Kennedy-Wunsch Lecture 2010

Presenter: Miles Kennedy
Early Days of Chemical Engineering in New Zealand

It is an honour to have my name linked with that of one of New Zealand's great chemical engineering pioneers, Donald Sandys Wunsch. I met Sandys Wunsch in the late 1950's when he was Chairman of the Council of the Department of Scientific and Industrial Research and I still remember the interest he showed in the work being done by the Department's chemical engineers. It's fitting that we have had Arthur Wilson from the Lactose Company of New Zealand to tell us first hand about Sandys Wunsch. Arthur is himself a chemical engineering pioneer. He must be one of the few surviving chemists who gained associate membership of the Institution of Chemical Engineers by the examination route, including the notoriously difficult Home Paper – which involved the full design and costing of a complete chemical plant, and was intended to take about 3 months to do.

It has been suggested that I take a historical perspective for this inaugural lecture with some personal reminiscences, so I will do my best. If, in talking about chemical engineering education, I seem to put undue stress on the Canterbury department, that in no way reflects on the exciting developments that have taken place at Massey, Auckland and, more recently, Waikato. But after a 40-year association with Canterbury as a student, external examiner, visiting lecturer and finally staff member, it is that department which I know best.

To mark New Zealand's centennial in 1940, the Department of Internal Affairs published, in two volumes and 24 parts, Making New Zealand - Pictorial Surveys of a Century – "as a presentation of the Dominion's history in a popular and easily assimilated form." Making New Zealand doesn't have a lot to say about industrial development. One part is devoted to refrigeration. It tells us how this opened up new markets for butter and cheese; and notes that the NZ Refrigerating Company set up the first freezing works at Burnside near Dunedin, in 1881. And we're told of the first shipment of frozen meat from Port Chalmers to London in 1882, the sheep having come from the Totara Estate near Oamaru. Another part of the series deals with Manufacturing but there isn't much here that relates to chemical or allied industries – ropes from native flax, tanning, cement, - that's about it.

A better idea of the significance of such industries at that time comes from another centennial publication called Chemistry in the Development of NZ Industry, which was put out by the NZ Institute of Chemistry. This contains about 20 short articles on the part chemistry then played in NZ's industries – meat, dairy, wool, leather, fertiliser and sulphuric acid, coal and gas, food and drugs, portland cement, pharmaceuticals and brewing. Several of the authors were key players in the historical development of chemical engineering in this country. For example, Dr JC Andrews AMIChemE, who was then associated with the meat industry but later became Technical Director of Ivon Watkins in New Plymouth. Dr Andrews was Massey University's first Chancellor and he proposed that a food technology degree course be established there.

Then there was Dr Roy Gardner, a consulting industrial chemist of Dunedin who was still going strong when I was there in the 1960's; Dr Gardner was one of the earliest New Zealanders to become a full member of IChemE. Another author was Max Carrie who was then with the dairy industry but later became the Canterbury Frozen Meat Company's chief chemist. Max followed the examination route to AMIChemE and it was he, along with John Pollard and Brian Earl, who, in 1970, spearheaded the move to form a Chemical Engineering Group within the NZ Institution of Engineers.

This booklet gives a far better picture than Making New Zealand of the importance of chemists and chemistry in New Zealand in 1940. For example, chemists were first appointed to the fertiliser industry in the 1880's, the meat industry in 1890, and at Milburn Cement in 1899, while the tanning industry appointed its first full-time chemist in 1915.

In his 1985 history of the Canterbury Chemistry Department, Professor Hugh Parton gave the whereabouts of many of the department's early graduates. Ones from the early 1900's went to the Christchurch and Wellington Gas companies, the meat works and the tanneries. By the 1920's to 1940's, employers included BALM Paints, ICI, Vacuum Oil, Wilson Malt Extract, and the lime, ceramics and clothing industries.

I've dwelt on this period at some length, because 1940 represented a milestone in New Zealand's development; but none of the centennial publications gives any inkling that there might be a need in industry for that newer breed of person – the chemical engineer. Yet only four years later, Canterbury College appointed its first lecturer in applied chemistry – Stan Siemon – to develop courses in chemical engineering. So what had changed?

First, there was a growing recognition by some chemists in industry of the need for chemical engineering qualifications and expertise. One thinks of the Sandys Wunsch approach with his Lactose Company chemists, but the need was also being felt by chemists in the meat and fertiliser and other industries. Second, a miniscule chemical engineering section had been set up in the late 1930's at the Dominion Laboratory of the DSIR; and when war broke out, this section had work to do to aid the war effort. Third, and predating these other influences, there had been moves within the Canterbury College chemistry department to establish teaching in chemical engineering.

Arthur Wilson has told us how Sandys Wunsch fostered chemical engineering within industry; so turning to my second influence, let me introduce two key players. One was Sir Ernest Marsden; the other was his protégé, WA Joiner. Marsden was an Englishman who had been one of Rutherford's top students at Manchester. On Rutherford's recommendation, he was appointed Professor of Physics at Victoria College in 1914, at the age of 25. In 1926, he became the Permanent Secretary – the CEO if you like – of the newly-formed Department of Scientific and Industrial Research, and he stayed in that position until 1947, when he was apppointed Scientific Liaison Officer and New Zealand Government Scientific Advisor in London. It was in that role that I got to know him rather well, a few years later.

Marsden was a short stocky man with enormous enthusiasm and vitality, whose

knowledge and interests ranged far beyond his own field of physics. He created the Grasslands Division of DSIR; the Wheat, Leather and Dairy Research Institutes; and, through what have been described as “his well-trained boys,” the Meat, Wool and Fertiliser Research Institutes.

At that time, the Dominion Laboratory – later to become the Chemistry Division – was the DSIR’s fount of chemical expertise. In 1924, a Victoria College chemistry graduate, WA Joiner, had been appointed to the Laboratory to do coal research. Marsden was aware of overseas developments in the new field of chemical engineering, and he arranged financial support to allow Bill Joiner to take a Diploma course in 1934/35 at the Ramsay Chemical Engineering Laboratory of University College, University of London. When Joiner came back to New Zealand, he was the country’s first native-born, academically qualified chemical engineer.

In 1936 he became head of a separate chemical engineering section in the Dominion Laboratory. By 1938, he had been joined by Lindsay Ledger, a mechanical engineering graduate from Canterbury, and Gordon Maskill Smith, a chemistry graduate from Auckland. Joiner and Ledger had been involved with a Foxton factory making wool packs and ropes from New Zealand flax. With the outbreak of war, this work intensified. The group also turned to fruit and vegetable dehydration, to provide dried foods for the troops in the Pacific. Joiner and his team designed from scratch a vegetable dehydration plant for Watties’ Hastings factory. They commissioned this, and it worked better than American-designed plants that had been put in at Pukekohe and Riccarton.

Later, the group became involved with apple drying at Motueka, and the design of tobacco-drying kilns; they designed seed dryers, and did some work on charcoal-fired gas producers for motor vehicles. In 1946, Joiner became Director of the Dominion Laboratory, and eventually Deputy Secretary of the DSIR. Gordon Maskill Smith, who became Head of the Chemical Engineering Section after Joiner, had passed his Home Paper in 1940 and Lindsay Ledger 10 years later.

But I’m getting ahead of myself; so let’s go right back to 1924, when Henry George Denham, Professor of Chemistry at Canterbury College, addressed the College Engineering Society on “The Chemical Engineer”. In his talk, Denham referred to engineer-chemists (and I think he meant the versatile creature which Arthur Wilson and his contemporaries later became) and he described how these men, together with chemical engineers, would build on the processes developed by laboratory and research chemists and would collaborate in the design, construction, operation and control of chemical plant. In a patch of purple prose he said “As much as this one can, however, say, and say with certainty – in chemical engineering there lies the greatest and the most lucrative field of development for engineering science.”

Denham’s talk is reprinted in full in Progress and Practice in Chemical and Process Engineering, edited by Roger Keey. This publication includes the Proceedings of the seminar held in conjunction with the 50th Jubilee of the Canterbury Department; and it also contains an excellent Prehistory of the Department by John Pollard.

There’s nothing to suggest that Denham’s talk made much impact on the Engineering Society; and the Depression was not the time to be seeking

Government support for a new venture. But in 1937, Denham submitted a memorandum to the Canterbury College Council, outlining the pressing need for chemical engineering in New Zealand. The Council reacted favourably and asked Denham to sound out the Secretary of the DSIR, Ernest Marsden. By this time, Denham was Chairman of the DSIR Council and he and Marsden were, no doubt, good mates. Marsden gave his opinion by saying “It is the best thing that can be done for industry in New Zealand. The one thing that is stopping the development of secondary industries is the lack of adequately trained chemical engineers or managers.”

Denham died in February 1943, but John Packer, who succeeded him as Professor of Chemistry, took over his negotiations with the Council, arguing that they were a “matter of considerable national importance. And one of some urgency . . . as a result of the changed conditions resulting from the war.” In October 1943, the Government approved a grant of £1100 to establish Chemical Engineering and Bill Joiner’s advice was sought as to what funding might be needed for capital equipment. A one-year postgraduate Diploma in Industrial Chemistry course for chemistry graduates was to begin in 1944 and the University of N.Z. Senate gave approval for a 5-year Chemical Engineering degree course to begin in 1945.

Hugh Parton, in his history, says that the degree course was planned without the help of a university teacher with specialist knowledge of the discipline, and with the requirements for registration of the graduates as engineers in mind. This is somewhat ironical, as it wasn’t for another 23 years that the New Zealand Institution of Engineers finally recognised the BE(Chemical) as meeting the academic requirements for membership of the Institution.The 5-year course as planned led to a BSc in Chemistry and a BE(Chemical). After the normal Intermediate, the First Professional year was to be as for the BE(Mechanical), as was the Second Professional year plus Stage 2 Chemistry. The Third Professional year was to include Chemistry 3 and a new subject called Applied Chemistry, plus Heat Engines and Economic Geology. The final year comprised Advanced Applied Chemistry, Hydraulics, Industrial Microbiology and Engineering Design 2 (Mechanical) with its 15-day final examination.

A Lectureship in Applied Chemistry was advertised and the successful applicant was Stanley Robert Siemon, who had a Master of Applied Science from the University of Queensland. Stan was 28; he had worked for the Queensland Meat Industry Board for 6 years and had part-time teaching experience in industrial chemistry. He had just completed the Home Paper for IChemE membership.

Stan and his wife arrived in Christchurch in July 1944. He found an office in the Chemistry Department and was given an old coal laboratory in the basement for his chemical engineering laboratory. It didn’t take him long to establish himself in the new environment. He was made a senior lecturer in 1947 and, by then, had already changed the course considerably, replacing the Applied Chemistry units with Chemical Engineering 1 and 2 and the 15-day mechanical design examination with a 5-day chemical plant design paper.

In 1945, Stan had one Diploma student – Peter Toynbee, who joined Maskill Smith at the Dominion Laboratory and later became the first Director of the Coal Research

Association. In 1946 there were 5 Diploma students, including John Pollard, who went first to the Dominion Laboratory and then to the Christchurch Gas Co; incidentally, John wrote a spendid social history called Requiem for a Gasworks. Altogether, 10 chemistry students graduated with a DIC. A couple went overseas; two became science teachers; and the others helped shape NZ's industrial development, including my class-mate, Stewart Betty, the last of the Diploma students, who eventually managed Skellerup's Empire Rubber Mills.

From the outset, Stan Siemon fostered close contact with industry – visiting factories from Edendale's Lactose Company to the cement works in Whangarei. He opened up practical work opportunities for his students and job opportunities for his graduates. In those days we had to do 6 months in mechanical engineering workshops and 3 in chemical works. The work was invariably poorly paid, compared with wool stores or freezing works, and we didn't always learn a great deal technically; but, at least in my experience, we learnt a lot about people, about union-management relationships and about communication.

The first student to finish the BE (Chemical) degree, in 1947, was Dick Harris who spent his working life with ICI in Sydney. Next came Don Baker who was hired by Stan Siemon for a couple of years as a temporary lecturer. He worked for Monsanto in Wales before returning to the family firm – Greggs of Dunedin. Prince and Putt were the next to graduate. Colin Putt joined ICI in Sydney and, in his spare time, became a notable international explorer and adventurer. He is still doing some consulting work in Sydney and keeps in close touch with his old mate, Rolf Prince. Rolf hardly needs an introduction to this audience. An émigré from Germany in 1938, he topped the New Zealand University Scholarships examinations six years later at the age of 16. He was the first graduate from the department to do a PhD – at Sydney. After a stint with the Distillers Co in the UK, and three years on Stan Siemon's staff, he went to a lectureship at Sydney; thence to the Chair at the University of Queensland, and finally back to Sydney as Professor and Head of Department. Rolf became President of IChemE in 1986, the first chemical engineer from outside the UK to become President of the Institution.

Three of us followed Prince and Putt – with some difficulty, I might add, because they had left a trail of devastation in their wake – like the time when they dumped what was then the new synthetic detergent – Teepol – into the civil engineering water circulation system, producing a tsunami of foam that filled the hallway and stairwell of the engineering school. Of my classmates – I've mentioned Stewart Betty already; Dick Barker left a promising career with ICI to go back to the family farm; while John Mathews worked in Bahrein, Canada, the UK and the States before returning to New Zealand as Chief Engineer for the Tasman Pulp and Paper Co. We found the degree quite arduous – with an average of 34 hours a week of lectures and laboratory for the four professional years. We certainly didn't have time to be aware of the immense efforts being made by Stan Siemon on behalf of the embryo department and its students. He had had to teach all chemical engineering elements of the degree; develop laboratory courses; scratch up money for books and equipment; tussle with the administration; maintain contacts with industry; all the time trying to pursue his research interests in surface chemistry.

In 1951, Stan urged the College Council to make Chemical Engineering a full

department of the School of Engineering with its own Chair. The Council obliged and the new department was established in 1952, but it took another five years for the Chair to materialise. Still, in 1960, Professor Siemon – now Dean of the Faculty of Engineering – was able to take his department with the rest of the School to its new home at Ilam – and at last give his staff and students fine accommodation, including what was to become the Denham Laboratory. Five years later, having built up a strong chemical engineering department at Canterbury, he went off to the University of Melbourne to do it all over again. The Centennial History of the School of Engineering records that Stan is one of the few persons after whom buildings at Canterbury are named, and notes that "at Canterbury, where one needed to be a Rutherford, Hight, Connon, Ngata, Alpers or Jobberns to be so remembered, the honour is real."

Still, this was all very much in the future when I was a final-year student in 1950. That year, Stan Siemon had at last got some substantial help in the form of Dr Thomas Hagyard. Tom Hagyard was unusually well qualified, academically and professionally, when he came to Canterbury. He had BSc(Hons) and PhD degrees in physical chemistry from the University of London and extensive research and development experience with ICI and the Boots Pure Drug Co. Tom came in the winter, and lectured to us wearing a heavy tweed overcoat, while introducing us to such exotic concepts as HETP's and HTU's. Our textbook, by the way, was Elements of Chemical Engineering by Badger and McCabe, published in 1936; supplemented by the second edition of Perry.

Tom took over the supervision of our research projects, and also looked after the full-day laboratory classes in the basement. He was not amused when we skipped labs one fine day and went up onto the Port Hills to play cards and drink beer. When we got back he launched into a stiff lecture but got thrown off balance when Stewart Betty presented him with a large all-day sucker. Tom took it and stalked off; but he told me years later he had always had a soft spot for the class of 1950.

From the outset Tom Hagyard was one of the liveliest researchers in the School of Engineering. He did fundamental work in electrochemistry, aided by doctoral students Brian Earl, Ken Kirkpatrick and Ivor Watson – yet he was equally concerned with applications to cathodic protection in boilers, corrosion of power station penstocks, and hypochlorite manufacture from seawater. An American Master's student, Al Sacerdote, did basic work on the viscosity of fluidised beds, while other students looked at the feasibility of fluidising a channel in the sea-bed to prevent the formation of sand-bars at West Coast river-mouths and harbours. David Teplitzky and Kevin Free carried out rigorous analyses of the solar salt ponds at Lake Grassmere. And Tom wrote numerous Economic Bulletins for the Canterbury Chamber of Commerce on the possibilities for chemical manufacture in NZ, including anode carbon from Stockton coal, titanium dioxide from Westland's ilmenite sands, and the prospects for establishing a calcium carbide industry.

But perhaps his greatest legacy to the department and its graduates were the final-year design projects, where small groups of students worked as a team with Tom as goad and mentor. Always, his projects were related to the development of a chemical industry in New Zealand; and design and research were often inextricably interwoven. And after Tom's untimely death in 1971, his former student, colleague

and friend, Brian Earl, continued in the same vein, almost as if Tom were peering over his shoulder.

Despite the best efforts of Stan Siemon and Tom Hagyard, there were few jobs for young chemical engineers when I finished in 1950. There was a position advertised with the Benhar Potteries near Balclutha, making sanitary earthenware – ie lavatory pans. That didn't impress my new fiancee. In retrospect, it would have been an interesting job, but another opportunity appeared, thanks to Ernest Marsden.

At that time, there were very few scholarships which would allow science or engineering students to do postgraduate study overseas. Dr Marsden somehow persuaded Government that the Armed Forces needed some scientifically-trained personnel, so the Defence Scientific Corps was established. The idea was that a graduate would, after suitable training, be commissioned in the Army, Navy or Air Force and would then be sent overseas for 2-3 years, hopefully to get a higher degree. He (they were all he in those days) would then return to New Zealand for a similar period, and one might hope that he would remain in the country thereafter. The tab for all of this would be paid for out of the Defence budget.

On the whole, I think the scheme worked well. It lasted for about 10 years and Defence Scientific Corps scholarships were awarded to over 50 graduates. A few eventually left the country and made their name overseas – like Graeme Low, who became Director of the British Atomic Energy Research Establishment at Harwell; and the late Ian Axford, who gained an international reputation in the States and Germany - though he did return to become Vice-Chancellor of Victoria University and, later, Chair of the Foundation for Research, Science and Technology.

Among those who remained, there are some names you may be familiar with. Dick Earle, who was the chief research engineer for the Meat Industry Research Institute before taking the foundation Chair of Biotechnology in Kelvin Scott's Faculty of Food Science and Biotechnology at Massey University; Ted Richards, Professor of Food Technology, and Clem Hawke, Reader in Biochemistry, also at Massey. Ray Meyer, Dean of Engineering at Auckland University; Brian Woods, Professor of Engineering Mathematics and John Bargh, Professor of Electrical Engineering, both at Canterbury; Lester Davey, who became Director of Meat Research and Stan Simpson, Director of Wool Research; and another chemical engineer – Kevin Free, who worked for Du Pont's in Wilmington and became a member of the Delaware State Legislature before he saw the light and returned to Auckland's Chemical and Materials Engineering Department.

In my case, I had several months of officer training at Trentham at the start of 1951, before being seconded to the Chemical Engineering Section of the Dominion Laboratory at Gracefield. I was living on an army base at Palmer Head, and getting to the Wellington Railway Station was a unique experience. It was at the height of the great waterfront strike – New Zealand's largest ever industrial dispute, with 20,000 workers on strike in support of the waterfront workers. Each morning, I was a front-seat passenger in the lead vehicle of the huge army convoy that took soldiers from Fort Dorset into the city to work the wharves.

At Gracefield, I worked with an Englishman called Noel Vere-Jones. He was a

biochemistry graduate from the University of London who took his AMIChemE by examination, while working for Bengers Foods in Manchester. Bengers made baby food and other milk products and was eventually taken over by the Fisons group. After the war, Noel brought his family to New Zealand and he was able to get a job with Maskill-Smith's group. He was a great acquisition, as he was a very experienced chemical engineer and had a wealth of design knowledge which made him a splendid mentor for a young and inexperienced graduate. He was somewhat reserved and he disliked the DSIR bureaucracy - he preferred his roses far more - and I don't believe that he or his work at Gracefield ever received the recognition, within or outside the organisation, that they deserved.

Vere-Jones and Norman Law, who later became the first Director of the Meat Industry Research Institute of New Zealand, had developed a new process for dehydrating chunks of meat to give a product that was surprisingly edible. I got the job of designing a small, rotary, vacuum dehydrator that could handle a charge of 50-60 lb of raw meat. I finished the design, but before anyone could check my calculations or drawings, my wife and I were on our way to the UK on the first ship to leave Wellington after the end of the strike.

Next stop for me was the Cambridge University Chemical Engineering Department. This had been established in 1948 thanks to a handsome endowment from Shell. One PhD student had been and gone and I was the second. The head of the department was Terence Fox, a Cambridge graduate in mechanical engineering who had worked at ICI Billingham. His handpicked staff included Stanley Sellers who later set up the Swansea chemical engineering department, and was President of IChemE in 1964; Kenneth Denbigh who later went to a Chair at Edinburgh University, then to the Chair of Chemical Engineering Science at Imperial College; John Kay, who later became Professor of Nuclear Energy at Imperial College; Peter Danckwerts, who preceded Denbigh at Imperial College then followed Fox at Cambridge, and was President of IChemE in 1966; and a couple of years later, John Davidson who followed Danckwerts as Head at Cambridge, and was President of IChemE in 1971, giving his blessing to the move by New Zealand's chemical engineers to link up with the NZ Institution of Engineers. One other notable person in the Department was Francis Bacon, whose fuel cell later helped to get Neil Armstrong to the moon.

Forgive me for the name-dropping – but it was a heady environment that I found myself in. I was the only research student for a couple of months – then two others joined me. We took our morning and afternoon tea with Fox and his staff and we had a much closer relationship with our supervisors than I later found to be the case with larger departments elsewhere.

My supervisor was Peter Danckwerts – a war hero with the George Cross and an MBE for bomb disposal work. I was very much in awe of him until one evening when he invited my wife and me for supper – we toasted marshmallows over a bunsen burner and drank neat gin – and I felt much more at ease with him thereafter. I won't bore you with details of that far-off research. Suffice to say that Lewis and Whitman's two-film theory of gas absorption was published in 1924 and was still being used in 1951, even though it had never been tested experimentally. Danckwerts considered the theory unrealistic, and abandoned the notion that a rate-controlling stagnant film

of liquid could somehow exist at the gas-liquid interface in typical absorption equipment. He suggested that I go away and read papers he had published on what became known as the penetration theory, then come up with ideas for getting experimental results that could be used to test his theories. That led to the building of a small packed column and a rotating drum, a sketch of which appeared in the 3rd or 4th edition of Perry. I still have the Mark I version at home.

Thanks to Ernest Marsden, there was a hiatus at the halfway point of my research, just at a time when everything that could go wrong was going wrong. My wife and I were having lunch one day when I opened a letter from Marsden saying I should stop my PhD work and go forthwith to Harwell. AS White and Clive Pratt, who was later a professor in Stan Siemon's Melbourne department, were investigating the possibility of producing heavy water at the Wairakei geothermal field, using the abundant cheap energy there for distillation. Marsden had told them he had a keen young New Zealand chemical engineer who would love to join the project team ie me. I spent a fortnight at Harwell and enjoyed it, but Pratt was appalled at the notion I should have to abandon the PhD and thanks to his efforts, and with Danckwerts' help, Marsden was persuaded to let me return to Cambridge. Fortunately for me – because the heavy water project was dumped some time later.

Peter Danckwerts became the grand old man of chemical engineering in the UK – not that he was all that old. I spent time with him a few weeks before his death in 1984; and I've been reminded of him a lot lately because his biography is being written by Peter Varey, a former Director of Publications at IChemE.

After finishing my PhD and spending some months as a process engineer with the Lyons organisation in London, I went back to Gracefield at the start of 1955. Maskill-Smith's group had grown much larger and was involved in a much wider range of work, especially in connection with developments at Wairakei in the harnessing of geothermal energy. For me, it was déjà vu – back to meat dehydration; but once my army service was ended I was able to get involved with more interesting work – looking at growing and harvesting chlorella in the Auckland Metropolitan Drainage Board's oxidation ponds; making dilute hydrochloric acid by ion exchange for muriatic casein manufacture – a project suggested by Kelvin Scott, then with the Dairy Research Institute; and investigating the recovery of lithium and other minerals from geothermal water at Wairakei. Fifty years on, I had a letter from the GNS Science Crown Research Institute to say this was still a hot topic.

Outside the DSIR and the Dairy Research Institute, job opportunities for chemical engineering graduates hadn't changed much since 1950. But in 1955, chemical pulp and paper production started at the New Zealand Forest Products Kinleith mill, and the Tasman Pulp and Paper's Kawerau mill, and this opened up a whole new world for chemical engineers. I remember meeting a young Canterbury graduate in 1956 – Warwick Olsen – who was brimming over with enthusiasm for his job at Kawerau. I spent several days at the mill in 1965; by then, Warwick was Mill Manager and not too many years later he became the Managing Director.

Towards the end of 1968, I took out figures for the 100 or so Canterbury graduates working in New Zealand, whose whereabouts I knew. The dairy industry employed 2, though another 8 were at the Dairy Research Institute; only 1 was in the meat

industry with 2 at the Meat Industry Research Institute; fertilisers and sulphuric acid accounted for 4 as did soap and synthetic detergents; 9 worked in the agricultural and fine chemicals industries; but 22 were employed in the pulp and paper industry. However, significant changes were on the horizon, with the opening of the Marsden Point oil refinery in 1964, NZ Steel's Glenbrook mill in 1968 and NZ Aluminium Smelter's Tiwai Point plant in 1971. By 1974, there were about 250 Canterbury graduates working in New Zealand. Pulp and paper accounted for 34, with 16 now in the dairy industry; 13 in the oil and natural gas industries; 7 in steel and aluminium manufacture; and – a new entrant - 13 working for consulting organisations.

Fast-forwarding to 1980 - this was something of a watershed year in New Zealand's industrial development. The year before, the Government had taken a far-reaching decision to make New Zealand 50% self-sufficient in transport fuels by 1986. It was the eve of the think-big projects and whatever one now thinks of the merits of those large projects, they certainly opened up a whole new range of opportunities for chemical engineers.

In 1980, I was President of the NZ Institution of Engineers (later to become the Institution of Professional Engineers NZ). In my trips to Institution branches I was able to visit chemical works up and down the country – from the aluminium smelter to the oil refinery, and the fertiliser works in Napier to the Maui A off-shore platform. I could not help but be impressed by the opportunities for chemical engineers that had opened up around the country in the 35 years since Stan Siemon had started teaching a handful of students at Canterbury. New Zealand should be thankful for the foresight of Stan and those who supported him; his focus on the industrial needs of New Zealand has paid huge dividends ever since. And, of course, it hasn't been Canterbury alone for many years. Dick and Mary Earle and their colleagues at Massey University, and Alan Titchener and Geoff Duffy and their colleagues at Auckland were just as vigilant in foreseeing the need, and meeting it, for graduates in biotechnology, chemical and materials engineering.

Before I finish I should like to touch on a couple of topics. The first could be seen as complementing Hannah Corbett's paper on Women in Engineering. It was Charlotte Whitton, one-time mayor of Ottawa, who said "Whatever women do, they must do twice as well as men to be thought half as good. Luckily, this is not difficult."

Our first woman student was Thongtip Hongladarom from Thailand, who finished the degree in 1966 and later returned for a Master's with Tom Hagyard. Thongtip has had a stellar career in Thailand over the last forty years – in academia, industry, consulting, think-tank ventures and the like. If you Google Thongtip you will find that she has a title – Khunying – like Dame or Lady. She is a former Executive Director of the Petroleum Institute of Thailand and is currently a member of the Institute's Council of Trustees comprising 32 of the country's most influential industrialists and Government officials. Thongtip is the only woman.

Three years after Thongtip, we had three women students. One of them – Jennifer Ann Murrow – Jenny Culliford – had years of consulting and project engineering experience in the UK, Iran, and back in the UK, before returning to a senior management position with Kingston Morrison, now Sinclair, Knight, Merz. In 1997, Jenny was appointed Chair of the NZ Engineers' Registration Board, the first woman

to have been appointed to this very significant role. Gretchen Kershaw – Gretchen Kivell – came along a year after Jenny. Again, she had had overseas experience in the UK chemical industry before returning to New Zealand, to hold high-level positions in project management with Kingston, Reynolds, Thom and Allardice, in education with UNITEC Institute of Technology, and as a Director of the Worley Group. And, of course, Gretchen became an exceptional President of the Institution of Professional Engineers NZ – the first and so far the only woman to have been so elected.

Except perhaps for Thongtip, who came from a society where women engineers were readily accepted, all our early women chemical engineers faced massive hurdles. Even to become students they may have had to overcome opposition from parents, teachers and friends. They faced discrimination in the Engineering School – though not, I hope, within our department – and on graduation they had to cope with employers who very often didn't know what to make of a woman engineer. But overcome these obstacles they did – and it is largely due to their pioneering efforts that so many young women nowadays choose to enter chemical engineering and related disciplines.

My final topic concerns chemical engineers and their professional institutions. Stan Siemon encouraged his students to join IChemE. Dick Barker and I became student members in 1950. In 2001, the then-President, John Perkins, wrote and congratulated me on my 50 years membership and sent me a facsimile copy of the Quarterly Bulletin that announced my election. That same bulletin contains the names of those who had qualified for Associate Membership by examination in that quarter. They include John Dryden from the Lactose Co; Lindsay Ledger from DSIR; Terry Douglas, also of DSIR, who became New Zealand's first Chief Air Pollution Control Officer; Charles Martin, that idiosyncratic character who became a most colourful and capable consulting chemical engineer; and William Ernest Russell. I haven't mentioned Bill Russell before. He was a chemical engineering pioneer in the Sandys Wunsch mould, but it was with the fertiliser industry that Bill left his legacy. As well as starting a chemical engineering dynasty with son David and grandson Bruce, both Auckland graduates, Bill chaired the IChemE Panel that carried out the first Moderation of the Canterbury degree in 1978.

Most early chemical engineers belonged to the New Zealand Institute of Chemistry. Dr Jack Andrews and Bill Joiner had helped found the Institute. Both became Presidents as did Dr Roy Gardner, Max Carrie, and Stan Siemon himself; and Stan's students, even though they were engineering students, tended to link up with NZIC on graduation. As far as the New Zealand Institution of Engineers was concerned, Stan was not a member, and Don Baker was turned down flat when he applied. The very first article in the Institution's journal, New Zealand Engineering, was a paper called The Chemical Engineer by Maskill Smith, published in October 1946; yet it was 20 years before corporate members of IChemE were accepted into NZIE without further examination. Even in 1971, the official history of the Institution by WL Newnham makes no mention of chemical engineering. Yet it was in that year that the Chemical Engineering Group of NZIE was formed, changing the face of the Institution forever. And although our numbers may have been small, at least 6 Presidents have come from our ranks.

In 1965, the Institution of Chemical Engineers formed a small advisory committee to help it with membership and other matters. The Committee was convened by Bill Joiner; it comprised Gordon Maskill Smith, Don Baker, Terry Douglas and Tom Hagyard – I took Tom's place after his death. In a sense, today's meeting represents a coming-of-age. The NZ Committee gave way to the Chemical Engineering Group; we have seen the evolution of that Group into the Society of Chemical Engineers New Zealand, the Agreement of Cooperation between the Society and IChemE, and the final transformation of the Society into SCENZ-IChemE in New Zealand. It has been a long journey to reach this goal, but if you listen carefully, you may just be able to hear the applause ringing out from Donald Sandys Wunsch and those other far-off pioneers.

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