SCHOOL OF ENGINEERING

UNIVERSITY OF WESTERN AUSTRALIA

A Brief History

Prepared for the Review of the Bachelor of Engineering Degree at the University of Western Australia

by

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In an isolated community such as this and difficult financial times there is a natural tendency for people to look upon the University as an unnecessary luxury, but I am quite sure that its work is essential for the proper development of the country.

Vice Chancellor Hubert Edwin Whitfeld, 1933 (1)

Introduction

The 1913 foundation statute of the University of Western Australia stated that 'it [was] desirable that provision should be made for further instruction in those practical arts and liberal studies which [were] needed to advance the prosperity and welfare of the people'.(2) This statute governed and continues to govern the University of Western Australia, but the directive is broad enough to allow for varying visions of the roles of the university. This history examines the changing roles of the Engineering Faculty of the University of Western Australia, tracing differences in the work of the Faculty through the years.

The focus of this work is on what has been taught in Engineering; what was believed to be essential; how Engineers have been trained for their profession at the university. This history is structured chronologically, and in each section I explore the differing visions of the Faculty of Engineering. That is to say, I examine what the Faculty was expected to achieve over the decades.

Foundation Years

When the University of Western Australia was founded in 1913 there were three faculties- Engineering, Arts and Science. The early growth of these faculties was hindered by the outbreak of World War One almost immediately after the year of foundation. However, despite the difficulties encountered in this period, the Engineering Faculty, under the direction of Professor Whitfeld, tentatively began to develop an ethos which stressed developing well-rounded Engineering graduates.

Mining and Engineering was one of the foundation chairs of the University of Western Australia, along with Agriculture, Maths and Physics, Biology, History and Economics, English, Chemistry, Geology and Philosophy.(3) In 1913 the university began teaching, with 184 students enrolled across the three faculties. Twenty seven of these were Engineering students, instructed by Professor Whitfeld, the inaugural chair of Mining and Engineering, and A. Tomlinson who lectured in Structural Engineering. In 1915 they were joined by P.H. Fraenkel who taught Electrical Engineering. These three men developed a five year degree in Engineering which was suitable for both students fresh from school and for men who had previously been studying Engineering at the existing technical schools.(4)

The university lacked a permanent home for its first twenty years and was situated on Irwin Street in Perth. The Engineering Faculty, however, was housed at Mr Shenton's house in Crawley. In 1935 Fraenkel recalled the crowded conditions, noting that one of the ground floor rooms was a lecture theatre, one was a mechanical lab and the third was the professor's office.(5) The Faculty was naturally under equipped at this time, with the stable being used to house the steam and gas machinery, the largest of which was a six horse power horizontal engine driven by a small boiler. These deficiencies were, of course, exacerbated by the outbreak of World War One in 1914.

The war affected the Faculty in other ways too. The state as a whole had very high rates of enlistment, with about a third of all men aged between 18 and 44 going to the war and over half being killed or injured.(6) The Engineering Faculty, a repository of many skills highly desirable to the army, was affected even more severely than the other faculties. About twenty students signed up; some were killed and others didn't return to their studies. Members of staff also volunteered for duty. For example, W.G. Townsend, a mechanical assistant, enlisted.(7) The Faculty also pledged 'any assistance' the Faculty could provide in the manufacturing of munitions.(8)

In 1915 Whitfeld and N.T.M. Wilsmore from Chemistry became honorary directors of the War Munitions Supply Company of Western Australia.(9) At the end of the year they went to the United Kingdom to help with munitions production, with Wilsmore later returning to Perth but Whitfeld staying on. In 1916 he began work as an assistant inspector of steel in the United States and two years later he worked on nitrogen fixation for the British Ministry of Munitions. Indeed, Whitfeld was absent for so long that the Senate debated whether or not his contract should be renewed. They argued that the cost of Whitfeld's professorial wages could be saved if his contract was not renewed and pointed out that he had not communicated adequately with the university while he was engaged in his war work.(10) His contract was eventually renewed, but the Engineering staff were seriously understaffed throughout the war and the situation was only marginally improved with peace.

In Whitfeld's absence, Tomlinson became the acting professor. In addition to the significant loss of teaching staff Tomlinson had to negotiate funding difficulties and shortages of materials caused by the war. The University of Western Australia was a free university, which did not charge students fees. Instead, the University relied on the West Australian government for grants but these were rarely felt to be adequate. In May 1915 the Senate had to allocate an extra £300 to Mining and Engineering 'to carry on this year's work'.(11) In July that year, the Faculty also requested a grant of £10 000 for the 'erection and equipment of certain buildings at Crawley', a grant which, given the war conditions, was not forthcoming.(12)

The war also had an impact on internal arrangements of the School. In 1915 the structure of the Bachelor of Engineering was changed radically. The degree was temporarily suspended and a three year Bachelor of Science (Engineering) replaced it. Students could specialise in Civil, Mechanical, Electrical or Mining and Metallurgical Engineering.(13) The shortened degree graduated competent engineers needed for the war, and it was intended that those who completed this shortened degree could complete the Bachelor of Engineering after the war.

Although all these changes were probably necessary in the war conditions, they were not popular with the students. In 1918 a group of Engineering students sent a letter of complaint to the Vice Chancellor, stating that they were 'greatly discouraged' and suffering from 'a general feeling of unrest, dissatisfaction and instability'.(14) They complained that some lectures and laboratories had not been staffed and they called for the reappointment of Fraenkel whose contract had recently expired. Their complaints were investigated and declared to be ill-founded, but their recommendations were in fact implemented. Fraenkel's contract was renewed and in 1919 the Vice Chancellor was able to send a circular letter to all Engineering students informing them that the five year Bachelor of Engineering degree had been restored.(15)

For the first half dozen years of fits life the Engineering Faculty was unable to implement coherent policies. Rather than developing its own vision of the purpose of the Engineering Faculty, it was forced to react to the exigencies of political and economic factors. Yet these early difficult years saw the genesis of ideas which were to shape the Faculty into the next decade, as they did the university itself. Very little material dealing explicitly with the philosophies of the Engineering Faculty at this time survives, but the discussions at the early meetings of the Faculty suggest an unspoken assumption that the university should offer higher education and be quite distinct from the existing technical colleges. At the very first meeting of the Faculty there was a debate about whether courses at the Kalgoorlie School or Mines and the Perth Technical School should be given 'recognition'.(16) Although it was decided that students could be given credit for previous work at these institutions, any suggestion of 'cooperation' with the Perth Technical School was vehemently rejected in 1918. The university staff stressed that such cooperation would be 'unworkable' as Perth Technical School was 'essentially a trade school'.(17) These early discussions did not explicitly define the role of the university, but they implied that the University of Western Australia was to provide something quite distinct from mere technical training.

These ideas underpin the reminiscences of Marcel Aurousseau, a member of the Science Faculty at this time. Writing in 1928, Aurousseau noted that:

The discomfort of things, rather than of persons, was extreme, but we were able to deliver our lectures, conduct our practical classes, hold our field excursions, and to carry on a certain amount of research work, in a manner worthy of our main purpose. That purpose was, I take it, to educate as bachelors, masters, and doctors, all those in the State of Western Australia, who should present themselves and prove, to our satisfaction, their fitness; and, in a broader way, by our own spontaneous efforts, to diffuse knowledge in, and increase knowledge of, the State of Western Australia. At least, that was how it seemed to appear to my colleagues and myself though nobody ever told us that so much was expected. It was a personal feeling, uttered in our doings.(18)

Aurousseau saw the university as offering the opportunity for higher education and research, but this role was not overtly defined. The precise nature of this higher education was developed in more explicit detail in the following decades.

The Twenties and Thirties

With the war behind it, the Engineering Faculty began to expand. Despite some financial difficulties and inadequate staffing, the Faculty increased in size and set up a permanent building at Crawley. Perhaps more importantly, the Engineering Faculty also began to develop a coherent vision of what students should gain from university education. Under the direction of Whitfeld, now returned from his war service, the Engineering degree combined technical instruction, practical work and general education, self-consciously intended to make graduates into 'cultivated citizens' who could express themselves and who understood the humanities.(19)

During this period the restored five year Bachelor of Engineering was honed. The degree involved two years of general instruction in Science and the Arts and three years of work in Engineering. Students could specialise in Structural, Mechanical, Electrical, Mining, Metallurgical and Chemical or Architectural Engineering.(20) The smaller majors all were under the supervision of Whitfeld, while Tomlinson ran Civil and Fraenkel ran Electrical.(21) The course emphasised the fundamentals of Engineering. In 1916 Whitfeld had written that 'the main thing is to teach Engineering principles and not to try to give specialised knowledge, which must necessarily be mainly obtained in post-graduate practice' and, with Whitfeld at the helm, this philosophy remained paramount in the following decades.(22)

Practical work was emphasised in the later years of the degree programme. As a result at least one and possibly two years of the Bachelor of Engineering in Mining and Metallurgy were undertaken at the Kalgoorlie School of Mines.(23) Further, it was expected that students would undertake work experience in the long vacations of their third and fourth years. The Faculty regulations stated that:

The regular work at the University in each session in Engineering will end in September in each year, and during the six months' vacation from September to March every student will be required to obtain employment in some approved workshop, mine, or other engineering works or offices, and shall present a certificate that he has been so employed before entering upon the next year' course of study.(24)

Further, students were required to complete a certificate in first aid in order to be admitted to their degrees.(25) Such practical instruction distinguished the Bachelor of Engineering at the University of Western Australia from the degrees offered at interstate universities which were shorter and involved less applied work.

The Bachelor of Engineering also included some instruction in the humanities. The approved timetable for the 1928 Bachelor of Engineering, for example, included at least two courses from the Arts group, nine courses from the Science group, thirteen from the Engineering group and four from the Professional group of technical subjects.(26) This 'general education' was clearly seen as one of the strong points of the Bachelor of Engineering, a perception also held outside the university.(27) When the surveyors of Western Australia suggested that a course in surveying could be added to the Bachelor of Engineering in 1924, they stressed the need to provide surveyors with a 'wide general knowledge'.

There seems to be a general feeling amongst surveyors that a surveyor should possess not only great practical skills and accuracy in his work, but also a wide general knowledge such as a University is supposed to provide.... [T]he duties of a surveyor, no less than those of the Engineer, the architect, the lawyer or the doctor, require the highest grade of professional training.(28)

Although a major in surveying was not established until 1926, this letter highlights the combination of practical skills and broad liberal education which the Engineering degree encompassed in the 1920s and 30s.

Whitfeld had always argued that the Engineering course should develop 'cultivated citizens' as well as competent engineers.(29) In 1928 he argued that:

It is, of course, desirable that engineers should be able to use correct English, but I think it is even more desirable that they should acquire the habit of thinking about subjects other than engineering, and taking an interest in general movements of thought.(30)

He himself was both an excellent engineer and a liberally educated man. In fact, rumour suggested that Whitfeld became the Professor of Engineering in 1913 only because the Senate would not make Classics a Chair.(31) He had graduated from the University of Sydney with degrees in both Arts and Engineering and he was interested in the Classics all his life. In 1907 those working at Black Range mine at Sandstone said that he was 'not a bad sort of bloke; in fact, he was rather a good sort of bloke to work for, but rather odd, for he was reputed to carry a pocket edition of Horace about the Mine.'(32) In later years he placed the bust of Socrates in front of Winthrop Hall.(33)

Whitfeld became the first permanent Vice Chancellor of the University of Western Australia in 1927, at which point effective control of the Faculty of Engineering passed to I.I. Bowden, a man who shared Whitfeld's values and continued to emphasise the cultural education of Engineering students. The Engineering regulations at this time included a provision that students were required to read 'a certain selection of books embodying modern thought in literature, economics, etc.' during the long vacations.(34) The importance of the 'cultural education' of Engineering students was again stated in a discussion at a Faculty meeting in 1937. A Mr Hood 'remarked that it was obvious, from coming into contact with Engineers, that a cultural background outside the sphere of practical engineering was needed by all students and that the higher they rose in their profession the more obvious became this need.' (35) Speaking as Vice Chancellor, Whitfeld reiterated that 'everybody should be given a general outlook on civilisation.'

The structure of the Bachelor of Engineering was apparently a successful one with its combination of practical experience, technical instruction and liberal education. Hugh Rodgers, a graduate from 1938, recalled the nature of the course fondly.

The U.W.A. B.E. of the 1930s was diverse and much oriented to the Practical.... [Nonetheless] a highlight for us was compulsory First Year English.... A result of all this vacation work was we had something of a 'sandwich' Degree much favoured then by some English Technical Units. An outworking of this practical approach was U.W.A. graduates had a 'hands on' attitude....(36)

R.J. Fitch, a graduate from 1932, also stressed the well-rounded nature of the Bachelor of Engineering.

The course was primitive, being very short on engineering theory but long on humanities; it did none of us any harm. Indeed, our being pitched into the depression immediately after graduation was less of a trauma because of the hands-on nature of our studies.(37)

Certainly, the numbers of Engineering students increased steadily throughout this period. In 1920 there were 37 Engineering students among the 332 scholars on campus; in 1930 there were 85 among the 606 students at the University of Western Australia. In 1923 Whitfeld compiled a report on the employment of Engineering graduates in which he argued that 'there is certainly an opening for highly qualified engineers in Western Australia'.(38) His figures showed 19 graduates working for the West Australian government, 3 working for the Perth City Council, 5 working for private companies in Western Australia and 13 'gaining experience abroad'.(39)

Despite the high level of approval for the course, the Faculty still faced certain difficulties. In the 1920s and 30s the University expanded greatly and moved to the Crawley campus, but it was still faced with inadequacies in funding and staffing and problems with leadership. While the number of students increased, staffing, housing and equipment did not keep pace with these changes.

Engineering faced particular problems of its own. Ironically, the Faculty was troubled by the fact that Whitfeld had become the first permanent Vice Chancellor in 1927, leaving his position as Professor unfilled. Bowden had become the head of Mechanical Engineering in 1926 and O.F. Blakey, who came to the University of Western Australia in 1927, headed Civil Engineering.(40) However, there was no overall head of the Engineering Faculty and interdepartmental stresses could not be easily resolved. Such interdepartmental squabbling-particularly over the allocation of funds-was not resolved until all three departments were headed by Professors in the 1950s.

In addition, there were recurring difficulties in securing sufficient funding. The grants provided by the West Australian government were rarely viewed as adequate. The 1924 budget for the Engineering Faculty was £3724 which included just £200 for equipment. The Faculty commented that 'this sum [was] inadequate and that at least £1000 per annum [was] necessary to provide equipment for the Engineering School.'(41) Of course, the Faculty finances only deteriorated still further at the end of the decade with the Great Depression. Whitfeld wrote in 1932 that '[t]his University has been hit very heavily by the depression. Our income is largely dependent on the Government subsidy, and has therefore been reduced about 20% all round.'(42)

Although the budget had risen to £5498 by 1930, this allocation still did not adequately cover the costs of laboratories and equipment.(43) Indeed, in 1936 a report compiled by the Faculty pointed out that lack of funding meant that laboratories were not being properly supervised.(44) Two students had been seriously injured in the laboratories and the importance of securing more funding for extra staff was undeniable.(45)

Your Committee considers that the students are at present being submitted to excessive risks due to the fact that the nature of the laboratory work calls for a greater amount of supervision than the present staffing can possibly provide.... A very grave responsibility rests on any authority which fails to provide for such additional supervision as would enable the laboratory work at present undertaken to be carried out with reasonable safety.(46)

Yet the report had little impact and the Faculty continued to struggle with shortages of equipment and inadequate staffing.

Against this picture of inadequate funding and austerity came the bequests from Sir John Winthrop Hackett and Robert John Gledden. In 1926 the University of Western Australia began to use the money which the first Chancellor had bequeathed to fund scholarships and erect buildings. In 1927 Gledden gave an estate worth £60,000 to the University to fund travelling scholarships in the 'applied sciences, more particularly relating to surveying, engineering or mining or cognate subjects'.(47) At first, the money was used to fund interstate and overseas travel for individual students or members of staff, but after World War Two groups of students began to be taken on what were known as the Gledden tours. The Gledden bequest thus served the important purpose of reducing the isolation of the Engineers in Western Australia.

In the 1920s the Engineering students also came into contact with other students at the University of Western Australia on a more regular basis. The Senate had spent a great deal of energy arguing about the most suitable permanent site for the university-they were torn between King's Park, Government House and the Crawley campus-but between 1927 and 1932 the entire university moved to Crawley to join the Engineers. As part of this process, the Engineering Faculty also gained a new building, constructed in 1927 by the Public Works Department of the State government. The building, which cost £8825 at the time, still stands at the university, now acting as the tavern. R.J. Fitch recalls that:

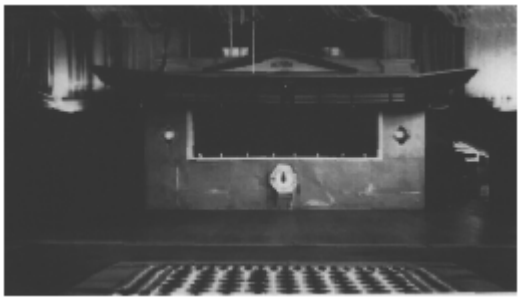
[t]he facilities were less than primitive. Shenton House, with its accompanying galvanised iron sheds standing knee deep in wild oats-the latter posturing as laboratories-constituted the School's entire establishment until mid 1927, when the two story brick building alongside Shenton House was opened.... To all intents and purposes laboratories did not exist. There were a couple of boilers from the former Subiaco power stations, and an assortment of derelict items of machinery which we students tried to assemble and mount on concrete foundations which we had constructed previously by hand.(48)

This building was partially constructed by the Engineering students and Fitch recalls that in 1930 'we spent one afternoon a week mixing concrete and laying down floors in the laboratories'. Indeed, even a graduate from the 1940s, F.J. Buchanan, remembered that 'the various Departments were located in pretty crude out buildings much in the manner of an old fashioned farm, and one often thought the term laboratory was a gilding of the lily.'(49)

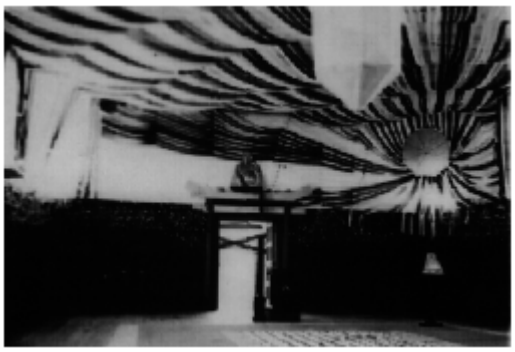
Shenton Park Engineering Building

In this period of expansion, the Engineering students began to identify as a special group on campus and to organise shared activities.(50) The first Engineering ball had been held in 1919 and these had become an annual fixture, after 1921 being organised by the University Engineering Club. Decorations for the top floor of Shenton Park for the balls became increasingly complex as pictures from the late 1930s indicate. Profits from these social

activities were used to fund actions of particular significance to the students. One of the first items paid for was the Hancock memorial window in Winthrop Hall and the Engineering library was also established with money provided by the UEC.(51)



UEC Ball, late-1930s



UEC Ball, late-1930s

Whitfeld, whose vision for Engineering had been so important, died in 1939, on the eve of the war. His death came at the end of a period of consolidation. Despite the financial problems of these early decades, the Engineering Faculty had gained a more suitable building and begun to offer the Gledden travelling scholarships. Following the disruption of World War One, the university had expanded rapidly and was now based at the beautiful campus at Crawley. Much of this progress was to stagnate with the outbreak of the next war.

World War Two

The impact of the second world war on Crawley campus could not be ignored. Troops were stationed on campus and students were enlisted. A graduate who enrolled in 1946 remembers of the immediate post-war era that:

There had been an American Air Corps base... on Crawley Bay, but they had by then departed and vacated their austere barracks... on the site of the present Currie Hall.... There was still a remnant of the Netherlands navy occupying the building which later became the engineering office, next door to Shenton House, (this was early 1946) but they moved out by the end of the year and the engineering school reclaimed the drawing office.(52)

When they reoccupied the buildings vacated by the army in 1945, the Faculty asked for the military to pay for the costs of cleaning up.(53)

Engineering was perhaps affected more directly by the war than were other faculties. Once again the Faculty had to deal with disproportionate shortages of staff, and special accelerated

courses were also re-established. At the Vice Chancellor's conference in 1942 all the Australian universities agreed to the proposal of the Commonwealth government and the War department that Bachelor of Engineering degrees be shortened to three year Bachelor of Science degrees with majors in Engineering.(54) A three year Bachelor of Science (Engineering) was therefore established at the University of Western Australia 'for the duration of the War'.(55) The practical components and the liberal education were removed to make a streamlined course. War priorities did not include Whitfeld's vision of the 'cultivated citizen' Engineer. This shortened degree produced qualified engineers for military service as quickly as possible and after the war, it was intended that it could be expanded to a Bachelor of Engineering with further study.(56)

The Engineering staff were overworked during the war years and anticipated little relief even after the return of peace. As early as 1943 the university began planning the expected 'post-war influx of students'.(57) The university estimated that Engineering would experience a fifty per cent increase in students, but the Faculty argued that even this figure was probably an underestimate. Most Australian troops had fought in the Pacific region and, as a result, the Faculty believed that fewer men would in future travel to Europe for a university education, as they had done after the previous war. The Faculty also noted that 'the present war is very largely an engineering war' which would 'probably induce' more men to study Engineering after the war. As it turned out, the Engineers were correct in estimating record enrolments in 1946. Between men returning to war-interrupted studies, men upgrading their Bachelor of Science degrees to Bachelor of Engineering degrees and students fresh from school, the Engineering Faculty was stretched beyond capacity.

The Engineering Faculty was met with a situation which they described as 'almost chaotic' in regard to building, staffing and equipment.(58) They acknowledged that they had been 'over optimistic' in thinking that they could handle teaching with existing levels of staffing and at least three more full time assistants in Structural, Mechanical and Hydraulics Engineering were demanded. In 1944 Dean Blakey wrote to Vice Chancellor Currie on the subject in the strongest possible terms. He had worked at the university, he said, for seventeen years in the hope of seeing Engineering develop into 'a proper professional school, both with regard to staffing and also buildings and equipment.'(59) Instead, he had seen the increase in number of students accompanied by diminishing grants and resources.

In the last year or so, much lip service has been rendered to University Education and, as a war activity one has carried on under many difficulties at a reasonably high pressure.... I have reached the conclusion that it is... a physical impossibility for one man to handle this work alone (even if the partial assistance of two senior students is available) and that full time assistance is definitely necessary.... I have realised that the University Administration is and has been in difficult circumstances and hence have attempted to carry on faithfully even though I have not even had the satisfaction of adequate remuneration. It is frequently stated that University Standards must not be lowered, but under the circumstances, our Standards must have been and must continue to be lowered whilst such a state of affairs exists.

The letter ended with a reiteration that Blakey's 'physical strength [was] not capable of continuing without assistance' and a further plea for increased provision for Engineering.

Blakey's letter represents a watershed in the development of the Engineering Faculty. If standards were sacrificed the war, so too was the liberally-educated engineer. But while standards were resurrected in the following decades, Whitfeld's vision was gone forever.

The Post-War Years

The decade after World War Two heralded the beginning of a period of positive expansion for the Engineering Faculty which has continued into the 1990s. Over this period, the Engineering Faculty began to emphasis research to a greater extent and to develop closer ties with industry. The Bachelor of Engineering was restructured to reflect these changes and the new priorities of the post-war. These changes, combined with increased funding and staffing, meant that the Engineering Faculty developed significantly in the 1950s.

In 1947 a sub-committee met to discuss restructuring the Bachelor of Engineering degree. They decided that the revised degree should include more technical training but, though it had its supporters, the liberal education which had hitherto been a fundamental aspect of the degree was henceforth to be abandoned.

The sub-committee was of the opinion that the proposed course would be sufficiently broad and of diverse interest to be expected to produce a well rounded man.... Various members had expressed the views that some purely liberal subjects might be included in the fourth or fifth years, but on the discussion of the proposed course later, it was found impractical to include such specific or optional courses without overloading the student or depleting technical requirements necessary for his fundamental professional training.(60)

Although the possibility of including a grounding in the humanities in the Engineering degree was discussed at various points in the following decades it failed to win support. In 1955, for instance, it was suggested that 'a special course in English Expression for Science students' could be run, but that it was 'impractical at the present juncture'(61)

Instead, the array of technical subjects was expanded. By 1955 the University of Western Australia offered both a Bachelor of Engineering and a Bachelor of Surveying as well as Masters in Engineering and Engineering Science and a doctoral degree in Engineering.(62) Majors in Surveying and Civil, Electrical, Mechanical and Mining Engineering were available.(63) To improve the teaching in these areas, new staff were hired. In 1947 Blakey had became the second Professor in the Engineering Faculty, taking the chair in Civil Engineering which passed to Keith Leo Cooper in 1953. In 1958 and 1959 Dr D.J.F. Allen-Williams and Dr Alan Billings became the chairs of Mechanical and Electrical Engineering respectively.

Mining, although an important specialisation for many Engineering students, was not given a chair and did not become a separate department. Students majoring in Mining continued to study their first three years at the University of Western Australia and the final two years at the Kalgoorlie School of Mines.(64) The regulations noted that:

These courses must be taken at the School of Mines, Kalgoorlie. It is recommended that the course be spread over not less than two years of part-time study, i.e., that the candidate should become engaged in approved mining employment...(65)

In 1958 the Engineering Faculty renewed its affiliation with the School of Mines of Western Australia for another five years.(66)

At the same time the university itself began to change directions, tentatively emphasising research as well as teaching. Although the Engineering Faculty had undertaken some research in previous decades, its primary work had always been teaching. In the 1950s, for the first time, links between the university and industry were explored.(67) In 1952 the Head of Mechanical Engineering, B. Downs, wrote to the Vice Chancellor 'It is my belief that the University should

seriously consider the relationship between the Engineering Faculty and the development of local secondary industry.' (68) However, these links between the University and Australian industry were only established slowly. As late as 1960 the suggestion that research should be a priority could still be dismissed.

There was considerable discussion on the role of research in the Engineering courses and it was felt that all the better students should not be directed into research if they intended in their future careers to take up jobs where work of this kind would not be available.(69)

About this time too, the lack of funding which Engineering had long experienced finally began to be resolved. In 1957 K.W. Taplin, the Head of Electrical Engineering, wrote of the 'difficult situation' of the Engineering Faculty and the need to find 'ways and means' to hire more staff from overseas and to send the locally-trained staff on interstate professional training. He made quite scathing remarks about the state of the Engineering Faculty, but ended by reiterating his hope that adequate funding could be secured to improve the Faculty.

It is an obvious fact that the present standing and reputation of the School of Engineering in this University is not as high as it should be if one considers that it has been established since 1913 when the University first began, and also considering that its students form an important fraction of the total under-graduate population of the University. We, who endeavour to carry on its work at the present time, have inherited a state of affairs where economy and expediency have coloured our point of view in all aspects of our work, teaching, research, and the maintenance of necessary profession contacts with Industry and Government work.... It is our hope that the Committee of Enquiry will be able to recommend financial support for the staffing of the Departments of the School of Engineering, to enable us to have a new deal and to begin an era of vigorous activity, where the loyalty and hard work of the present staff will be rewarded and the bringing in of new staff will raise the School of Engineering to the condition and status which we know it should and must have.

As a result of this and other approaches, funding did improve over this decade. Further, the Gledden bequest began to be used on a more systematic basis to meet some of the priorities identified by Taplin. Annual Gledden tours were set up which took groups of the brightest students to view interstate and international engineering works. All these changes combined to bringing the University of Western Australia into the international community of scholars. The appointees to the new chairs had been educated overseas or interstate-Cooper at the University of Melbourne, Allen-Williams at Cambridge and Billings at Bristol. Moreover, for the first time, the university began to attract reasonable numbers of students from overseas. Although there had been discussions in Faculty meetings about international students as early as the 1920s and 30s, the influx of overseas students really began after World War Two.(70) From 1951 onwards, overseas students, particularly students from South East Asia, were educated in Australia under the Columbo Plan.(71)

The post-war years were, then, a time of expansion for the University of Western Australia. The Engineering Faculty began to emphasise research and ties with industry and the Bachelor of Engineering degree changed to reflect these new values. Funding became more reliable and, as a consequence, new, internationally-educated staff were taken on. Both the research and teaching of the University were consolidated and improved.

The Sixties and Seventies

In 1961 the new Engineering building was opened. This building could take 400 students and house the three departments of Civil, Mechanical and Electrical and Electronic Engineering. With new, state-of-the-art apparatus purchased to equip the building, the Engineering Faculty became one of the foremost in Australia.

The Engineering Faculty had been agitating for a new, more appropriate building for years. As early as 1949 the Faculty had proposed:

'(i) that agreement be quickly reached and approval obtained for the layout of a new permanent Engineering School; (ii) that no further temporary buildings be erected, but that all new buildings be permanent structures...'(72)

By the late 50s 'a complete new Engineering school' designed by A.E. Clare and G. Finn was 'under construction'.(73) The new building was planned for future growth and was made to hold 400 students although enrolments at that time were only around 250 a year. Despite this precaution, the building was overcrowded by the mid 1970s and the new Electrical and Electronic building was set up close by. Although there were inevitable complaints that there was 'insufficient' money to equip it properly, the Engineering building was 'perhaps the most advanced in Australia at this time'.(74)

The 1961 Engineering Building

The building had cost £750 000, most of which had been provided by a grant from the State government although private grants had also been made. That these donations were appreciated cannot be doubted; the notes for the 1961 opening ceremonies listed guests who were 'Prize and Fellowship Donors', and a hand-written amendment described them as 'Generous Benefactors!' (75) The building was officially opened on May 19th 1961 by Charles W. M. Court, Acting Premier and Minister for Industrial Development. Despite some problems with the catering and rain, the ceremony was regarded as a success!

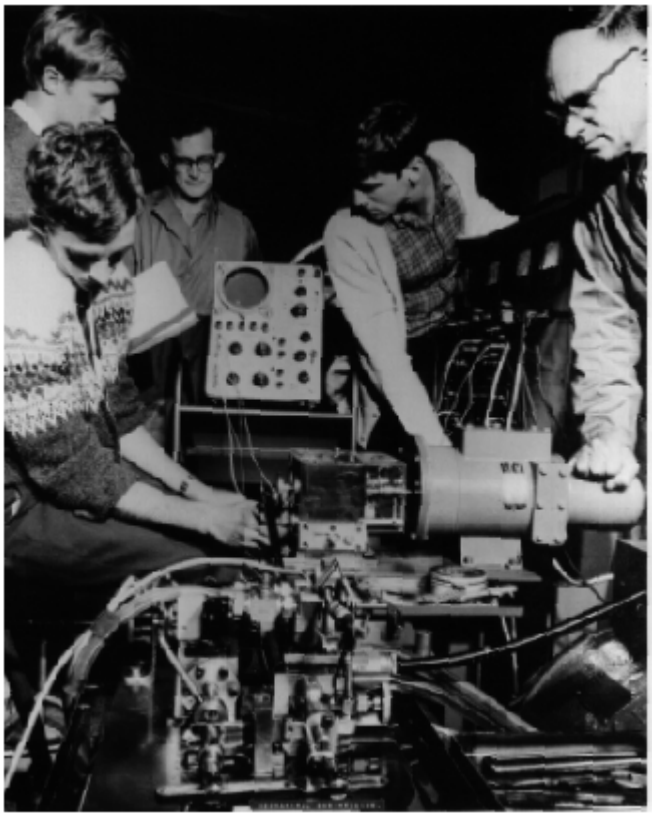
Another significant change in this period was the introduction of the shorter four year course.(76) By the 1960s the University of Western Australia was one of the few tertiary institutions in Australia to retain five year Engineering degrees. Though comparisons with other Australian and international universities showed that the standard of the final year graduates

was high, it was argued that it was unnecessarily so; and of course the students suffered a disadvantage in that it took them an extra year to complete their degrees. The five year Bachelor of Engineer degree was revised to a four year degree between 1966 and 1968.

The course restructuring minimised the number of subjects taught in the Faculty of Science and to reduce the years of Engineering common to all the majors from two to one. Additionally, practical requirements such as the six months of work in the penultimate year and the first aid certificate were removed from the course. Although the Faculty recorded some 'regret' at omitting practical work from the degree, they noted that they would be able to teach more students in the four year course and that this was the 'modern' structure of Engineering degrees.(77)

At the same time, the Bachelor of Engineer began to include new technologies. In 1974 a questionnaire on the use of electronic calculators was administered by the University Engineering Club.(78) In 1972 the Curriculum Committee recommended the proposals of the Head of Electrical and Electronic Engineering that a subject entitled 'Computer Technology' should be introduced.(79)

The Engineering Faculty continued to emphasise the importance of research and to incorporate the research and industry-based interests of its staff into teaching. In Civil there was work on concrete, granular soil and timber; Mechanical Engineers studied lubrication, air flow, heat transfer and air gauging of surface finishes; in Electrical and Electronic there was work on thin film technology and band-width compression. The Engineering Curriculum Committee was founded in 1963 to consider the implications of the Robbins and Ramsay reports on Engineering education in Australia. The Higher Degrees Committee was established in 1962 and oversaw the increasing number of postgraduate students in the Faculty.(80)



Mechanical Engineering Students, 1960s

Unfortunately, some areas of collaboration with industry were not continued. The Bachelor of Engineering majoring in Mining was cancelled in the 1960s despite protracted negotiations with the Kalgoorlie School of Mines. The major in Mining was described as 'temporarily suspended' in the Faculty handbooks between 1966 and 1987. Similarly, two separate attempts to introduce a major in Chemical Engineering were sponsored by local industry but both were unsuccessful. As early as 1961 the Faculty had recommended setting up a major in Chemical Engineering, but the proposal could not get through Senate.(81) The emphasis on incorporating research into teaching was, it seems, only intermittently successful.

Nonetheless, the revised four year degree was a popular one. The number of students increased steadily, reaching 600 in 1970 and 750 by 1980. The Engineering Faculty continued to attract international students, with twenty two per cent of the 1972 students coming from overseas.(82) The Engineering Faculty also began to enrol women in the late 1960s. The first female graduate was Miss R.K. Clarke, a Civil student, who completed her degree in 1970.(83) However, the number of female students increased only very slowly. By 1980 there were 750 women studying Engineering at tertiary level in Australia; at the same time there were 21 845 men. Women made up only 3.3% of female Engineering students by the end of the 1970s.(84)

The Fourth Year Civil Engineering Class of 1970

Further, the University Engineering Club appears to have had some difficulty in representing the interests of female students. By the late 1960s, the UEC had handed over its collection of books to the University library where they were set up in the Science Reading Room and concentrated on organising the social life of the Engineering students. This change in focus is apparent in the decision to move from publishing *Non Loqui*, a journal focussing on Engineering in general, to *Bend Sinister*, a magazine advertising the social events of the Faculty. *Bend Sinister* was clearly premised on a male readership and the social activities organised by the UEC-such as viewing female strippers-also presumed that the normative Engineer was male.

In the 1980s and 1990s there was a move to a wider and more diverse conception of Engineering, one which offered a variety of majors and presumed differences in interest among Engineering students. This change built on the advances in technology, equipment, housing and staffing set up in the expansion of the 1960s and 70s.

The Eighties and Nineties

Towards the end of the 70s the Engineering Faculty were concerned with the 'image of Engineering' and with the difficulties of attracting the best students.(85) The Faculty minutes record the belief that Engineering was seen as 'ecologically harmful' and 'perhaps too hard' but '[n]evertheless the meeting felt it was vital that a strong effort be made to get the message across to school pupils that Engineering as a rewarding and worthwhile profession, in the hope that the brighter students might be attracted into the Engineering courses.' The Faculty met this challenge by embracing new technologies and by broadening the number of streams of study available in the Bachelor of Engineering.

The Engineering Faculty were the first at the University of Western Australia to accept the importance of computers and digital communication.(86) In 1985 the Departments of Civil and Mechanical Engineering sponsored a laboratory with fifteen personal computers available to students. In 1985 a new subject, Computer Technology 105, was introduced at first year level and subjects at higher levels were revised to include information on digital technology. This new subject was seen as a way of adapting the Engineering course to the changing technologies of the late-twentieth century.

In speaking to the proposal the Head of the Department of Electrical and Electronic Engineering emphasised the reasons for the proposal. A substantial change in the needs for the education of Electronic and Electrical engineers in today's environment was becoming more and more evident and the Department had an obligation to adapt to this changing environment.(87)

Other, major changes to the Bachelor of Engineering were made in the late 80s and 90s, all aimed to make the degree more responsive to the changing roles of engineers in Australian society. In 1994 Engineering and Mathematical Sciences amalgamated into one Faculty. This Faculty now houses the School of Engineering and the School of Computer Science and Mathematics. First year Engineering students choose to specialise in either the Electrical and Electronic and Information Technology stream or in the Civil, Environmental, Material or Mechanical Engineering. In later years they can specialise in Civil, Electrical and Electronic, Environmental, or Materials and Mechanical Engineering.

The new major in Environmental Engineering was established in 1990. The departmental mission statement notes that:

The department aims to produce graduates who can design solutions to environmental problems by applying scientific and engineering principles. The focus is on applied mechanics and an understanding of the fundamental processes.(88)

This new department was headed by Professor Jorg Imberger and specialised in coastal Engineering, hydrology, environmental fluid dynamics and hydrological dynamics. These specialisations follow up on work carried out at the University of Western Australia in the 1960s, but places this work within the context of a broader understanding of environmental factors.(89)

Further, joint degrees were introduced for the first time in 1988. Engineering degrees could be combined with Science, Commerce, Computing, Mathematical Sciences and Asian Studies. The joint degrees tried to cater for student demand for increased diversity; they followed on from the introduction of such combined degrees in Law and Commerce. These fundamental

changes improved the Bachelor of Engineering, offering a wider variety of choices to students and producing graduates with a range of specialisations.

Such changes in the structure of the Bachelor of Engineering are mirrored in changes in the Engineering student body. In particular, it is striking that the number of women has increased dramatically in the past decade. In 1998 there are 346 female students among the 1713 students enrolled in Engineering degrees: 20% of the total student population.(90) At the same time, female students are concentrated in the joint degrees and in the 'softer' degrees such as Environmental Engineering. Women make up 80% of the students undertaking the joint Bachelor of Engineering and Bachelor of Arts (in Asian Studies); they are 56% of the Environmental Engineering students; and 27% of the students in the combined Engineering and Commerce degree.(91) The 'hard' majors and pure Engineering degrees remain male preserves.(92)

These changes in the profile of Engineering at the University of Western Australia are in line with the recommendations of the National Position Paper for Women in Engineering produced for the 1996 Review of Engineering Education.(93) The very first recommendation of this report was that '[e]ducational institutions must support the development of an inclusive culture', a goal to be met by 'improv[ing] the participation and success of women in engineering education' and 'creat[ing] inclusive educational programs that cater for the diverse range of interests, skills and abilities to enrich the future engineering profession.'(94) The fact that women are concentrated in the joint degrees and new majors suggests that these recently introduced streams are particularly attractive to female students. The increasing diversity of the Bachelor of Engineering reflects the increasing diversity of the student population.

The University of Western Australia has one of the highest proportions of female students among contemporary Australian universities. This is, in part, the result of collaboration with programmes such as Women in Science and Engineering in 1988. As well as encouraging high school students to select the sciences, WISE oversees the mentoring project set up in 1996.(95) Yet the numbers of women studying Engineering remain far lower than in any other sphere of University education. While enrolments of women in Engineering have trebled over the past twenty years, Engineering has not had the same success in achieving gender parity as have other faculties. The number of female students in Science and Law was also low in the 1970s but have since risen to represent half the students. Engineering alone continues to lag behind.

Further, the masculinist culture of the University Engineering Club continues to be represented as the 'dominant culture' of the Engineering student body.(96) Publications such as *Bend Sinister* are dominated by explicitly misogynistic material and defensively anti-feminist humour.(97) On a more positive note, the UEC have recently returned to their 'professional' role and have established the University of Western Australia Young Engineers association. The UEC thus currently have two arms, one organising the social life of the Engineering students and the other representing the interests of young Engineers at the Institution of Engineers.

This period also saw changes to the research profile of the Engineering Faculty. The University's mission statement stresses the importance of both teaching and research.

The University's primary mission is to advance, transmit and sustain knowledge and understanding through the conduct of teaching, research and scholarship at the highest international standards, for the benefit of the international and national communities and the state of Western Australia.(98)

The goals of the Engineering Faculty are even more explicit in the description of the links between teaching and research.

To establish a balance between teaching and research and between the numbers of undergraduates, postgraduates, postdoctoral fellow and junior and senior academic staff which ensures excellence in teaching and research, with an emphasis on research and strong links between teaching and research.(99)

As a result, the different departments in the Engineering Faculty tend to teach in areas of research excellence. The Electrical and Electronic Engineering has 35 members of academic staff as well as several research fellows. Electrical and Electronic specialises in artificial intelligence, parallel computing and visual communications. It runs the VLSI (Very Large Scale Integration) laboratories and the Centre for Intelligent Information Processing Systems. Materials and Mechanical Engineering has 21 academic staff and specialises in robotics, tribology, computational mechanics and thermofluids. The world's first robotic sheep shearing machine ORACLE was developed by the Mechanical Engineers at the University of Western Australia in the early 1980s. The Environmental Engineering department is the smallest and has only 9 academic staff. Despite being the foundation department, Civil Engineering is now only marginally larger than Environmental Engineering and has 12 academic staff. Civil Engineering specialises in geodynamics and on exploring the movement of contaminants through clay.

James Trevelyan and Roy Leslie with ORACLE, 1980

The Engineering Faculty also host several successful research centres which collaborate with industry. The Centre for Oil and Gas Engineering was established at the University of Western Australia in 1995. It was set up collaboratively by Murdoch University, Curtin University, the University of Western Australia and Woodside Petroleum who provided $1 000 0000 over five years to promote 'industry-focussed research'.(100)

In the 1980s and 1990s the Engineering Faculty has strengthened its research profile and enhanced links with industry. The teaching of the Faculty reflects this change and also mirrors the increasing diversity of the student body. The Bachelor of Engineering is now a broader degree with a wider range of potential specialisations, attracting a more diverse range of students.

Graduate Destinations

Most Engineering graduates from the University of Western Australia work as consultants or in manufacturing and mining. The most recent figures suggest that, regardless of the area of specialisation, students from the University of Western Australia move into well-paid work after graduation and that some graduates have outstanding careers in consulting and manufacturing.

The employment statistics for the 1996 Engineering graduates are the most recent to have been collated. These suggest that graduates with a Bachelor of Engineering degree earned a mean of $33 789 in their first year at work.(101) Graduates with an Honours degree in Engineering earned a mean of $34 347; those who had studied Engineering and Commerce earned $35 195; and those who had studied Engineering and Science earned $36 406.

Those who had majored in Civil Engineering were mostly working as consultants for companies such as Sinclair Knight Merz, Morley Ltd., Clough Engineering, CBI Construction and Fluor Daniel. Graduates who had studied Environmental Engineering were also employed as consultants for similar companies. As well as working as consultants, Mechanical and Materials graduates often worked as process Engineers in mining and manufacturing for companies such as Hammersly Iron and West Australian Speciality Alloys. Similarly, those who had specialised in Electrical and Electronic Engineering tended to work as consultants or in manufacturing for companies such as Honeywell, Fujitsu and JNA Telecommunications.

Some University of Western Australia Engineering graduates have gone on to outstanding careers in these areas. To list just a few examples, Aubrey D. Hosking, who graduated with honours in 1951, headed the work on the Snowy Mountain Water Reclamation Scheme. Lance Deegan, a 1972 graduate, is the Project Manager for the proposed Derby Hydro Project. Ronald J. Fitch, who graduated in 1932 and gained a Masters of Engineering in 1949, received the Order of the British Empire for services to transport.

Others work as consultants and head Engineering companies. A. Koenig, a University of Western Australia graduate from 1970, was the Director of Energy Safe for Western Australia. Brian Hewitt, now the Chief Executive Officer of Clough Limited, was a 1966 graduate from the University of Western Australia and Maxwell J. Webb, a 1959 graduate, is the head of Alcoa. And, on a more theoretical level, George W. Taylor completed his honours degree at the University of Western Australia in 1957 and went on to do doctoral work at the University of London and to earn a Doctor of Engineering from the University of Western Australia in 1981. He is currently the chief editor of *Ferroelectrics*, the Engineering journal.

Since 1913, the University of Western Australia has provided the Western Australian community with well-qualified, highly-trained and sometimes brilliant Engineering graduates. Over the decades, the degree has changed significantly in its structure and its purpose-the vision of the Engineering degree has altered over time. The continuing theme, however, remains a commitment to excellence.

Appendices

Appendix One: The 1928 Engineering Syllabus

The 1928 Bachelor of Engineering included at least two courses from the Arts group, nine courses from the Science group, thirteen from the Engineering group and four from the Professional group of technical subjects. The approved subjects are listed below.

Arts Group - Two courses in the following subjects:

English as prescribed for students in Engineering

French I as prescribed for students in Engineering

German I as prescribed for students in Engineering

Latin I as prescribed for students in Engineering

Greek I as prescribed for students in Engineering

Economics A or B as prescribed for students in Engineering

History as prescribed for students in Engineering

Logic and Psychology as prescribed for students in Engineering

Philosophy as prescribed for students in Engineering

Education as prescribed for students in Engineering

Science Group - Nine courses from the following subjects:

Mathematics I

Mathematics II

Chemistry I

Engineering Geology I

Physics I

Applied Mathematics I

Applied Mathematics II

Engineering Chemistry

Engineering Geology II

Engineering Physics

Applied Mathematics III

Mathematics III

Biology I

Engineering Group - Thirteen courses from the following subjects:

Descriptive Geometry

Applied Mechanics

Materials and Structures I

Materials and Structures II

Heat Engines I

Heat Engines II

Electrical Engineering I

Electrical Engineering II

Surveying I

Engineering Drawing I

Engineering Drawing II

Engineering Design I

Engineering Design II

Professional Group - Four courses from the following subjects:

Architecture and Building Construction

Astronomy and Geodesy

Materials and Structure III

Heat Engines III

Electrical Engineering III

Water Supply and Irrigation

Metallurgy and Assaying A and B

Mining A and B

Municipal Engineering

Railway Engineering

Works Management and Law for Engineers

Surveying II

Hydraulics

Military Engineering

Appendix Two: The Theft of the Science Banner

The theft of the Science banner in the 1940s was recalled by several graduates. Two versions of the story follow.

'There has always been much rivalry between the Science and Engineering students. One year the engineers determined to steal the science banner at the graduation ceremony, and let this be known. Consequently, the science students surrounded their banner in the procession with a group of burly bodyguards. However, the engineers had explored the architectural features of Winthrop Hall and knew that the spaces between the ceiling features were no more than chicken wire, linked with hessian (sic). One of their fellows got into the ceiling with a fishing line, cut back part of the chicken wire and, at the crucial moment, lowered the line, hooked the science banner and whisked it away to dizzy heights above the procession. Once in the ceiling cavity, the banner was quickly dropped to the ground outside the Hall where a waiting engineering athlete caught it, and raced with it to Stirling Highway, where another engineer on a motorcycle sped off with it.'

John Fall, Bachelor of Engineering 1950,

Lecturer in Electrical Engineering 1952 - 1993.

'In those days the U.E.C. emblem was entrusted to the safe keeping of one of the students, who kept it at his lodgings. One day, during his absence, to of the S.U.'s more experienced cracksmen were detailed to blind the landlady with science and filch the banner. Claiming to be Engineers,* these low types approached the unsuspecting landlady, and asked for the banner, quite truthfully explaining that it was "wanted for a Uni. ceremony." The landlady (God forgive her, for she knew not what she was doing) handed it over.....

It was not until the night of Graduation Ceremony 1942 (sic) that the Engineers found and opportunity to get revenge on the scientists.

Surrounded by an overstrength bodyguard the Scientists' banner moved into Winthrop Hall. Although they kept close to the wall and provided almost impenetrable protection on three sides, the stinkers forgot to provide an "umbrella".

An enterprising Engineer on the balcony above hooked it up with a fishing line and shot downstairs with it before the stunned scientists awoke to what had happened.'

*An obvious flaw in this legend is that even a landlady should be able to distinguish the evil countenance of a scientist, when compared with the bright honest physiognomy of an engineer!!!

Dick Wittenoom, "Emblem of the Engineers - the Battle of the Banners." *Non Loqui: Magazine of the University of Western Australia Engineers' Club*, 11, 1956, pp. 56-7.

Appendix Three: University Engineering Song

This song was current in the University Engineering Club from the 1930s to the 1950s. The last verse refers to the work of the Engineers in digging the pond in front of Winthrop Hall shortly before the opening ceremony for that building.

Long years ago to Bittern Park

Came Julius, alias Caesar,

At Cobden Bridge he beached his bark

And climbed a lofty tree, sir.

"Dear, dear," quoth he, "no road I see,

Fall in the Engineers, sir.

Review, survey, mark out and lay

A road from hence to here, sir.

Chorus:

For it is now as it was then

The Engineers they knew things,

They are the Big, Strong, Silent men

Who do not talk, but do things.

In days of yore, the Western shore

Was rude to King Canute, sir,

It rolled its waters to his feet

And wetted his best boot, sir,

"This is," said he, "too much for me.

Fall in the Engineers, sir,

Surround this shore, both aft and fore,

With docks and quays and piers, sir.

The captains and Kings depart,

As Rudyard once did not, sir,

By barge and bus, by road and rail,

By motor and by boat, sir,

By whatsoever made they cross,

Sea, Land, or Atmosphere, sir,

They cannot move a yard without

The lusty Engineer, sir.

Some time ago the Undergrads.,

A pond to build decided;

They said, "We'll toil and dig and mix,

With tea and cakes provided,

The Engineers, as is their way,

Spoke little if at all, sir;

But started right away to build

The pond beside the hall, sir.

Appendix Four: Professor Whitfeld

A photograph taken in 1993 shows the bust of Professor Whitfeld now standing in Whitfeld Court.

Statue of Professor Whitfield in Whitfeld Court

Appendix Five: The Engineering Teaching Staff, 1931

In the back row, Associate Professor Fraenkel and Professor Blakey can be seen. W.R. Baldwin-Wiseman and A.T. Bowden are seated at the front.

The Engineering Teaching Staff, 1931

These members of staff were remembered fondly by graduates of the University of Western Australia. A number of excerpts from Engineering graduates from the 1930s and 1940s are quoted here.

'A very high standard of dress was required by the Dean - Prof. Blakey - he was known to send students home to get dressed if they appeared in sandals/thongs. Ties were worn - usually the Engineering black with yellow stripes.... Some students particularly from St George's College wore gowns to lectures.'

Robert O. Cook, Bachelor of Engineering 1946.

'It was the habit of most students, during classes, to smoke profusely.... particularly [at] structural engineering lectures given by Professor Blakey, who also lit up several cigarettes. Lighting a cigarette for Prf. Blakey was a solemn ritual. He would take a fag from the packet and always put the cigarette in his mouth with the cork tip end outermost. Once striking the match to light it, would then reverse the cigarette and put the cork tip between his lips and apply the lighted match to the outer end. This ceremony was repeated on every occasion he smoked a cigarette. Towards the middle of the lecture, after about one hour, the air in the room... was just a blue haze, the smoke was so thick it was difficult to see what was written on the blackboard and I, personally, felt very drowsy and wanted to have a snooze.'

Gorden E. Randell, Bachelor of Engineering 1947.

'The headquarters of the Engineering school... [were] presided over by Professor Blakey as dean of the faculty; a kindly soul, but with a somewhat hypnotic voice which tended to induce students to nod off during his lectures. He was aware of this and as a counter attraction made a habit of always putting his cork tipped cigarettes into his mouth wrong way round, and then proceeding to light it. There always seemed to be at least one student alert enough to yell "Excuse me sir etc". It had the desired effect and the class would be alert for another 15 minutes. Fortunately he was an inveterate chain smoker.'

W.B. Kelliher, Bachelor of Engineering 1950s.

'I especially recall the unstinting assistance given to undergraduates by Professor Blakey.'

A.K. Weatherburn, Bachelor of Engineering 1935.

'The final years of the engineering degree, electrical and mechanical as major subjects were under the tutorship of Prof. Fraenkel, affectionately known as "Tater", as he always called the Greek letter 'thetha' as tater. His favourite indulgence was smoking big fat cigars. No cigarettes smoked by "Tater". Very undignified. Always a cigar during lectures and lab sessions.'

Gordon Randell, Bachelor of Engineering 1947.

'Professor Fraenkel was Dean of the Faculty and Head of the Electrical Engineering Department. He was by nationality a Dane, and when not going about his duties to the University of Western Australia was otherwise the Danish Consul for Western Australia. Or it could have been the other way about. Suffice to say that in the middle of a solemn lecture on the mysteries of electrical engineering, he would receive an urgent telephone call to advise him that one of his countrymen was in the lockup at Fremantle and that the ship on which he was a sailor could not depart without him. So having summoned a senior student to act as a tutor in his absence, away the Professor would go in the interests of justice and international relations.'

H.C. Morris, Bachelor of Engineering 1930s.

Appendix Six: Engineering Faculty Office Staff, 1931

This photograph was taken by the *Western Mail* in 1931 and shows the full staff of the Engineering Faculty at this time. The academic staff are seated in the centre and the general staff surround them. The division of work along gendered lines is striking.

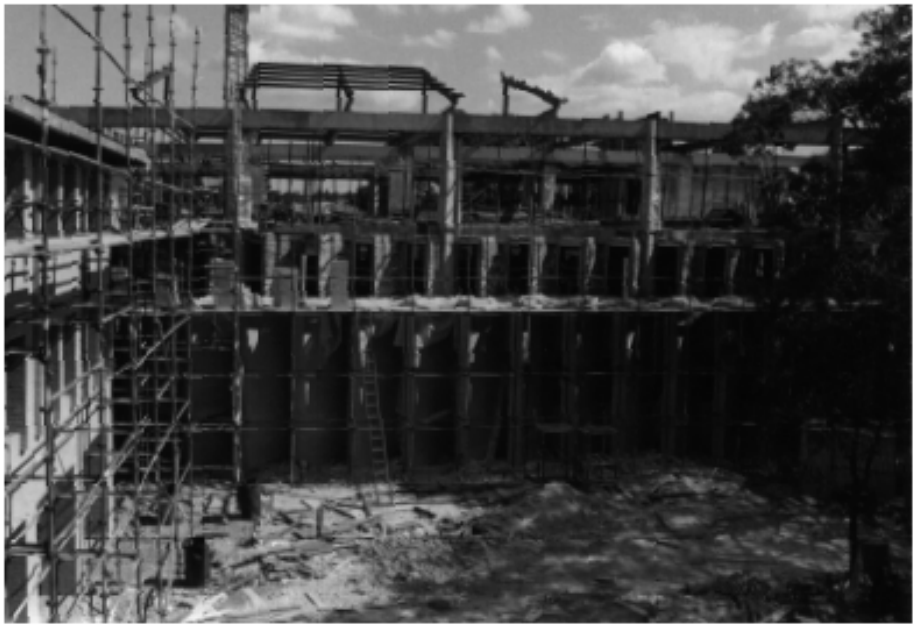
The Engineering Faculty Office Staff, 1931

Appendix Seven: The Engineering Buildings

These photos show the 1961 Engineering building and the 1975 Electrical and Electronic building. Although the 1961 building had been designed to allow for growth in student numbers, it was still too small by the early 1970s and the Department of Electrical and Electronic Engineering had to move into new quarters.

The 1961 Engineering Building

The 1961 Engineering building designed by A.E. Clare and G. Finn is shown above and the construction of the 1975 Electrical and Electronic building is shown below.



Construction of the 1975 Electrical and Electronic Building

The 1975 Electrical and Electronic Link Building

The Electrical and Electronic link building between the Departments of Mathematics and Electrical and Electronic Engineering.

Appendix Eight - Engineering Staff of the 1950s

The new Chairs in Mechanical, Civil and Electrical and Electronic Engineering revitalised the Engineering Faculty in the 1950s. The new staff, Professor David Allen-Williams, Professor Alan Billings and Professor Keith Cooper, were known as the ABC of Engineering.

Professor Keith Cooper is shown here in a portrait taken in 1952.

Professor Keith Cooper, 1952

Professor Alan Billings and Professor David Allen-Williams are shown in this picture of the Academic Council taken in 1975. Professor Billings is second from the left and Professor Allen-Williams is fifth from the left.

Professors Allen-Williams and Billings, 1975 (Image not in cached version)

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1. UWAA 2391, Whitfeld Correspondence. Letter to Sir Alan Anderson, 19th January 1933.

2. The University of Western Australia Act, 1911, cited in *Calendar of the University of Western Australia for the Year 1915* (Perth: Fred W.M. Simpson, 1914) p. 21.

3. Fred Alexander, *Campus at Crawley: A Narrative and Critical Appreciation of the First Fifty Years of the University of Western Australia* (Melbourne: University of Western Australia Press, 1963).

4. There were no female Engineering students until the late 1960s.

5. P.H. Fraenkel, "The Early History of the Engineering School." *Non Loqui: Magazine of the University of Western Australia Engineers' Club*, 1955, pp. 70-1.

6. Alexander, *Campus at Crawley* (1963) p. 95.

7. Alexander, *Campus at Crawley* (1963) p. 92.

8. Minute Notes, 8th July 1915 in University of Western Australia, Faculty of Engineering Minutes, 1913 - 1923.

9. Alexander, *Campus at Crawley* (1963) p. 93.

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24. Calendar of the University of Western Australia for the Year 1915 (1914) p. 86.

25. *Calendar of the University of Western Australia for the Year 1915* (1914) p. 86.

26. Minute Notes, 19th April 1928 in University of Western Australia, Faculty of Engineering Minutes, 1923 - 1939. Note Appendix One.

27. This was, however, not always appreciated. F.G. James, a 1938 graduate, recalls 'Professor Murdoch in 1933 in the English I lecture saying "If the Engineers in the back row would kindly sit down I will cast another pearl"'. F.G. James, Letter dated 9th September 1998. Now deposited in University archives.

28. Minute Notes, Letter received from the Land Surveyors' Licensing Board, 21st October 1924 in University of Western Australia, Faculty of Engineering Minutes, 1923 - 1939.

29. Alexander, *Campus at Crawley* (1963) p. 124.

30. UWAA 1548, Engineering Students - Question of Compulsory Arts Subjects, 1928. Whitfeld made these comments in response to a suggestion from Fraenkel that the Engineering course could be restructured. He added that 'informal discussion' of the course would be sufficient, commenting tactfully that '[t]here is a good deal to be said against calling special meetings during the hot weather'.

31. Alexander, *Campus at Crawley* (1963) p. 180.

32. Somerville, vol I, p. 270, cited in Alexander, *Campus at Crawley* (1963) p. 180.

33. Alexander, *Campus at Crawley* (1963) p. 185.

34. *Calendar of the University of Western Australia for the Year 1923* (Perth: Fred W.M. Simpson, 1922) p. 58.

35. Minute Notes, 16th June 1937 in University of Western Australia, Faculty of Engineering Minutes, 1923 - 1939.

36. Letter dated 29th September 1998, Hugh C.G. Rodgers to Emma Hawkes. Now deposited in the University Archives.

37. Letter dated 31st August 1998, R.J. Fitch to Emma Hawkes. Now deposited in the University Archives.

38. UWAA 1238, Employment for Engineering Graduates - Correspondence from Professor Whitfeld, 26th April 1923.

39. Whitfeld' s definition of 'abroad' was quite loose. His figures showed 3 graduates in England, 1 in Sweden, 2 in the United States of America, 1 in Singapore, 1 in Persia and 5 in the 'Eastern States'. UWAA 1238, Employment for Engineering Graduates - Correspondence from Professor Whitfeld, 26th April 1923.

40. Alexander, *Campus at Crawley* (1963) p. 182.

41. Minute Notes, 27th September 1923 in University of Western Australia, Faculty of Engineering Minutes, 1923 - 1939.

42. UWAA 2391, Whitfeld Correspondence - Letter to D.V. Portus, 10th February 1932.

43. UWAA 0530, Departmental Estimates for 1930.

44. Report to the Faculty of Engineering of the University of Western Australia, 4th August 1936 in University of Western Australia, Faculty of Engineering Minutes, 1923 - 1939.

45. In 1934 John Taylor fractured his arm when there was an explosion in a high pressure cooler in a diesel engine. In 1936 P.H. Randell was carried over the flywheel of a diesel engine. Report to the Faculty of Engineering of the University of Western Australia, 4th August 1936 in University of Western Australia, Faculty of Engineering Minutes, 1923 - 1939.

46. Report to the Faculty of Engineering of the University of Western Australia, 4th August 1936 in University of Western Australia, Faculty of Engineering Minutes, 1923 - 1939.

47. *University of Western Australia Calendar for 1953* (Nedlands: University of Western Australia Text Books Board, 1953) p. i.

48. Letter dated 31st August 1998, R.J. Fitch to Emma Hawkes. Now deposited in the University Archives.

49. Letter from September 1998, F.J. Buchanan to Emma Hawkes. Now deposited in the University Archives.

50. Note Appendices Two and Three, describing the activities of the UEC and outlining their song.

51. The University Engineering Club Report on the Engineering Library for 1946 survives in the UEC club room.

52. Letter dated 8th September 1998 from W.B. Kelliher to Emma Hawkes, now deposited with University Archives.

53. Minute Notes 23rd February 1945 in University of Western Australia, Faculty of Engineering Minutes, 1940 - 1949.

54. *Calendar of the University of Western Australia for the Year 1943* (Crawley: University of Western Australia Text Books Board, 1943) p. 157.

55. Minute Notes 23rd February 1942 in University of Western Australia, Faculty of Engineering Minutes, 1940 - 1949.

56. As a 1946 graduate, Buchanon notes, 'One presumes the basic principle was to maximise the production of professionals for the armed services, industry, and if as a nation we survived, for post-war redevelopment.' Letter, September 1998, from F.J. Buchanan to Emma Hawkes, now deposited in University archives; Letter dated 1st September 1998 from Kenneth John Kelsall to Emma Hawkes, now deposited with University archives. Mr Kelsall notes that he started his degree in 1939 and was informed that he would be given a B.Sc. (Eng.) in 1942. In 1946 he returned to study and completed the B.Eng.

57. Minute Notes 14th October 1943 in University of Western Australia, Faculty of Engineering Minutes, 1940 - 1949.

58. Minute Notes 14th October 1943 in University of Western Australia, Faculty of Engineering Minutes, 1940 - 1949.

59. Minute Notes 19th July 1944 in University of Western Australia, Faculty of Engineering Minutes, 1940 - 1949.

60. Report of the Committee, 25th June 1947 in University of Western Australia, Faculty of Engineering Minutes, 1940 - 1949.

61. Minute Notes 3rd August 1955 in University of Western Australia, Faculty of Engineering Minutes, 1954 - 1957.

62. *The University of Western Australia Calendar for 1955* (Perth: Joshua Pilpel) p. 165.

63.*T he University of Western Australia Calendar for 1955* p. 165.

64. *The University of Western Australia Calendar for 1955* p. 165.

65.*The University of Western Australia Calendar for 1955* p. 169.

66. Minute Notes 1st December 1958 in University of Western Australia, Faculty of Engineering Minutes, 1957 - 1962.

67. The 1957 Murray Report stressed the importance of research conducted in universities. Alexander, *Campus at Crawley* (1963) p. 421.

68. Memorandum from Downs to the Vice Chancellor, 18th February 1952 in University of Western Australia, Faculty of Engineering Minutes, 1949 - 1954.

69. Minute Notes 31st October 1960 in University of Western Australia, Faculty of Engineering Minutes, 1957 - 1962.

70. Minute Notes 17th February 1950 and Minute Notes 14th February 1951 in University of Western Australia, Faculty of Engineering Minutes, 1949 - 1954.

71. Michael Edelstein, *Professional Engineers in the Australian Economy: Some Quantitative Dimensions, 1866 - 1980*, Working Paper in Economic History (Australia: Australian National University, 1987) p. 9.

72. Minute Notes 23rd June 1949 in University of Western Australia, Faculty of Engineering Minutes, 1949 - 1954.

73. Minute Notes 6th October 1958 in University of Western Australia, Faculty of Engineering Minutes, 1957 - 1962.

74. Minute Notes 6th October 1958 in University of Western Australia, Faculty of Engineering Minutes, 1957 - 1962; Alexander, *Campus at Crawley* (1963) p. 442.

75. UWAA 1806, Opening of Engineering Building, 1961.

76. David Allen-Williams, "Engineering" in *Campus in the Community: The University of Western Australia, 1963 - 1987*, ed. B.K. deGaris (Perth: University of Western Australia Press, 1988) p. 296.

77. Minute Notes 8th July 1965 in University of Western Australia, Faculty of Engineering Minutes, 1965 - 1969.

78. *Bend Sinister*, 6.2 (May 1974).

79. Minute Notes 29th February 1972 in University of Western Australia, Faculty of Engineering Minutes, 1969 - 1972.

80. Christine Shervington, *History of Registrar's Office Archives, 1913 - 1960* (University of Western Australia, 1981).

81. Minute Notes 15th May 1961 in University of Western Australia, Faculty of Engineering, 1957 - 1962.

82. Allen-Williams, *Campus in the Community* (1988) p. 298.

83. Allen-Williams, *Campus in the Community* (1988) pp. 297-8.

84. Pamela Roberts and Sue Lewis, *The National Position Paper for Women in Engineering for the Review of Engineering Education* (Australia, Institution of Engineers, 1996) p. 5.

85. Minute Notes 10th May 1978 in University of Western Australia, Faculty of Engineering Minutes, 1978.

86. Indeed, in 1960 the university had acquired its first computer on the advice of John Fall of the Engineering Faculty and Ted Maslen and Jim Lumsden from Physics and Psychology. John Fall, Letter dated 28th August 1998. Now deposited in University Archives.

87. Minute Notes 12th October 1983 in University of Western Australia, Faculty of Engineering Minutes, 1981.

88. http://www.cwr.uwa.edu.au/todee.html, 15th September 1998.

89. John Turner, a 1960 graduate, remembers Richard Silverster's study of beach erosion. 'To track currents, we helped him drop 3 000 coloured table tennis balls into the sea at set distances out from the Leighton-City Beach coast. They were weighted so they just floated, ie. so as not to be influenced by wind. Dick then went public, offering a reward for each ball found on the shoreline. Result: Months went by but, to my knowledge, not one of those balls was ever seen again.' John Turner, 5th September 1998. Now deposited in University Archives.

90. According to figures provided by Women in Science and Engineering.

91. According to figures provided by Women in Science and Engineering.

92. Kim Thomas, *Gender and Subject in Higher Education*, The Society for Research into Higher Education (United Kingdom: Open University Press, 1990).

93. Roberts and Lewis, *The National Position Paper for Women in Engineering for the Review of Engineering Education* (1996) p. 1.

94. Roberts and Lewis, *The National Position Paper for Women in Engineering for the Review of Engineering Education* (1996) pp. 1-2.

95. Sato Juniper, *Student Mentor Scheme: Report for the Equal Opportunity Advisory Committee* (WISE, 1998).

96. Sato Juniper, *Women in Science and Engineering, Annual Report 1997* (University of Western Australia, 1998) p. 10.

97. To choose just a single example, the 1997 *Bend Sinister* described '[f]eminists - [w]ho are sure to find something to sue us about in this years bend despite the fact we have toned it down about five shades. (Get a sense of humour, a real sex life and have a shower and shave you mad dog, hairy armpitted, squealing bushpigs)'. *Bend Sinister*, (October 1997) p. 9.

98. University of Western Australia, Faculty of Engineering and Mathematical Sciences, Strategic Plan, 1998.

99. University of Western Australia, Faculty of Engineering and Mathematical Sciences, Strategic Plan, 1998.

100. http://www.ems.uwa.edu.au, 15th September 1998.

101. Les Emery, *The 1997 Survey of Graduate Destinations: A Report on the Activities of the 1996 Graduates from the University of Western Australia* (1997).