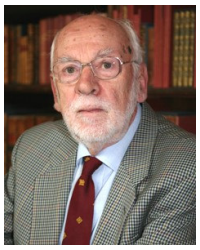
An Eighteith Birthday



A Response, 28th February 2010

by Ron Ferrari (1966)

Dr Ferrari celebrated his 80th birthday on 3rd February 2010. Shortly thereafter a large company of Fellows and guests drank his health after dinner in Hall. Dr Ferrari responded as follows.

Master, Fellows and guests, it is with great pleasure, no little gratitude and some personal astonishment that I stand here in Trinity responding to a toast on having reached my 80th birthday. In what follows I will try to expand upon events which have led to my being here today.

I was born in Hornchurch, Essex into a working-class family which had just moved to the suburbs from East London. My father was Italian, brought from Northern Italy as a young child with three siblings by my effectively single-parent grandmother. Grandma moved into a disused pub in the London Docklands area, setting up a shop/café there. My maternal grandfather was Swedish seaman who settled in the East End to marry my one English grandparent; my mother was one of their nine children. Father was a thorough artisan, good and ingenious with his hands. After working as a driver of solid-tyre London buses, in 1916 he joined the Royal Flying Corps and served his time in the First World War as an aircraft-engine mechanic. Then he ran a fleet of tankers for an East London tar distillery, as chief mechanic and organizer. My childhood was permeated with Dad's things mechanical and electrical. He messed about with motorbikes, an Austin 7 car and many other bits of engineering, while my earliest memories include listening to the radio which he had himself built.

I had four siblings. Soon after the family moved to the new suburban house in Hornchurch my eldest brother Charlie as a teenager suffered a brain tumour and had an operation to remove it. These were early days for brain surgery; he was left severely disabled but he lived to a ripe old age, a forceful, sometimes awkward, personality but always displaying great fortitude.

My early education was at a Hornchurch state primary school which excelled in its teaching. I took lunch-hour violin class-lessons (at 6d a time) and sometimes played solos at school. Then came the Second

World War and, at short notice, our family was required to leave our home because of its proximity to the nearby RAF Hornchurch fighter air-base, my father technically being an enemy alien despite having served in the Flying Corps at that aerodrome. We found a council house in nearby Dagenham. There, in the 'Blitz' of 1940, the family survived an almost direct hit on the back-garden Anderson air-raid shelter in which we were sleeping, so close that the shelter lay precisely at the edge of the twenty-five foot bomb-crater. Remarkably none of us was injured and I'm told that I remained asleep after the impact! After this my mother and we three younger children went into lodgings in a village near Derby, giving me the lasting experience of living in the country. I took and passed the 11 + exam from Mickleover village school, while we returned home in mid-1941. By this time my father, with disabled Charlie, having had enough of living in a bomb-damaged council house, moved back to the empty Hornchurch house, ignoring the bureaucracy which had forced us out.

My 11+ choice was the South East Essex Technical School, a mid-1930's educational experiment where, without neglecting academic learning, you could also study practical science, technology and commerce. This all took place in a brand new architect-designed building complex in Dagenham that also doubled as an adult polytechnic, which later became part of the East London University. Things were disrupted by the war but I prospered academically, and played violin in the school dance band. I won the school science prize in the 5th form and was presented with it by RA Butler, then the Minister of Education. With my white hair and white beard, some friends have teased that I look like a prophet; had that been so I would have said to RAB as he shook my hand 'We are going to meet again in twenty years time, you as Master and me as Fellow of Trinity!'

In the Schools Certificate as it was then I got a goodly bunch of A's but, in 1946, what then? There was no sixth form at the Technical School, for if you wanted further education the adult Technical College was there in the same building. Instead of the Higher Schools Certificate, for some there was the London External Intermediate BSc exam. My family didn't quite understand why, like most of my peers, I didn't go out and get gainful employment at 14 or 16. However, dear old RAB solved my problem by creating legislation that allowed me to get an Essex County maintenance grant, the Inter BSc counting as a *degree* examination. I took this exam in one year at 17, doing double maths, physics and chemistry with A's and B's. My cousin Christine Sandeman, whose family had remained in an East London terraced house, married a boy with a physics degree from Imperial College, London. Still with a year in hand I

decided that Imperial College was also the place for me. Meanwhile at the Tech I embarked upon their external 'general' degree course in physics and maths, still with my County grant. I took the Imperial College entrance exam and got one of their Royal Scholarships for a place, with full financial support, to read mathematics.

In 1948, just after the war, Imperial College only had the facilities to teach the maths course for two years whereas the University of London, of which IC was then part, required three years of study. So after two years, I took on an engineering-related piece of research work on the mathematics of elastic waves in concrete strata—with airfield runways in mind. I wrote a dissertation, getting the IC masters degree diploma as well as then qualifying for the London University BSc degree. In the two IC summer vacations I worked first in the electronics research laboratories of the Dutch Post Office at The Hague, the next year at a new hydro-power station on the Arctic Circle in Finland, variously helping or hindering with surveying.

At that point I might well have gone on to do a PhD but with the family wonderment that, aged 21, I was still at 'school', I took the option then to do my National Service, getting a commission in the Royal Air Force. I did a 3-month course on radar on which I gained top marks, perhaps because I found electromagnetic radar waves a tad simpler than stress waves in concrete while I already had some useful electronics background. I was selected to work in the Operational Research Branch at the headquarters of RAF Bomber Command in High Wycombe where I did interesting things relating to radar, still in its infancy, and in countering the Cold War, which could have turned hot. I signed on for an extra year but realised that becoming a regular member of the armed services wasn't part of my life plan. I mixed with many war-veteran surviving aircrew, and went on quite a few test trips in the uncomfortable four-engined wartime aircraft. Most of my research interest since then has been concerned with those ephemeral electromagnetic waves, which have proved not to be all that simple. I took violin lessons in High Wycombe and had a string quartet which included two members from the Ministry of Supply who professionally did business with Bomber Command

After the RAF, in 1955 I took a job with the Research Laboratories of the General Electric Company in Wembley and worked on semiconductors in their early days. Following research done at Bell Laboratories in the USA and using silicon crystals 'grown' in Wembley, I formed a one-man band and constructed working silicon rectifiers which, ridiculously small, I showed could power an electric fire somewhat unnecessarily with direct current. Such rectifiers were new in Europe.

When a production line was set up, I moved back to electromagnetic waves. In the early1960's there was a quest in the communications world to go to higher and higher frequencies—tens of GigaHerz were just about the limit then, because the delicate copper structures required of possible electronic devices were awkward to construct and tricky to employ. One possible alternative was to utilize the reaction between an electron beam and magnetised gas discharge 'plasma'. Drawing on some predictions, originating again from the Bell Labs, I personally constructed a microwave amplifier based upon such a scheme. My amplifier worked but aspects of its performance didn't stack up with the simple Bell Labs theory. I had access to an early mainframe Ferranti digital computer, learned its programming language and showed that a more sophisticate version of the Bell Labs theory, needing serious computation, gave results which did agree with my experiments, constituting the basis for my first scientific paper. This was the start of my lifelong interest in modelling electromagnetic devices on a computer. However, my rather capricious gas discharge device was overtaken by the invention of laser and semiconductor high frequency devices.

A music society, far from a one-man band, then flourished at the GEC Research Laboratories at Wembley. Every so often the society members would divert their research energies into some ambitious musical venture in a way which perhaps would never happen in industry today. It was indirectly through one of these events that I met and married (in 1959) my life's partner Judy. In fact later on Judy sang a lead part in a GEC Labs performance of Handel's *Acis and Galatea* while I led the orchestra. Also during this time I turned more and more to playing the viola, which I found gave me great satisfaction when playing chamber music. I auditioned for and was offered a part-time place to study the viola at the Guildhall School of Music. Still continuing with my GEC job this led, also in1959, to my getting the LGSM performers' licentiate.

Cornell University in the USA invited me in 1964 to take over the supervision for a year of a graduate student investigating electron beam–plasma interactions, while the regular supervisor Lester Eastman was away. The GEC gave me unpaid leave while Cornell paid me handsomely. Nothing particularly exciting happened as a result of the research work but I was also called upon to take over quite a lot of Eastman's teaching, more than I had bargained for. I gave a full semester's course on physical electronics and assisted in the electromagnetics teaching. By this time Judy and I had two young children and, overall, for us the year away, living on the beautiful Cornell campus represented halcyon days. We travelled around and made many good friends, quite a few of them

musical. The Cornell year was another turning point in my career; I applied for and was appointed to a lectureship in the Engineering Department here in Cambridge starting in October 1965

To lecture at Cambridge and perform lab demonstrations was a salutary experience. Charles Oatley here in Trinity was very supportive, found me supervisions to do for the College and a year later I was appointed to the Trinity Fellowship which I have held ever since. I took over a research student half-way through his project on gas discharge plasma diagnostics. Together we successfully modelled his electromagnetic probe using a numerical procedure which was pioneered at Imperial College in my time there and was now ripe for mounting on the Cambridge Titan mainframe computer. This reinforced my earlier excursion at the GEC into numerical modelling of electromagnetic devices.

In 1968 I was appointed to a three-year stint as University Proctor. This period included a time of extreme student unrest, culminating in the arrest of a dozen or so students on criminal charges of riot following a disturbance late in 1969 at the Garden House Hotel. There are aspects of that unhappy affair that never became public, because of the formal constraints of the legal procedure which ensued.

I have frequently joined in with Trinity and University music. One memorable experience in the early 70's was leading a string quartet which went on a summer tour in Yorkshire, accompanying the University Chamber Choir. This mixed-voice choir, run by Richard Marlow in the days when Trinity choir itself was all-male, can perhaps be regarded as a precursor to the present-day choir here, of which we are all very proud.

My research activities continued into the 1970's with taking on graduate student Eric Munro to do a PhD in electromagnetic modelling. Early on, Eric and I attended an invited seminar given by one Oleg Zienkiewicz, who was successfully solving some differential equations used in structural mechanics by what he called 'the finite element method' and who continued as the doyen of the finite element method until his recent death. To-day this methodology represents a tool much used in engineering and physical design. After that early seminar, Eric and I went away saying to each other, 'Hey, these equations are just like the ones we want to solve!' So we set about applying the finite element method (FEM) to electromagnetics, Eric in particular to the hitherto intractable nonlinear problem of magnetic-lens design for the electron microscopes at that time being pioneered by Oatley's Group in Cambridge. Eric went on to win a Trinity Title A Fellowship for this work. Another Group, at McGill University, led by Professor Peter Silvester, was independently working on

the FEM applied to electromagnetics and I arranged for Eric to spend a month or two with them in Montreal. Later on in 1973 I spent a whole sabbatical year working with Peter's group, gaining much from the interchange of ideas, while at the same time writing a text book *An Introduction to Electromagnetic Fields.* The whole family, now with four children shepherded by Judy, accompanied me for that year, experiencing the somewhat extreme climate of Montreal—minus 30 to plus 30 degrees Celsius. Everybody had a whale of a time!

I returned, charged up, to Cambridge and, as well as doing my stint of University lecturing and Trinity supervising/direction of studies over many years, have added my bit to the FEM electromagnetics modelling scene. For quite a time this topic remained literally static–-that is to say it was mainly concerned with electrical machine design and couldn't handle time-variation anything much faster than the 50 cycles of domestic and industrial mains electricity AC supply. Anything approaching the frequencies of radio waves, microwaves, optics and so forth encountered an extra, troublesome, term in the governing mathematical theory. With two successive research students, a couple of FEM papers (1976 and 1981) were produced that contributed substantially to breaking this barrier, now usefully overcome.

A liking for the open air had led me to dabble with mild mountaineering in the Austrian Alps. So in 1976 when asked by my Trinity colleague Keith Miller to go to on to the Vatnajökull glacial ice sheet in Iceland to help in radio-echo depth sounding through the ice there—analogous to radar detection in air—I jumped at the chance. Radar waves penetrate really cold ice well, but this is a 'wet' glacier, mostly at 0 Celsius. Some Canadian research suggested how one might overcome the wetness, by using a pure, unmodulated, pulse utilising its own spectrum as the carrier frequency. I took on the design of the antenna and calculated that it should be an 80 metre-long wire, with many resistors appropriately spaced along it. This was constructed in the Engineering Department, with waterproofed transmitter and receiver units, and then shipped to Iceland. That June the Icelandic Glaciological Society took Keith, myself and Title A Fellow Gerry Owen in their tracked snow-vehicle on to the 40 x 60 mile wide and 6000 foot high Vatnajökull icefield, to test our equipment. It worked as predicted. On the way they took us to Grimsvötn, an active volcano paradoxically covered in ice, which our hosts assured us wouldn't just then be doing any of the strange things expected of that combination; we peered over the caldera edge. Maybe placing as many as three Fellows in such an unlikely location can be counted as a Trinity excess; surely no other college would have hazarded more than two

Fellows thus. We were later left to test our equipment, sheltered in totally inadequate Glacier Society tents, when a force 10 gale blew up, forcing us to retreat on foot to a glacier hut some ten miles away.

Our successful tests were static ones, done at a single location. The indefatigable Keith Miller resolved that we would return on our own the following summer, 1977, to trail the equipment the length and breadth of Vatnajökull to carry out a proper survey. This we did with a party of six, five from the Engineering Department and Jim Bishop from the British Antarctic Survey (BAS). We moved around with a converted amphibious, tracked, military Weasel, known to work well on ice. It had been presented to us by BAS; they also lent us two decent tents that could withstand even a 100 mph gale. The daunting logistics of this venture were entirely solved by Keith Miller's genius. As a result we did the first-ever extensive survey of the Vatnajökull ice thickness profile, finding depths of nearly a kilometre in places. That's a story in itself. In my family we have a scale of uncomfortable situations, with camping on a glacier in the rain placed at the high end.

In 1980 I visited Russia, sponsored by the Royal Society and the Russian Academy of Sciences. I saw at first hand something of what it was like to be in the Soviet Union during the Cold War. It was certainly a creaking bureaucratic giant but I was warmly welcomed everywhere by the academics I met. My point of contact was Ukrainian engineer Sergei Khotiaintsev, a specialist in optical waveguides at the Kiev Polytechnic University, who had been a visitor at Imperial College. He invited me to Kiev; I gave a seminar and was shown much of the academic, cultural and historical highlights of the city. Sergei also quietly bemoaned to me the problems of Soviet life. Having a passing interest in probing frozen earth with radar I was invited to visit the Permafrost Institute in Yakutsk, in the northeast of Siberia on the mighty Lena River. There was an unscheduled 24-hour delay at Novosibirsk on the outward flight from Moscow, due to fog and I experienced, unmonitored by the Academy of Sciences, the extraordinary privation of the airport lounge with seemingly hundreds of Russians also similarly delayed. I was well received in Yakutsk and gave a seminar with a running translation performed by their local interpreter, but the slide-projector broke down!. I was then flown a time-zone back, via the Siberian diamond mines at Mirny, to a hydropower station in the permafrost. My visit there ended with a weekend picnic cruise accompanied by the permafrost scientists and their families on the enlarged Vilyuy river, tributary to the Lena, upstream of the dam. This was in the motorboat used to monitor possible damage to the frozen landmass. They flew the hammer and sickle from their mast, just for my

benefit!

My work on 'finite elements' continued meanwhile. In 1983, with coauthor Peter Silvester, I published *Finite Elements for Electrical Engineers*. There are better books about on the subject today but ours did go to three editions and was translated into four different languages. Sergei Khotiaintsev did the Russian translation, and at 1½ roubles per copy under the old system it sold very well; Sergei and I still keep in touch.

In 1990 I took early retirement from my Engineering Department's University Lectureship post but continued with my Trinity teaching. While some thrive, gaining strength from teaching to stimulate their research, I personally found that the full Departmental and College load inhibited my output. I believe that some of my best personal research has been done since 'retiring': I have written on the FEM numerical modelling of electromagnetic waves in periodic lattices, including photonic crystals, and authored the first paper to solve the related classical quantum periodic lattice problem by the finite element method. In 1994 I received the Cambridge ScD in recognition of my published works. Recently, in collaboration with colleagues at Stellenbosch University, South Africa, I have introduced and published papers on new way of modelling electromagnetic wave-scattering in hollow waveguides. I am currently pursuing personal work extending this methodology to fibre-optic waveguides which I believe has brought up some further new fundamental aspects. So that is where I am today, also fortunate in still being able to enjoy my passion for playing chamber music

It is with much gratitude that I acknowledge the support of Trinity College which has contributed much to what I have related here. Finally I want to pay tribute to Judy for her vital part in all of this, and to my children and seven grandchildren. who all have made it worthwhile.