Kennedy Wunsch Lecture, May 2018

Canterbury University

Where did I go wrong?

Welcome – I was both honoured and over-awed at the invitation to deliver the IChemE Kennedy Wunsch lecture and am very disappointed that Miles Kennedy is not able to attend tonight.

You would all know where I'd gone wrong if I did not refer to the previous presenters of the Kennedy Wunsch Lecture. Miles Kennedy's inaugural lecture was an encyclopaedic tour through the early history of the profession in New Zealand. The two most recent by Tissa Fernando and John Abrahamson have been inspirational – Tissa outlining a lifetime of invention and entrepreneurial success and John, a stellar career in academia and world-leading research.

With such a hard act to follow I decided my only option is to concentrate on failures, both my own and others. Where did I go wrong? Well – agreeing to deliver the Kennedy Wunsch Lecture certainly ranks right up there amongst my bigger mistakes!

How did a nice kid like me end up a Chemical Engineer? First of all, a tendency to pull things apart – usually to see how they worked. I went to a small, three-room primary school and to keep me out of his hair, my teacher gave me projects to research. The very first seminar I delivered was to a mixed class of 10-to-12-year olds on internal combustion engines, explaining the differences between spark-ignition and compression-ignition engines. I was so impressed with my own knowledge that I took the distributor cap off the family car and pulled out the rotor spindle. It refused to go back, requiring an 8 km call-out from the not-so-friendly local mechanic.

A turning point in my sporting career was reached playing cricket against the neighbouring primary school, where I top-scored with 11. Where did I go wrong? I had achieved my sporting peak and I should have quit while I was ahead.

Secondary school cemented in me an abiding interest in science – in particular a love of explosives. I can remember the composition of gunpowder to this day. Despite some notable pyrotechnical successes, and a few failures, I still have a full complement of fingers and both eyes. A wide-awake careers advisor put chemistry, physics and maths together and came up with Chemical Engineering. I had never heard of Chemical Engineering but when I found out that a company called Lever Brothers offered a study-award for Chemical Engineering, I was quickly convinced. I applied, had the mandatory interview, was awarded one, and I was on my way. After an initial year at Victoria University I was off to Canterbury University.

I have a very clear memory of my first arrival in Christchurch. Having sailed overnight on the inter-islander ferry, the MEV Maori, I rode my motorbike over the Port Hills road, there being no road tunnel in 1962, and saw nothing but a vast grey blanket spread out below me penetrated by the very tip of the Cathedral spire.

At the very last minute (i.e., a couple of days to spare) I had been offered a place in Rolleston House which I accepted with both relief and enthusiasm. In 1962 there were five chemical engineering students at RH which economised on expensive text-books. One of our group of budding engineering maestros turned up for Saturday lunch with no eyebrows and a very orange complexion. Mac had been making nitro tri-iodide and had spread it on his windowsill in the sun. Where did he go wrong? He had touched it to see if it was dry.

The New Ilam Engineering School

The Engineering School had very recently been established on the new Ilam site, on the very northern edge of the city, with the Chemical Engineering Department occupying the eastern corner. At that time the Ilam site was shared with only the Fine Arts Department, which occupied the old Ilam homestead, and Fine Arts students shared the Engineering School cafeteria. Now, if you'd seen Engineering students and Arts students in the 1960s you would understand why this was an interesting mix. Engineering students were, sadly, very conservative and Fine Arts students were not. They wore interesting haircuts (even the males!), dramatic make-up, weird clothes, smoked roll-your-own cigarettes that gave off a strange smell and they were widely rumoured to indulge in free love. With regards to cigarettes, smoking was widespread within the student population; during the mid-morning recess the Engineering School concourse was so thick with smoke that you couldn't see from one end to the other.

With respect to the free love, the rumours were almost certainly promoted by the Fine Arts students themselves. Where did we go wrong – that band of "involuntary celibates"? It was not for lack of trying; and remember, there was only one female student in the whole of the Engineering School!

The Chemical Engineering Department

The Chemical Engineering Department consisted of Prof Stan Siemon, Reader Tom Hagyard and Lecturers Roger Keey, Brian Earl, John Peet and, in our final year, Maurice Allen. Our 1st Pro cohort of just 20 was lectured in all the usual Chemical Engineering stuff as well as a bit of structural engineering, electrical engineering and engineering drawing. We also took Chemistry 2, for which the Chemical Engineering students streamed out of our 9-10 am lecture, raced into the city campus for a Chemistry lecture and then raced back to the Ilam campus for Engineering Maths 2 with the redoubtable Dr Mary Harding.

The engineering syllabus was very crowded with high class-contact hours - and probably is still. Being scared to miss anything important, ensured that a sufferer's cold or 'flu' was shared around. On one notable occasion I attended Chemistry labs with a particularly heavy dose of the 'flu '.

The experiment we were doing that day was the distillation of a mixture of methanol and benzene – using Bunsen burners as the heat source. What could possibly go wrong? As I transferred a sample for analysis by pipette I managed to set the tip of the pipette alight. I promptly emptied the pipette into the nearest beaker which, unfortunately for me, contained more benzene. With lightning reflexes I moved to snuff out the now briskly burning mixture in the beaker by placing a handy watchglass over top. I am certain it was no-one's fault that the beaker smashed and in no time there was a cheery benzene blaze across the whole bench-top! With commendable presence of mind, I announced to anyone interested that I had the 'flu' - and retired to bed.

At the end of our B.E. courses all the engineering disciplines completed a 5-day design examination. Because of the mythology surrounding it, this was approached with a mixture of trepidation and fascination; how would we perform? Our project was unveiled on Monday morning as a multiple-effect evaporator for a sugar refinery. It was what would now be called an open-book exam and, although the nominal hours in the drawing office were from 8 am to 5 pm, we were allowed to take our working documents away with us. We compared notes on what we were working on quite freely, although if anyone thought he was onto something particularly clever he probably kept it to himself. I managed to survive the whole five days on about eight hours sleep and, along with my colleagues, marked the end of my under-graduate education by handing in a huge bundle of calculations and drawings at 5:00 pm on the Friday afternoon.

Practical Work, Lever Brothers

Apart from the very welcome income, one of the major advantages of the Lever Brothers study award was the opportunity to complete my practical work requirements at the Petone factory. I was provided a navy-blue boiler suit and I worked in the mechanical workshop for two of my summer vacations. I learned a lot – much of it associated with the overhaul and repair of the factory equipment during the Christmas-New Year shutdown. In mid-summer and working in pretty hot parts of the factory, it was quite common for the fitters to wear little under their boiler suits. On one such occasion I was chipping slag off a weld in an awkward part of the factory when a large piece of red-hot slag flew into the top of my boiler suit. As it felt as though it was about to start a small forest fire in my chest hair I grabbed the front of my boiler suit and pulled it away from my chest – only to have the still red-hot piece of slag drop right onto what Spike Milligan would somewhat optimistically have referred to as my wedding tackle. On that occasion I knew exactly where I'd gone wrong!

In addition to machining and welding, I managed the unauthorised overhaul of a big old "Triumph 650" motorbike. My welding skills also came in handy when, several years later, I constructed a steel-framed trailer in the Department's Denham Laboratory over a long weekend.

On my last period of practical work required for the B.E. degree I worked in the company drawing office and was given the job of designing a platform to hold pallets of soda-ash in 25 kg bags. I made allowance for the platform to hold at least twice the specified load, for earthquakes of more than specified accelerations, for hits from errant forklifts etc., adding substantial safety factors all the while. I even calculated the Euler buckling load on the supporting legs. It would have survived a small thermo-nuclear attack. When I submitted my completed design, with supporting calculations to the head draughtsman, he ran a critical eye over the drawing, ignored the calculations, and casually suggested that I should double the size of all the key structural members. Where did I go wrong?

Lever Brothers, Petone - my first real job

Lever Brothers, Petone, was a major New Zealand manufacturer of consumer products generally grouped into hard-surface cleaners, personal toiletries and laundry products. Soap-making was really the mainstay of the business and it was a great introduction to the processing industries. Unit operations abounded - bleaching and filtration of the tallow and coconut oil, saponification reactions with caustic soda, phase separation of the glycerol into brine, evaporation of the brine to recover the salt, centrifugation to separate solid salt from glycerol, distillation and then de-odorisation of the crude glycerol. Depending on the quality of the tallow and the blend of tallow and oil, the semi-finished soap would be directed to Lux soap flakes, toilet soaps under several brands, Sunlight laundry soap, Rinso and Persil soap powders and even sand-soap.

Manufacture of many of the other products, such as toothpaste, shampoo, dish-washing detergents and hard-surface cleaners, involved the mixing of solid and liquid ingredients and the inclusion of colours, flavours and fragrances. Some even involved the adjustment of consistency to account for seasonal temperature variation.

I joined the Development Department under initially Rob Carlyon, and then Adrian Skidmore, both Chemical Engineering graduates from Canterbury, and became a "white coat". The Development Department did a lot of testing of potential products and variations in ingredients etc. Until the company started manufacturing its own base detergents in 1966, all detergent products were compounded from raw materials from other chemical manufacturers, many overseas.

One of many interesting projects was to compare floor cleaner-polish formulations. The object was to test three locally available and cheaper materials, polymer and resin emulsions and a detergent, against the more expensive ingredients sourced through Lever Brothers UK. Suspecting that there might be synergistic interactions between the major ingredients, I decided on a full factorial experiment which involved making up sixteen (2^4) separate batches of the floor polish and applying them to carefully prepared black and white floor tiles under strictly controlled conditions. I enlisted colleagues to independently assess outcomes such as cleaning ability, clarity and colour, brightness of polish, scuff-resistance and water-spotting. Interesting but futile - we couldn't improve on the original UK formulation and ingredients.

Laundry Powder Trials

A particularly interesting set of experiences was occasioned while we were trying to improve the company's soap powder by pre-drying the soap base prior to mixing with the other main ingredients and spray-drying the mixture. We found a good-sized plate heat exchanger with an appropriate pressure rating and set it up to heat the soap base with high-pressure steam, ejecting the super-heated soap into a tank acting as a soap-steam separator. A large man-hole in the top of the tank vented the steam and allowed me to hear and cautiously see what was going on. The trial was going extremely well until I found that I was getting drenched – further complicated by a very loud siren. Unnoticed by me (and everyone else I might add) the steam vent from the tank was directly below a fusible link in the fire-water deluge system. First mistake!

Not only was I getting wet, so was my precious tank of pre-dried soap base. Showing commendable presence of mind I reached across the steam vent and dragged the manhole lid across. Second mistake! Despite the considerable pain of a live steam burn, I shut off the steam supply, turned off the soap pump and left the building to join some 350 company employees on the side of the road. I was the last to leave the factory so they all knew who the culprit must be, and I was greeted by cheers, jeers and rather half-hearted applause as we waiting for the fire brigade to finish its mandatory inspection and clear the site for re-occupation – and a chance for me to get to the local hospital out-patients' department to have my burnt arm attended to. The boiler suit had provided some protection and the cold fire-water had helped, but anyone who has been close to a fire-water discharge will know that it is dirty, rusty and particularly smelly.

But wait – there's more! It just so happened that I had chosen the day that the parents of my then girlfriend (later wife) were visiting Wellington and had invited me out to a show. I had no time to get home to change so I turned up at the theatre in a pretty sorry state – well and truly late, dirty, smelly and damaged.

If you were non-plussed at the negative reaction of my factory colleagues on having an hour's break from work from a false fire alarm you don't understand the significance of the "bonus system". Almost everyone on the factory floor was on a bonus system, based on their department's output. This meant that any time the "white coats" wanted to run a trial that might have any effect on production it was necessary to put all of that production department or line onto full bonus. Continuing to experiment with improvements to laundry powder, and not wanting to disrupt normal production and incur the cost of the required full bonus payments, we decided to produce and pack off our trial batch over a lunch-hour. The trial "blow" went well and the resulting laundry powder was packed off in plain packages for consumer trials. All that was needed was to put all the plain-packaged powder into cartons.

The two young women that normally did this job were a cheerful pair who spent their time chatting-up the fork-lift drivers, waving to friends, and occasionally picking up and opening a folded carton, slipping it over a chute, folding in the bottom end and pushing a pedal when the required number of soap-powder packets had accumulated on the conveyor belt. Automation pushed the packets into the carton, dropped the full carton onto another conveyor belt, glued and closed the top and bottom and sent it to the warehouse. A colleague and I decided that we would do that part – how hard could it be! When the girls (and the rest of the factory) returned from lunch they found two very embarrassed "white-coats" shovelling up spilled laundry powder, extracting mangled packets out of the machinery and waving goodbye to part-filled and strangely-buckled cartons *en route* to the warehouse.

Salt and glycerol recovery

Glycerol is a high-value by-product of soap manufacture and is flushed out of the soap by liquid-liquid extraction with concentrated brine, the resulting mixture being known as lye. Both the salt and the glycerol were recovered by concentrating the lye in a double-effect evaporator operating in a semi-batch mode. Lye was supplied to the first stage and the concentrated liquor accumulated in the second stage until the salt crystallised out and was separated from the concentrated brine-glycerol mix in a basket centrifuge. The glycerol was then recovered by vacuum distillation.

The process used a lot of steam and I developed what I thought was a clever technique that would use less steam and water. We did some trials and proved to everyone, including the operators, that the method worked and the steam savings were achieved – and I provided a revised set of operating procedures. I don't know to this day where I went wrong, but as soon as my back was turned the operators reverted to their previous mode of operation.

I worked for Lever Brothers (subsequently Unilever) for nearly four years and it was a good employer as well as providing me with an excellent background in the industrial applications of an engineering education. One of my reasons for leaving Lever Brothers was the apparently inexorable transition from a technical role into a management role. I was enjoying the technical side of chemical engineering and was not particularly interested in a move into production management.

Fertiliser Manufacturers' Research Association (FMRA)

My fiancé, Gay, had finished her degree at Victoria University and her next step was to attend Teachers' Training College in Auckland – so that was where we headed. Gay and I were married in Hawera early in 1969, timed in part so that my old rowing crew could attend. One of my best friends through University and Rolleston House was Graham Jamieson. Graham had gone to work in a petroleum refinery in Geelong, Australia, but was last heard of in Holland. I sent him a wedding invitation anyway, in the hope that I might squeeze a present out of him. The RSVP came from Kapuni if you please, just 15 km away – announcing that Graham and Lesley would be there with bells on!

I have quite forgotten how I found out about the job at the Fertiliser Manufacturers' Research Association **(**FMRA), but it was fortuitous. FMRA was formed to undertake research associated with the production and use of agricultural fertilisers in New Zealand and was part funded by government and part by New Zealand's several fertiliser companies. In those days "fertiliser" meant superphosphate made by the reaction of imported phosphate rock with sulphuric acid. FMRA was staffed by a Director and a group of about eight professionals - mainly physical and analytical chemists, two agronomists, and one engineer (me) - plus several technicians, a librarian and a gardener. I really enjoyed working on what were genuinely relevant issues in a collegial and multi-disciplinary organisation amongst interesting people and on a semi-rural location in Otara, south Auckland.

I worked primarily on manufacturing, materials handling and emissions control problems for the member fertiliser companies. There was a particular problem with the phosphate rock imported from Christmas Island which turned out to have impurities that interfered with the acidulation process and caused a range of problems with the product superphosphate. The work was published in a paper in the "NZ Engineering" journal in 1973.

Several of the people I worked with had research qualifications and I started to consider whether, if I wanted to progress in the research community, I should have something similar. FMRA was overseen by a board made up of senior personnel from the contributing fertiliser companies and a few government nominees, principally from academia. Brian Earl was one such nominee and at some stage we must have talked about the possibility of my returning to Canterbury to undertake a research degree.

I should admit also to having difficulties with the Director and was keen to have a change of scene. None of us is pleased to have our carefully written prose corrected (and frequently improved!) by someone else but I took particular exception to having my thorough error analysis described as "mumbo-jumbo" and deleted.

Chemical Engineering Department, University of Canterbury

And so it was that I returned to Canterbury as a geriatric post-graduate student and started a PhD under Brian Earl. The Department had changed significantly over the intervening seven years. Although several core staff remained, Stan Siemon had left and Tom Hagyard had died the year before. Miles Kennedy was the new HoD and Arthur Williamson, Jim Stott, Ian Gilmour and John Abrahamson were additions, as was the five-story Siemon Block.

The very considerable range of talents around the table in the post-grad lunch room made life interesting. I'm not going to dwell on that period, not because I didn't enjoy it but because I did – and probably for a bit too long!

To keep food on the table, once we had started a family, I must acknowledge Miles Kennedy's ability to pull odd bits of funding out of his sleeves. All the post-grads took on laboratory supervision and report marking, and I also did a bit of Fluid Mechanics tutoring with Miles. At one stage I was even appointed as a deputy assistant junior part-time lecturer and taught Linear Algebra to a dangerously bright group of final year students who opted to take Maurice Allen's Engineering Maths 4 option.

In 1973, during my time in the Chemical Engineering Department, the world was shaken by the first of the "oil shocks". I did not appreciate it at the time but, looking back, I believe the oil shocks of 1973 and then 1979 changed the trajectory of my career.

Kingston Reynolds Thom and Allardice (KRTA Ltd)

I have Miles Kennedy to thank also for my next job. Miles was, I think, the first Chemical Engineer to be elected as President of what then was the New Zealand Institute of Engineers (NZIE) and must have mentioned my up-coming availability in discussion with the incoming President, David Thom. David was a principal of the Auckland-based consultancy Kingston Reynolds Thom and Allardice – or KRTA Limited as it soon became. At the same time as I was offered a job by KRTA I was negotiating a position with a major Control and Instrumentation company in the US. KRTA was pressing me for a decision and the US company was taking its time to make up its mind so, after much soul-searching, I confirmed with KRTA. I will never know where a different decision might have taken me but I stayed with KRTA, despite a few name changes, for the next 35 years.

The Philippines

KRTA had secured a New Zealand Government aid contract to provide the Philippines, through the Philippine National Oil Company (PNOC), with geothermal services including geoscientific exploration, drilling, well-testing and resource assessment.

I joined KRTA in October 1977 and by November I was on my way to the Philippines, having had a lightning fast introduction to geothermal technology by way of a one-day visit to Wairakei. Pretty heady stuff after a somewhat closeted academia and dramatically accelerated by the downstream effects of the oil price crisis. I was expected to be away for about a week but, because things on site were moving so fast, did not get back to Auckland for six weeks, leaving Gay and two small children boarding with an aunt. Letters were regularly sent in both directions – not one was received at either end.

I had joined the company after a few years of exploration on the island of Leyte and just as a substantial, high-quality resource had been confirmed. As a result, the range of services was soon expanded to include environmental services, reservoir engineering and the design of geothermal steam-fields and power plants. For the next several years I spent around three months per year on what were known as "short missions" to the Philippines culminating in the commissioning of the Tongonan power plant, comprised of three 37.5

MW_e turbine-generator units. KRTA had been responsible for the design of the steamfield for PNOC and the power plant for the National Power Corporation (NPC).

My particular areas of involvement were the pipelines to deliver two-phase steam and brine to the separator stations, efficient separation to provide clean steam and the delivery of steam to the power plant. Disposal of the separated brine was a major issue and, after considerable investigation and trials, reinjection into the reservoir was accepted as the preferred solution. Although the major electrical load on Leyte was a copper smelter with a demand of around 15 MW_e, various factors combined to limit load growth for several years. With a small electrical base-load and highly variable domestic and commercial load this meant that the electrical demand varied enormously and both the steamfield and power plant had to be operated to cope with this.

Steam purity (pertaining to the residual dissolved solids entrained in the steam) is of critical importance in the satisfactory long-term operation of geothermal steam turbines and maintaining steam quality under rapidly varying flow rates and pressures poses particular challenges. Dissolved solids carried over into the turbine can have a damaging effect on glands and turbine blades, requiring frequent and expensive shut-downs for maintenance.

One of my minor triumphs in the Philippines involved getting the first deep well on Negros Island to discharge. The exploration well had been drilled into the side of a mountain and both high temperatures and permeability had been ensured. It was a particularly deep well, around 3,500 m I think, with a static water level some 600 below the wellhead. Airlifting is sometimes successful with shallow wells but the usual method of getting a newly-drilled well to discharge was to compress the well to push the water level down into the high temperature zone, allow it to heat, and then release the pressure. If the boiling water column reaches the surface the well will usually continue to discharge.

This technique did not work for this particular well because of the depth of the static water level and the 600 m of cold steel casing between the high temperature region and the surface. After a bit of analysis, we came up with a plan to use a small diesel-fuelled boiler to simultaneously heat and compress the well. It was quite an expensive approach but it worked and the well proved to be a very powerful producer. The PNOC manager, who had been concerned at the cost and very sceptical of our success, presented me with a bottle of whiskey – which the Regional Manager of the time promptly commandeered. Where did I go wrong? The Palinpinon resource now supports some 200 MW_e of generation capacity.

In 1989, after a few years of economic and political turmoil, including the 1986 revolution that overthrew Marcos and then five attempted *coups d'état* against Corazon Aquino, I went to live in the Philippines – this time with the family. It was a wonderful experience for us all and none of us would have missed it. It was a very busy couple of years, working within a very demanding client's office on a very wide range of activities over some five geothermal project sites. A couple of highlights are worth mentioning, one being the first time the Tongonan power plant at last achieved full output on all three turbines – around seven years since the plant was commissioned. This was only achieved by connecting the island of Leyte, via Samar to the main Philippines island of Luzon. The other highlight was the sixth and final *coup* against the government of Corazon Aquino and complicated for us by having my mother staying with us at the time. After about three tense days we "escaped" from our central city suburb to a suburb on the outskirts of Manila and returned home a couple of days later to find a hole in the roof and a bullet lodged in our son's bed.

Indonesia

When the New Zealand Government allocated aid funds to support geothermal technology for developing countries, KRTA was awarded the contract for the Philippines and Geothermal Energy New Zealand (GENZL) was awarded Indonesia. As their experience and capabilities grew, both companies looked elsewhere for opportunities and KRTA started looking seriously at Indonesia as well as the US, Japan, Canada and Africa. I made several marketing trips to Indonesia from about 1980 and found it surprisingly different from the Philippines. In addition to an abundance of volcanos, Indonesia probably has more geothermal generation potential than any other country.

After what felt like years of chasing Indonesian government departments (Pertamina and PLN), we landed a feasibility study on excellent dry-steam prospect with an American oil company – which proved to be the first of many.

Canada

My geothermal involvement in Canada was brief but interesting. In 1982 I was sent to Vancouver to establish a downhole well-measurement contract and I was not expected to be there for more than a week. Our client was BC Hydro and our office in Vancouver occupied part of a floor in their substantial headquarters. The financial crisis of the time in British Columbia meant that one whole floor of the building was assigned to assisting staff that were being made redundant.

I put in a bit of time in Vancouver but eventually was provided a great big pickup truck and headed up to site. The project was quite high in the Rockies, three hours drive north of Vancouver where three deep wells had been drilled. Reasonably high temperatures had been found but poor permeability, so the wells would either not discharge or, if they did, not continuously. I'm a temperate-climate person and after so much time in the tropical Philippines and Indonesia I loved it. It was late October, the snow was steadily creeping down from the tops and the local wild-life was heading south to their winter quarters - elk, bears, salmon, wolves and too cold for the viciously biting flies. What's not to love?

In the event, I was living in a Canadian drilling camp for seven weeks while overseeing well-testing operations and waiting on an engineer to take my place. On my return to Auckland I was met by Gay at the airport but instead of a welcoming hug she held me at arms' length and said "What the hell have you done?" Where did I go wrong? It transpired that I had lived rather too well and came back 8 kg heavier than when I'd left. I blame it on long days, extraordinarily good catering and the cold climate. In reality, it was just greed.

Kenya

In 1984 KRTA was invited to provide an engineer to join a World Bank team to assess progress with geothermal development in Kenya – and I was lucky enough to be chosen. Kenya was just fantastic! The World Bank team comprised a German economist, a Belgian resource specialist, an American drilling expert, an English logistics engineer. Interestingly, the *lingua franca* (when I was not around) was Spanish. We had undertaken a very comprehensive investigation and had only a couple of high-level meetings to complete the mission when the Kenyan Government elections intervened. Elections are taken very seriously in Kenya, and Nairobi in particular, with routine mayhem and occasionally mass murder. We were strongly advised to leave Nairobi for a few days so engaged a vehicle and driver and went on safari.

After my first and fascinating taste of Africa I spent two weeks at World Bank headquarters in Washington DC completing my report. Washington DC is very attractive in late October and I was lucky enough to be shown around by one of the team members. With my final report and before I left for home I also submitted my record of expenses which caused some consternation to my team leader. Where did I go wrong? Apparently, I had lived far too frugally, which was seen as making it difficult for those who expected the World Bank to bankroll a much more extravagant lifestyle.

I really enjoyed Kenya and the Kenyans and was fortunate to be involved in a couple more contracts that KRTA won in Kenya. I found myself working closely with Paul Quinliven, another UC Chemical Engineering graduate, although our two companies (KRTA and GENZL) were competing for projects in Kenya. Paul eventually joined KRTA and I worked closely with him in Indonesia. After a hiatus from about 1987 to 1996 Kingston Morrison won a small piping contract, then another and then a couple of major power plants – maintaining a foothold in Africa to this day.

Short-term visits to other places

In the interests of name-dropping I should make passing mention of Fiji, Papua New Guinea, East Timor, Taiwan, Iran, Japan, the US and Yemen. All of them interesting, some fascinating, with the weirdest being Yemen. Where did I go wrong? Due to an airline mix-up, I flew around the middle east for two days with no sleep, arriving in Sana'a at 7:00 am for 9:00 am meeting. I was completely stunned and it must have been obvious as I was allowed to defer the meeting until the next day. Iran was interesting in that I had driven through the country some 50 years earlier. The saddest would have been East Timor – robbed by Australia to the south and raped by Indonesia to the north.

Other Chemical Engineering Projects with KRTA, Kingston Morrison and SKM

Although geothermal projects formed a major part of my career I was very often involved in a wide range of other projects ranging from the bizarre to the optimistic to the disgusting. Due-diligence studies, failure investigations, process plant performance trials and feasibility studies were a significant part of my work.

The petroleum crises of the 1970s resulted in the investigation of a wide range of transport fuels options. An early project was the design of an Ethanol from Woodwaste process for a timber-processing client and, later, saw the unfortunate closure of an Ethanol from Woodwaste plant that had been very sensibly designed (although not by KRTA) to use geothermal heat to power its ethanol distillation columns.

On behalf of the Liquid Fuels Trust Board, a consortium of engineering consultancies undertook a major study to evaluate the production of transport fuels from coal, forestry and agriculture. As part of that I was sent to Germany, the Netherlands, the United Kingdom and the US in an attempt to glean a little information on how the rest of the world was planning to manufacture transport fuels from coal. Where did we all go wrong?

By the 1990s, the issues of global warming, the environment and sustainability were having a far greater influence on decision-makers and technologies such as geothermal and biomass were benefitting. Unsurprisingly, the production of process heat, electricity, transport fuels and chemicals from woodwaste have also been recurring themes and have resulted in several interesting projects in New Zealand, Australia and Fiji.

I have had my fair share of involvement in projects that for whatever reasons did not achieve a desired outcome. One of these was the sad failure of a plant to extract resins and waxes from a kauri swamp in Northland. Extensive field work and laboratory trials had confirmed the resource and a method of extraction and processing to deliver a range of high-value materials. A commercial-scale plant had been designed (by others), manufactured and installed but, unfortunately, the step from laboratory to full-scale was too great. The very first step, solvent extraction of the resins and waxes from the peat, did not work. While having had no prior input into the debacle, Kingston Morrison was engaged by the client and provided a pragmatic solution that might well have worked. Despite this, the bank foreclosed and the whole plant was dismantled by the receivers and sold off in pieces. I believe the project has recently been revived.

Another project that showed promise was the development of a process to dry and burn sewage sludge. I was invited to review the process design for a company called Enviro Energy and built a numerical model of the process in Excel. The result was sufficiently promising for the company to build and operate a near-commercial scale pilot plant which obtained promising performance data and, to my mind, proved the viability of the process. SKM's involvement in the Sludge Total Energy Recuperator Module (STERM) was the observation of a couple of long-term trials to take relevant measurements and confirm the plant's performance. Numerical modelling continued to optimise pilot-plant performance and as a basis for full-scale plant design. No clients could be found to undertake the next step and, despite the promising pilot-plant performance, I believe the company has folded.

Algae are interesting little things with the potential for fodder or fuel; they can be grown from dairy whey, for example, using the residual nutrients. They may also be grown in brine, dosed with nutrients, sparged with CO_2 from a handy coal-fired power plant and fuelled by sunlight. I put a lot of effort into a design for an Australian organisation but was stymied by a client who didn't understand that at some point the design has to be frozen in order to complete the P&IDs.

The production of trimethyl borate for timber treatment was an interesting project and one that touched on work done in Canterbury by Roger Keey and Maurice Allen, alongside Russell Burton of Scion, a past President of SCENZ. I went right back to basics and did a distillation design by hand – Roger Keey would have been proud of me. I have no idea whether I went wrong as I don't think my elegant design was ever implemented. If you're interested – 13 plates with a reflux ratio of 4.4.

In another distillation related project, we were engaged to find out why a small distillation column was not working. On opening the column we found that the packing, comprising small rubber dolls, had collapsed over time and the dolls were cuddling each other in a heap at the bottom of the tower. We specified an appropriate dumped packing, advised the client of the likely cost – and heard no more!

Other projects and products that were interesting included microsilica, ferro-silicon, sulphur, feldspar for fibre-glass, herbal extractions, nitrogen oxides recovery, medical wastes disposal, natural gas seeps, coal-seam gas, industrial cogeneration, oilseed extraction, phytochemicals, zeolite and medium-density fibreboard.

What does it take to be an engineer?

I made my way relatively easily through university by being able to pass examinations, but it takes much more than an ability to pass examinations to be a good engineer. Two of the most capable engineers I know had great difficulty passing exams and took 7 and 10 years respectively to get their Mechanical and Electrical BE degrees. One built the first TV set I watched from bits and pieces. He spent a good bit of his life picking apart the coding on the computer systems of expensive cars – because the manufacturers were not prepared to authorise access to their code. The other headed up one of NZ largest manufacturing and contracting Engineering companies.

I was lucky to work with some very talented engineers, many of whom could and did run rings around me in terms of experience, general capability, rapid recall, spotting the flaw in a design and speed of assessing fast-moving situations.

Employer of engineering graduates

Over the course of 35 years I had a hand in employing many chemical engineers, the very first including Tony Menzies, Dr Clive Couldwell and Gretchen Kivell, all graduates from UC. Clive and Gretchen in particular were returning to New Zealand with valuable international experience. I found relatively little difference in general capability between the New Zealand universities, or indeed between chemical engineers from other countries.

In particular, I was always impressed by the capabilities of brand new graduates and even students. In my last couple of years at SKM I sat next to a young Asian woman graduate as she got to grips with the wide range of technical issues that were dropped onto her in the course of normal work. I was often able to assist her but, just as often, found myself asking her for assistance with issues relating to software techniques and complexities.

Women in Engineering.

In my 1962 intake at CU there was just one female student, who was in the Electrical Department. In the following year the delightful Thongtip Honglaradom, from Thailand, joined the Chemical Engineering Department. While I was at FMRA I employed Margaret Clark as a Chemical Engineering student getting her practical work experience. When I returned to the Department in 1971 the proportion of female students averaged around 30%, and I remember encountering several extremely bright and competent young women while supervising and marking laboratory work.

When I joined KRTA there were no female professionals although support staff were predominantly female. Around 1980 I employed Gretchen Kivell (nee Kershaw) as the first female engineer in the company. Gretchen had just returned from the UK with pretty valuable experience and took no time in establishing herself within the company. When KRTA joined Morrison Cooper and Partners to form Kingston Morrison in 1990, I worked with another highly competent chemical engineer in Jenny Culliford (nee Morrow); both these women made very significant contributions to the engineering profession as President of IPENZ and Chair of the NZ Engineers' Registration Board respectively.

Computing within KRTA

Something of a revolution occurred in the world of calculation with the advent of programmable calculators, probably in the late 1970s. Of these (with its extensive range of functions and stable of accessories such as printers, memory cards, maths, stats and games packages etc) the HP45 was undisputed king. Because of the HP45's manifest capabilities, we bought them with our own money!

Having worked extensively with the University's Burroughs mainframe computer and the Department's DEC, I was surprised that KRTA had no computers at all. A computer was installed by around 1980, but solely for accounting and payroll. I enlisted the services of a good friend who had been the computer services manager at Waikato University and who came into the KRTA office to give senior staff a talk about computing, including hardware, software, capabilities and opportunities. Soon after that the company purchased its first personal computers - two tiny DEC "Rainbow" PCs for an office of around 150 personnel. I have no recollection of the specifications of these PCs but they required a boot disk to get them running and they ran Lotus 123 and WordPerfect. Within about a month these machines were booked out from early morning until late in the evening.

The future of Engineering

Technology is moving faster than it ever has. My mobile phone has more overall capability that the mainframe IBM 1640 that the CU Engineering School purchased in 1961. It has far faster processing speed, far greater memory and it has communications capabilities that had not even been dreamed of. Fifty years ago it was barely even science fiction (Does anyone remember comic-strip detective Dick Tracy and his watch radio?) and is now ubiquitous and international – and additional capabilities are added all the time.

How then to prepare prospective engineers for an unknowable future? The laws of chemistry, physics, mathematics and thermodynamics continue to be nibbled at around the edges, but the fundamentals have remained intact for long enough to suggest that they are still the basis of robust engineering analysis and, therefore, the basis for a sound engineering education.

Some aspects of engineering design these days may at times appear formulaic – i.e., the identification and compliance with the relevant design codes. Most engineers know, however, that different countries, different clients, different materials, different constraints – and even different nationalities - can introduce all sorts of complexities. In these situations there is no substitute for an ability to understand, interpret and undertake the fundamental analysis that underpins these codes.

The Engineering Institutions

As a long-term member of the Institution of Chemical Engineers (IChemE) I was closely involved as the Society of Chemical Engineers New Zealand (SCENZ) negotiated its transition into IChemE. For professional engineers in the country, however, I believe we should also maintain a close relationship with Engineering New Zealand.

These organisations provide a range of services and support that many engineers are often only vaguely aware of and some that are very seldom used. As is so often the case, the local committees are comprised of volunteers who put in a great deal of time and effort on behalf of a wider group. One of the more important services that IChemE contributes to on behalf of New Zealand engineering graduates is the regular review of the New Zealand engineering schools to ensure curricula and student attainment are being maintained to Washington Accord standards.

Conclusion

Where did I go wrong? In my choice of a Chemical Engineering degree and following a career in engineering, I don't think I did. It has taken me to interesting places, provided a good living and introduced me to wonderful people, both clients and colleagues. Was my decision to undertake a post-graduate degree a good idea? By working in an engineering consultancy for most of my career rather than in research, my time might have been better spent in a wider range of industries. In saying that, however, the qualification has occasionally been useful and, over the course of my career, I have employed five PhDs, all of whom were extremely capable engineers.

With the benefit of hindsight, would I do it all over again? Without hesitation!