNSW and moved to Canberra as Chief Defence Scientist. He retired from that position in 1986 and returned to UNSW as Executive Director of the Australian Maritime Engineering Cooperative Research Centre.

He received numerous honours including the A. G. M. Michell Medal in 1985 and the P. N. Russell Medal in 1988, both from Engineers Australia. He was a founding Fellow of the Australian Academy of Technological Sciences and Engineering (FTSE 1975).

Around 1992 he developed a brain tumor which affected his speech, and he died in January 1994 at age seventy-one. Averil Fink died in February 2011 after a long career as Executive Director in the NSW Council on the Aging.

Donald William George

Don George was born in Adelaide in November 1926; he was a Mech/Elec graduate (B.E. 1948). His academic career began as a Lecturer in Electrical Engineering at the NSW University of Technology (now UNSW) where he was from 1949-1953. He then went to the U.K. Atomic Energy Establishment at Harwell, where he worked as Experimental Officer in the period 1954-55. He married Lorna Davey in 1950 and they had a son and a daughter. Don became a Senior Research Officer at Harwell and Lucas Heights (NSW) during 1956-60.

He returned to the University of Sydney as Senior Lecturer (1960-66) and then Associate Professor of Electrical Engineering (1967-1969). He completed a PhD with Professor H. K. (Hugo) Messerle as supervisor in the early 1960s, working on electrode conduction in plasmas, with potential application to

magnetohydrodynamic electricity generation. Some work was published in 1962 in the Journal of Fluid Mechanics and it has received twenty-two citations, which is a good result. Further work on conduction in hot gases with the Messerle group followed until his appointment as P. N. Russell Professor of Mechanical Engineering in 1969. After that the ISI database lists nothing except a few short general papers written when he was Vice-Chancellor at Newcastle (1975-1986). He retired in 1986. He was elected a Fellow of the Australian Academy of Technological Sciences and Engineering (FTSE) in 1977.

Figure 12 Professor Don George. Photo reproduced with permission of The University of Sydney. Ref. No. G77_1_0510.

Roger Ian Tanner

The following (slightly edited) remarks were made by Vice-Chancellor Dr. Michael Spence as he conferred a Silver Medal for forty years service to the University on Professor Tanner, at a ceremony in the Great Hall. The date was 25 July 2011, Professor Tanner's seventy-eighth birthday.

> Raised in the country near Wells, Somerset, England, Roger Tanner left school at seventeen to work as an apprentice at Bristol Aero-Engines (now part of Rolls-Royce). After three years the company sent him to Bristol University on a scholarship to undertake a Bachelor of Science in Mechanical Engineering (First class honours 1956). He then won a King George VI Memorial Fellowship which enabled him to complete a Master's degree in Electrical Engineering at the University of California in Berkeley. A job on campus on a lubrication project, made necessary due to lack of money to live on, led him to switch interests to what became his main area of expertise: rheology, the study of the deformation and flow of matter.
>
> After a brief spell back at Bristol's, Professor Tanner joined Manchester University as an Assistant Lecturer in Mechanical Engineering in March 1958 and studied for a PhD (awarded July 1961) on the modelling of non-Newtonian fluids. In 1961 he responded to an advertisement for a Senior Lecturer in the Department of Mechanical Engineering at the

University of Sydney where the Head of School, Professor Tom Fink, was looking to build research capability.

Professor Tanner was promoted to Reader in 1964. He left Sydney in 1966 to become Associate Professor of Engineering (and in 1969, Professor) at Brown University in the USA. He returned to Sydney in 1975 to become the fifth P.N. Russell Professor of Mechanical Engineering- a title he still holds. He discovered, some time after his appointment, that in the mid-1960s the Russell family complained that the relevant professors of engineering at the University did not style themselves as P. N. Russell Professors, and they suggested that therefore the University should return Sir Peter's bequest to them. Since then Roger Tanner has always been careful to use the full title.

Roger Tanner has written four books on rheology and is (or has been) on the editorial board of five journals. He was awarded the Edgeworth David Medal by the Royal Society of NSW (1966). He was the inaugural winner of the Australian Society of Rheology Medallion in 1993; other awards include the A.G.M. Michell Medal from Engineers Australia (1999) and the British Society of Rheology Gold Medal (2000). He is a fellow of the Australian Academy of Technological Sciences and Engineering (FTSE 1977); the Australian Academy of Science (FAA 1979); Engineers Australia (2002); American Society of Mechanical Engineers (2001); the Australasian Fluid Mechanics Society (2010) and the Royal Society of London (FRS 2001). He has published about three hundred papers, and has received continuous ARC support since 1975; current projects include modelling bread dough rheology and a study of suspensions with non-Newtonian matrix fluids. He has just concluded a twelve-year collaboration (via the Polymer Cooperative Research Centre) with the Moldflow company, culminating in a co-authored book on injection moulding, published by Springer-Verlag in July 2011.

He married Elizabeth Bogen in 1957 in Las Vegas, Nevada; they have five children and fifteen grandchildren. David Tanner FTSE is a 1980 Mechanical Engineering graduate, Jacqueline is a Chemical Engineering graduate (B.E. 1984, University Blue for Judo), Edwina has just completed her M.Sc. in Marine Science, and Ian is a B.A/B.Ed. Sydney graduate; Rebecca studied Science (B.Sc) at UNSW. Besides working at the University, Roger enjoys opera, golf and language study- he is too slow around the tennis court these days.

Figure 13 Roger Ian Tanner, 1999.

Table 1. Heads of Mechanical Engineering and School AMME

From	To	Name	Years
1883	1915	William Warren	32
1915	1942	Henry Barraclough	27
1942	1959	George McDonald	17
1959	1960	Keith Mann-Hart(Acting)	0.7
1960	1968	Tom Fink	8
1969	1974	Don George	5
1974	1974	Roy Henderson (Acting)	0.5
1975	1975	Hugh Nelson (Acting)	0.5
Jul-75	Sep-77	Roger Tanner	2
Oct-77	Sep-79	Bob Bilger	2
Oct-79	Sep-81	Roger Tanner	2
Oct-81	Dec-83	Bob Bilger	2
Jan-84	Dec-85	Roger Tanner	2
Jan-86	Sep-86	Bob Bilger	0.8
Oct-86	Dec-87	John Kent	1.2
Jan-88	Dec-89	Roger Tanner	2
Jan-90	Dec-90	John Kent	1
Jan-91	Dec-92	Bob Bilger	2
Jan-93	Dec-99	John Kent	7
Jan-00	Jun-00	Yiu-Wing Mai (Acting)	0.5
Jul-00	Dec-00	Assaad Masri (Acting)	0.5
AMME School			
Jan-01	Dec-03	Assaad Masri	3

Jan-04	Dec-07	Lin Ye	4
Jan-08	Present	Steve Armfield	4

References

J.M. Antill (1979) *Barraclough, Sir Samuel Henry Egerton (1871- 1958).* Australian Dictionary of Biography, vol 7. (Also see http://adb.anu.edu.au/biography).

J.J.C. Bradfield (1932) Engineering Year Book, University of Sydney, p11-12.

W.F. Connell, G.E. Sherington, B.H. Fletcher, C. Turney, U. Bygott (1995) *Australia's First-A History of the University of Sydney 1940-1990.* Hale and Iremonger, Sydney.

L.d'Alpuget (1965). *Bent Girl:Amazing surgery with wire, screws.* The Sun, August 17, p1.

H.H. Dare (1933) *The Engineering School, 1886-1888.* Engineering Year Book, University of Sydney, p11-12.

M.R.Gourlay (1999) Draft of *William Henry Warren; A Biographical Summary*. (Unpublished paper).

R.F. Halliday (1957) *The Ship Model Tank.* Engineering Year Book, University of Sydney, pp83-85.

K. Mann Hart (1960) *George Gilmour McDonald.* Engineering Year Book, University of Sydney, p42.

I. Moffitt (1961) *Project could make history.* Sydney Morning Herald, Jan 10.

A. Nicholas, S. Ediriweera (2011) *Conservation management plan; Sir Peter Nicol Russell Memorial.* Architecture 9028 report, University of Sydney.

W. Rourke (1994) *Teacher and front-line engineer.* Sydney Morning Herald, March 8, p.12.

C. Turney, U. Bygott, P. Chippendale (1991) *Australia's First-A History of the University of Sydney vol 1 1850-1939*. Hale and Iremonger, Sydney.