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Engineering Heritage Canberra Professional Career Series

ENGINEERS AUSTRALIA
Canberra Division

The Institute of Engineers Australia

Engineering Heritage Canberra

National Engineering Oral History Program

INTERVIEW LOG

Interviewee: Peter O'Neil Carden **Tracks: 5 = 4 hours, 52 minutes recording time**

Interviewer: Simon Grose

Place of Interview: 6 Wynter Place, Hughes, ACT

Dates of Interview: 2, 10, 17 and 23 November; 14 December 2014

Restrictions on Use: None - see Interview Release Form

Peter Carden in conversation with Simon Grose
Session 1
2 November 2014
6 Wynter Pl Hughes, ACT

00.00 – 02.32
Peter was born in Melbourne in 1930. His father was from the Lakes District in UK. He was in the merchant navy, joined the British Navy in WWI and then worked as a taxi driver in Paris where his first wife died after giving birth to Peter's half-brother Dick. His father and Dick then came to Australia and settled in Sydney, but it would be almost 50 years before Peter discovered that Dick existed.

02.32 – 04.30
When the Great Depression hit in late 1929 Peter's father was a real estate agent in Sydney. He and Peter's mother were married in Sydney in 1930 then moved to Melbourne where Peter was born. After two years in Melbourne Peter's father – who had developed a cancer in his leg - moved to Adelaide where he had a brother who was a doctor. Peter and his mother returned to Sydney and lived with her parents in Rose Bay. His grandfather, William Green, who died when Peter was about 10, was an influential and well-loved father figure for Peter. A former Mayor of Tamworth, he was a free thinker.

04.30 – 10.50
Peter discusses his father's early life. Peter's mother's father was born in Newcastle-on-Tyne. He followed his older brother to Australia, probably bringing his mother with him. He would marry Phoebe Baker, the daughter of a brickmaker in Maitland.

10.50 – 12.30
Peter's father eventually returned to England where he died. Dick also stayed in England and has also died.

12.30 – 16.08
Peter attended Rose Bay Primary School and then Randwick High. When his grandfather died early in WWII Peter was given a dog as a new friend. After his mother died in the middle of the war Peter and his grandmother moved to Ipswich to live with her other daughter who was married to a bank manager. They had two daughters. Peter went to Ipswich Grammar, was a healthy teenager and generally happy, enjoyed the companionship of his dog. After matriculating in 1948 he got a Commonwealth Scholarship to attend the University of Queensland.

16.08 - 18.50
"I was always going to be an engineer". His grandfather had had a workshop where he made teaching aids for schools and painted watercolours. Peter started making things there. His mother and grandmother always told him he would be an engineer.His science teacher at Ipswich Grammar, the headmaster, was a good teacher. Another teacher, Mr Hadgraft, who taught English and Ancient History, was also influential. "He widened my outlook and taught me about life…during my career I realized you have to communicate… and I put it down to him".

18.50 – 22.15
He boarded at Kings College at UQ. University life was good, he had good friends and had just enough money by working during holidays. After the war work was not hard to find. His first holiday job was at the Ipswich Railway Workshops which was a big operation. Another year he went to Sydney to work for a telephone manufacturer, and another to the Weapons Research Establishment outside Adelaide. The last was Mt Isa, "because of the lead bonus".

22.15 – 26.00
In 1953 Peter graduated as a Bachelor of Engineering – Electrical in Communications and married Shirley Franklin from Townsville who had graduated from the Queensland Teachers Training College in Brisbane. "We just clicked and that was it." Peter recalls that his travels around Australia during his undergraduate years were mainly by hitchhiking.

26.00 – 27.30
He and Shirley went to Mt Isa at the end of 1953 where he would work for the lead/zinc mine and Shirley worked as a teacher. "It was a wild west boom town". They rented half a living room in the house of an Irish family. "They landed in Brisbane, took a train up to Mt Isa and they didn't know what hit them. They had nowhere to live so they engaged a builder who wanted the lead bonus too so they ended up with a house that cost a fortune". Peter built a partition across the living room. Because the house was on the top of a hill the water pressure was not strong enough during the day to get water to the house, so at night they filled the bath with water to use the next day. Bathing was done under a tap.

28.30 – 33.00
After 5 months in Mt Isa Shirley was pregnant so they decided to leave Mt Isa. Peter "wrote to the Government" asking for a job and he was given a position at the Weapons Research Establishment as an Experimental Officer. They travelled there by train, with two suitcases and two bicycles, changing trains at each state border and each capital city. His new boss, Dr David Robertson, "a really great bloke" was researching Doppler radar to identify the velocity as well as the position of targets. Peter was designing and making "electronic stuff" including wave guides, with access to a very well stocked equipment store, "anything you wanted, they had it".

33.00 – 38.20
Peter enjoyed working under Robertson because "he would tell you what he wanted and why, and let you go, give you minimum guidance, and that was good for me". The pay was good (about 800 pounds a year, plus a house), and they were able to buy an Austin A30 "that went all over Australia". He drove it to Adelaide to visit Shirley when she was in hospital to have their first child and was held up by the Queen's procession through the city as part of her 1954 visit to Australia.

38.20 – 42.40
Peter was offered a year-long position in the UK to study guided missile technologies. They came very close to going but decided to stay in Australia. Robertson had been a student of Sir Mark Oliphant in the UK and when the man responsible for the electronics at Oliphant's new Research School of Physical Sciences at the Australian National University died, Oliphant invited Robertson to join him. Peter stayed at the WRE, joined a different group and spent more time visiting Woomera. When the holidays came he and Shirley, baby Christopher and Shirley's sister drove from Adelaide in the A30 to visit Canberra. He spent a day visiting Robertson and his colleagues at the ANU "and at the end of the day I was offered a job, that's the way it was in those days".

42.40 – 46.50
"There were two parallel buildings looking down on the Molonglo flats where the racecourse was and the golf club…coming off at right angles was this huge building, very high, with an overhead crane, and that was where Oliphant's big machine was going to be." Peter was working there within a few months of the holiday visit. They got a house in Deakin – 25 Carrington St - as part of Peter's package. It was a prefabricated wooden house from Sweden. Peter recalls a stimulating group of new colleagues at the ANU including Jack Blamey, Len Hibbard, and William Smith. "They were all very interesting characters and they were describing things I could just understand."

Peter Carden in conversation with Simon Grose
Session 2
10 November 2014
6 Wynter Pl Hughes, ACT

00.00 – 05.40
Discusses Oliphant's early career, including a period in the Cavendish Laboratory at Cambridge under Ernest Rutherford. Recalls Oliphant discussing Cavendish colleague Peter Kapitza, a Russian who gained the Nobel Prize for discovering the superfluidity of helium, who was also "a magnet man".
"Most of the physicists of those times were engineers because the great discoveries came from the equipment that they built…Oliphant himself was an engineer…he spent all his time constructing things…thinking up new equipment".
When he came to Canberra Oliphant wanted to build a proton synchrotron. Funding was limited so he and his team, including Jack Blamey and Len Hibbard, worked on designing a cheaper version than existing systems.

05.40 – 10.00
Explains how the synchrotron design aimed to generate a vertical magnetic field in a ring 20-30 metres in diameter to contain proton beams. No precedents anywhere in the world. The machine would need "at least a million amperes…and huge quantities of cooling water". Describes an earlier plan to build a smaller version using a large magnet built by BHP: "But I think he (Oliphant) kept an eye on what was happening overseas and he kept thinking 'How can I do better'….so the magnet became the homopolar generator…and that's when I came on the scene".

10.00 – 15.50
Peter recalls the main members of Oliphant's team in 1955 when he joined them, and the status of the project. Four rotors had been fabricated but a big problem was the need to glue them together into two pairs "so they could get the voltage up…so it had to be an insulating bond".

15.50 – 18.00
Hibbard devised a solution using strips of rubber which were cleaned in acid and the bond created with epoxy resin. It was a major effort and it worked first time. "We didn't have to pull it apart…we didn't know how to."

18.00 – 22.05
Peter was given the responsibility to devise and build the bearings and stub axles for the homopolar generator (HPG). Describes the challenges involved "it was like balancing a battleship on a six foot pole".
They had to be oil bearings. "I didn't know much about oil bearings, but I learnt all about oil bearings pretty smartly and adapted things called Mitchell bearings…backed up by a piston arrangement…to correct any tilt." The pistons required the installation of a feedback loop so they could correct any tilt, in the early trials this was done manually with a joystick.

21.05 - 23.50
Describes how the current was drawn from the apparatus via jets of liquid sodium potassium alloy - "very dangerous stuff...that's where Ken Inall came in, he was the NaK man". But the NaK and the oil in the bearings

“was not a good combination”. They were both eventually abandoned after one staff member was blinded while trying to clean the mix of oil and Nak from the machine. With responsibility for the bearings, Peter was working at a highly experimental level in an area of engineering in which he had little experience, but he was not overawed: “It wasn’t scary”.

23.50 – 25.40
Discusses Oliphant’s manner and style as a group leader. Academics (“I was just an academic”) wore white coats and others wore khaki coats. Oliphant addressed all by their surnames. He found Oliphant approachable. When he eventually resigned as faculty head and retired to a small laboratory he invited Peter to work with him “to have some fun”.

25.40 – 28.50
Back to the HPG trials. There was a need for a dummy load – something to absorb the current being generated in the absence of the synchrotron. Dick Marshall was responsible for devising this: “it was about the size of our kitchen or even bigger, big steel plates that would go up and down in a huge vat of caustic soda”. Trials worked well, the generator delivered expected pulses of more than one million amps. In one trial, when some plates of the dummy load made contact, a pulse of 1.8 times that strength was recorded (as reported in a *Nature* article in July 1962). Peter recalls noticing in prior trials that although the rotors were spinning at around 800rpm the motion was not readily visible. They were not shielded, Peter recalls “you could actually touch the things – that was before we had the NaK of course”.

28.50 – 30.30
“When we got a pulse, these things stopped – in a second…it was quite alarming really, they just stopped dead…it all ran so well.” However the problem of the oil and NaK mixing became insurmountable. Seals and drains were in place to contain the oil but “the NaK was splashing all over the place and we ended up with this NaK sludge”. The machine was pulled down for cleaning, during which the staff member was blinded “because NaK burns in air, instantaneously”. By this time (1963) Peter was working at MIT in the US.

30.30 – 34.40
Peter gained a Masters degree from UQ for his work on the bearings. The HPG development was undertaken in parallel to development of the proton synchrotron it was expected to serve. Peter describes Wib Smith’s work building the proton injector. His offsider was Hillary Morton. David Robertson built the apparatus to generate radio frequency voltages. When he finished he returned to the Weapons Research Establishment in SA but would regularly drive to Canberra in his MG to visit.

34.40 – 38.10
Peter’s original job title was Research Engineer but would come to be known as Research Fellow. Meanwhile, the synchrotron project was “really struggling” despite the success of the ancilliary projects to support it. “I think it just folded because of money”. This was in the late 1960s. By then a second generation HPG had been built which used air bearings and carbon brushes instead of NaK jets. Peter was involved in instrumentation and other aspects of the project.

38.10 – 42.00
Peter reflects on the reasons the synchrotron project failed, mainly due to its boldly experimental nature.

42.00 – 43.15
Peter corrects a couple of errors in the first session regarding his family history.

43.15 – 60.00
Peter recalls life in Canberra. In 1958 he and Shirley bought a block of land in Fitzgerald St, Yarralumla, opposite what was then Corkhill's farm. They moved in 1962. Meanwhile they had two sons, Christopher and David, and while living in Deakin they built a tent trailer in their living room. When David was about 8 months old they hitched the trailer to the Austin A30 and drove to Townsville to visit Shirley's parents. Bruce Highway was all dirt. On the way back they were caught in very unseasonal heavy rains. This was commonly attributed to atomic bomb tests in the Monte Bello Islands off Port Hedland in WA, where two tests were held in 1956. Peter and Shirley recall the trials and tribulations of the return trip - being bogged, punctured petrol tank, stranded in flooded landscapes, drying distributors in the rain, camping in the tent trailer in floodwater….
Sons went to Forrest Primary and the Yarralumla Primary.
Peter and Shirley talk about how they both come from households where healthy diets were important. Shirley's parents had what would now be seen as an organic garden. Neither has smoked. Now have 13 grandkids, all healthy.

Peter Carden in conversation with Simon Grose
Session 3
November 17 2014
6 Wynter Pl Hughes, ACT

00.00 – 04.50
In 1962 Peter spent a sabbatical year at MIT's Magnet Laboratory in Boston with his family, now two sons and daughter Gillian. They had a house provided, down the road was Wib Smith who shared his Plymouth car with them. Bruce Montgomery headed the Magnet Lab. Peter found several differences with the ANU, one being the ready availability of liquid helium. The lab developed magnet devices for use in solid state physics research, and Peter's work was mainly with superconductor magnets.

04.50 – 11.20
The main problem Peter was asked to investigate was the tendency for super conductor magnets to suddenly fail. He explains the configuration of the experimental apparatus, outlines the understanding of the problem and the stage to which the research had developed when he joined the laboratory. Plotting points of failure showed no consistent pattern: "It was all over the place and you couldn't draw a straight line".

11.20 – 15.00
Peter suggested that the nature of the problem could only be discovered by continuously measuring a magnet's performance, so it was an instrumentation challenge. Outlines his approach to the issue by measuring resistance. This worked. "Everyone was amazed at what the result was…the line would go up beautifully smoothly and then all of a sudden it would go boom down, and then it would go up again." The performance followed a sawtooth pattern. Peter says the MIT culture was akin to ANU's in that is was derived from the Cavendish Laboratory: "You had to make new instruments before you got new science. All those early scientists were also engineers, extremely clever engineers". MIT offered Peter a job but he says he didn't want his kids growing up as Americans.

15.00 – 25.30
Discusses work on non-superconductor magnet concept designed by Francis Bitter at MIT. The magnets were stacks of thin circular discs which had radial slits to allow them to be interleaved to form a continuous coil, and aligned holes to allow cooling water to flow through the stack. Peter recalls at an Open Day he put up displays of the work he was doing but the Americans were not impressed, preferring to keep things more secret. He recalls flying to a conference in Syracuse in a two-seater plane piloted by another scientist. They lost their way in bad weather and followed roads as a guide to find the airfield. Describes travels in the US, and the social life. Peter recalls that a draughtsman at MIT who was black was wary of going into some parts of the town.

25.30 – 28.30
Soon after returning to Canberra they drove to Ayers Rock, three kids and Shirley pregnant with their fourth, now in a Holden. Peter recalls that, earlier in Boston, eldest son Christopher, who was a Cub, had to make a car out of a block of wood and wheels for a race to see which one would run fastest down a slope. Peter made sure the axles and wheels were as fiction-free as possible. His car won, got his photo in local paper."I think it taught him a big lesson."

28.30 – 29.50

They were living in Fitzgerald St Yarralumla with the four kids and back at the ANU the synchrotron project was "just about dead". Oliphant had resigned as head of the School of Physics, but he retained a smaller laboratory. Peter declined an offer to join him as assistant.

29.50 – 32.25
Recalls a trip to Oxford while he was at MIT to visit Nicholas Kurti, Professor Physics. Peter's ambition was to use the HPG to build "big magnetic fields, beat the Americans at their own game… they could get to 20 teslas and I wanted to go to 30". He knew there were many solid state physicists in Australia, mainly Melbourne, who could make use of such a facility. He had written to Kurti, the "top man at MIT", Oliphant and others (John Jaeger, ANU foundation chair of geophysics, mentioned later at around 50.30), seeking support for this proposal. All replied positively. He got approval from the ANU.

32.25 – 34.45
The new head of School, Gordon Newstead, was supportive of the magnet project. "I had quite a good team, lots of money, it was amazing." His project was one of three requiring the heft of the homopolar generator (HPG). The others were a rail gun project headed by Dick Marshall and a high-powered laser project headed by Ken Kendall. The HPG – now with air bearings and carbon brushes – was operating well. "Nobody wanted the million amperes but we wanted quite a bit, half a million sometimes". Peter recalls most of his team members.

34.45 – 35.50
The project drew from the work of Bitter. "Our concept was an outer magnet that would produce, say, 15 teslas, half of the field we needed, using the standard technology from MIT. To top it off we wanted a new sort of a magnet that would fit inside". But Bitter's discs would not work for this so they devised a new approach: nested coils.

35.50 – 45.30
Peter explains the nested coil concept and its implementation – size, choice of alloy, machining, etc. Components made in Wollongong, paid for by ANU under a tender process. "The liaison was fantastic." The coil material "was wider than it was thick…we had to bend it the hard way". Coils were turned on a lathe while epoxy resin was injected "so you ended up with glue between all the turns, dripping down a bit…we'd make it pretty then put it in the oven to cure". Before that process they were sandblasted and treated with waterproof enamel. Peter explains the configuration of the nested coils, water cooling structure, and the arrangement of prods to introduce current. It ended up being "pretty complicated", including the instrumentation. The assembled unit was about 500mm in diameter and was placed in a fibreglass water manifold.

45.30 – 46.40
Peter explains water cooling infrastructure because "cubic metres of water had to get pushed through this". Two large spherical pressure vessels were made in Sydney, one to contain compressed air, the other to contain water under pressure, "we'd just push the water through with air, as quick as you could go".

46.40 – 47.50
Initial tests of the system were undertaken. "That was pretty dramatic, gradually building up to 30 teslas or 300 kilogauss…we wanted to go to 310 kilogauss just so we could say we had got to 30 tesla..we got there, and as far

as we could tell there was no damage done…it was all repeatable." They only pushed it 301 kilogauss two or three times. "We declared the magnet was ready for research."

47.50 – 49.10
Researchers from Monash and Sydney began using the magnet and the then Head of School, Ernest Titterton decided the magnet could be the basis of a Department of Solid State Physics. The proposed head was Alan Runciman who was in Dublin. "They sent me over there to check him out…what would I know about solid state physics? …What I wanted was somebody who would use the magnets, he wouldn't give me a guarantee but he said they would be very useful." He arrived in February 1971 to head the new department at ANU 'but he was a bit of a disappointment because he didn't use the facilities the way he should'.

49.10 – 50.30
Meantime Dick Marshall's rail gun had no research customers from outside the ANU (he left to another role in the US) and as the laser laboratory evolved it had no need for the HPG's power, so the magnet laboratory was the only project to justify keeping the HPG operating. "There was this big debate, where was the money coming from." Visiting researchers regarded it as a national facility so didn't expect to have to pay to use it. "It just all fizzled, Oliphant wasn't there any more."

50.30 – 54.00
"As far as it went it was pretty good, but no research project goes forever." Peter explains what he knows about some of the solid state research projects which used the magnet facility. Discusses progress in super conducting technology.

54.00 – 56.00
Recalls that the magnet was above a workshop where the staff hung spanners and other tools from the ceiling on chains. When the magnet pulsed (up to 10 seconds) the tools stuck to the ceiling. Recalls on Open Days they would do tricks like mounting a display of compasses so people could see the needles jump into a new position when the magnet pulsed. Peter thinks the magnet laboratory – and the HPG - closed down in the early 1970s.

56.00 – 58.00
Peter recalls how he enjoyed leading a team. "We had a very very close bonded team…we had lots of meetings…you've got to tell all your guys what you are doing…each had a job and provided a lot of input…very loyal and hard working…gee they were lovely blokes…I used to hold the meetings where the academics had their tea break so we could all sit in the good chairs and have a cup of tea."

58.00 – 59.00
Peter's reputation now based on his magnet work, documented and reported in journal articles. It was also recorded by the ANU photography unit which took film footage at each stage of the development of the magnet facility. This was edited into a finished film that "was sent down to Film Victoria" but, as at the date of this conversation, no copy of that film is available.

59.00 – 1.03.20
In around 1969/1970 Peter took another sabbatical year, this time in Oxford. All the family went except eldest Christopher who was at UNSW. Peter worked with the Oxford Instrument Company, headed by Martin Wood,

which supplied instruments to Oxford University. They asked Peter to design a magnet that fitted inside a superconducting magnet. He used the nested coils approach. He had a room at Oxford but spent very little time there, did no research and gave only one lecture. Most of time was spent working on the design of the new magnet in a very old stone house at Taston, outside Oxford, which they rented from an Oxford Don who had gone to Canberra.

1.03.20 – 1.08.30
His boss at Oxford was Nicholas Kurti. When he returned to ANU the magnet he had designed for the Oxford Instrument Company was not under construction so he and his team formed a company called Research Technology Canberra to design and construct it in their own time. The ANU did not underwrite or otherwise support the project but did allow the use of its facilities. "We did a lot of the work in our garage, and a lot of the guys had their own home workshops." Most of the work was done at night. Shirley recalls that it was the first official export from Canberra. Daughter Gillian, an art student, designed wineglass and umbrella graphics for the case to show which way up it should be carried. Peter and Shirley returned to Oxford so he could oversee its installation. There were problems with the cooling system leaks, these had to be fixed by the Oxford Instrument Company "so it wasn't a perfect job".

1.08.30 – 1.13.20
Peter describes the circumstances of arranging an export from Canberra, rather than Sydney. Oxford Instrument Company offered him a position and flew him and an employee to Washington to meet their US representative. They traveled from the UK via Iceland. In Washington they were put up in the agent's yacht moored on Chesapeake Bay. One day the three of them went for a sail and got caught in a storm. Peter had sailing experience and very much enjoyed the adventure.

1.13.30 – 1.15.08
With the Oxford magnet installed and the magnet laboratory closed at ANU,"I was wondering what I was going to do next…that's when I started thinking about big things". His thoughts were shaped by the 1972 oil crisis and the book *Limits to Growth*. "We've got to do something about energy." He was interested in hydrogen, nuclear fission and fusion. He eventually came to the point of view that solar energy was the only sustainable solution (to be discussed next session).

1.15.08 – 1.18.54
Discusses life in Canberra, especially Shirley's involvement in organic gardening which resulted in her becoming president of the Canberra Organic Gardeners in the late 1970s. She was also the driving force behind establishment of community gardens in the city. Peter also became interested in beekeeping.

Peter Carden in conversation with Simon Grose
Session 4
November 23 2014
6 Wynter Pl Hughes, ACT

00.00 – 03.54
Peter investigated fusion energy as a possible new area of research. It was interesting from a scientific point of view but had several engineering problems. Metallurgical issues: the neutrons "mucked up the crystal structure" of any containment vessel. Sourcing the required isotopes of hydrogen – deuterium and tritium – was difficult, the former at very low concentrations in the oceans, the latter by bombarding lithium with neutrons.
"The only sustainable thing is solar, and it has to be easier… so I came back to the ANU determined to hit Professor Stephen Kanef, he was the new Head, and that's what I did…he said he was agreeable… I was a one-man solar energy unit in the Department of Engineering Physics."

03.54 – 09.10
"It was a matter of finding a niche." At that time photovoltaic research was centred in Sydney and "rooftop stuff" in Melbourne, "so we went for high temperature large scale thermal". Peter outlines the opportunities and challenges, and early conceptual work which led to focusing on steerable mirrors. Discusses the tension between need for basic research and applied outcomes, and the need to compete against coal on cost. Discusses the economics in the context of high interest rates. Also the practical problems of installing and operating arrays of mirrors in the field.

09.10 – 12.50
Kanef backed Peter's choice to use the expertise of the auto sector to produce pressed-steel dishes. "Mass production was the thing we were relying on." Discusses reflective surface options, and the need for the dishes to autonomously follow the sun. "That was to do with robotics and computers, two things that were in their infancy at that time." In 1976 Peter published a paper: *Artificial Intelligence in Solar Power Systems*.

12.50 – 13.40
Peter had moved into a totally new area of research. "That's what universities are supposed to do…you had to go out on a limb otherwise your publications would not be unique…you are supposed to break new ground all the time."

13.40 – 16.20
Discusses the challenges involved in gathering the energy from an array of dishes and storing it. He came to focus on chemical storage options. Discusses different approaches being followed in the US (sulphur trioxide and methane) and their problems. "I thought, we'll go for ammonia (NH3) because no one else is doing ammonia…and there was a whole industry we could call on…it was already piped around."

16.20 – 22.05
"Thermodynamics happened to be one of my strong points." Funding then came from the National Energy R&D Corporation (NERDC) enabling him to build a team, including Owen Williams from NZ. Robert Whelan, who had worked with Peter in the magnet laboratory, was head technical officer. Williams headed the work on the ammonia storage concepts and Peter concentrated on developing methods to construct a prototype aluminium

reflector about 3.5m in diameter. Discusses efforts to use a mould process. The proposed size was too large for a Melbourne contractor to provide a single sheet of aluminium so "I made a terrible mistake, I should have reduced the mould to compensate but instead I said 'why don't we weld a bit on'." The weld in the sheet would fail as it was moulded. "That was a disaster."

22.05 – 23.50
"At the same time, Owen had a disaster." A heater in a tank of ammonia was left on overnight, causing the tank to explode. "That shut us down for a while." Williams left. "I was left with a shambles."

23.50 – 26.50
Discusses how he and Kanef spent a lot of their time on giving presentations here and overseas in the quest for funding. Peter was uncomfortable with the need to "make false promises" about timetables and outcomes of the research, also frustrated with getting partial funding from NERDC and others. Discusses media interest in the solar thermal/ammonia storage during the mid-1970s when rising oil prices caused an energy crisis. A model of a proposed pilot plant was displayed in the foyer of the Department, although this was not welcomed by all staff. "The mathematicians didn't like it, this was not science." Strong public interest enabled them to gain funding for a year, after which they would have to find external funding.

26.50 – 29.05
Kanef "had a secret research project with the NSW Government which he wouldn't tell me about". This was revealed while Peter was at a conference in the US when the NSW government announced funding for a solar thermal power station at White Cliffs. "I was miffed." This damaged the partnership with Kanef (although in their later years they remain in social contact). The ANU created a public company for the White Cliffs project. "All my research money was absorbed, my blokes were absorbed…and I thought this was an absolute waste of money." *(Constructed in 1981, the White Cliffs Solar Power Station consisted of 14 solar thermal parabolic dishes capable of total output of 25kWe. In 1996 these were replaced by photovoltaic systems with a combined capacity of 45kWe and the station was connected to the national grid. It ceased operation in 2004 – Wikipedia)*

29.05 – 35.35
Peter continued with experimental processes to create parabolic dishes and with investigating options for steam engines to be driven by the steam generated by the dishes. He visited White Cliffs once. Became interested in the prospect of storing hydrogen in natural underground repositories. (Hydrogen and nitrogen would be created during the day by solar energy being used to break up ammonia; overnight the two gases would be recombined into ammonia and the heat generated by this process would be used to drive a turbine generator.) Discusses earlier visits to attend conferences in Japan and China (post the Cultural Revolution which ended in 1976).

35.35 – 37.10
Peter "gradually retired" from around 1980 by working part time and using up accrued leave. He and Shirley bought into the Crystal Waters permaculture farming cooperative in Queensland's Sunshine Coast hinterland.

37.10 – 38.05
Peter briefly explains how he gained his PhD from the ANU in 1976 for a thesis, *High-field electromagnets*, drawn from his earlier work.

38.05 – 44.20
Peter did not consider continuing his research career at another institution. “I wanted another life, my dear wife had supported me all this time and I thought it was about time we did something together.” It was around 1988 when they headed north. Peter discusses some of his last “dribs and drabs” of thermochemical research, including collaborations with Israeli and Indian researchers. Visited Siding Springs Observatory to look at how they coated their mirrors with aluminum vapour.
Peter was offered a redundancy and officially retired in 1988, aged 58.

44.20 – 47.45
Their children – now with families of their own – visited Crystal Waters but said it was too far away from their homes in Canberra and Wollongong for them to visit often. So they sold out of that after a few months. They moved to their holiday house at Tuross Heads and eventually bought five acres under the escarpment behind Berry. They built a house and set up a certified organic farming life, living there for 15 years.

47.45 – 50.30
Peter had little or no involvement in engineering or research, but did some work for a Sydney company which was developing storage facilities for the Collins Class submarine project. “It was a schmozzle. You had to do the calculations without any input of data, you didn’t know what were in these storage compartments, you were just told that it had to put up with the normal wear and tear of what a submarine does.” Had difficulty seeing eye-to-eye with the project managers. Visiting the Adelaide shipyard he realised the challenge they had in integrating components from a range of suppliers from several countries.

50.30 – 58.45
Peter reflects on the progress and status of solar energy technology since he left the sector. Rising demand for PV technologies has enabled mass production, bringing the cost down. Discusses the economics of the evolving mix of existing and possible future renewable sources and existing fossil fuel sources. Salt-based storage of heat energy currently the best available storage system. He doesn’t see a chemical-based technology with much promise. Forsees a national grid linking many different distributed sources of generation – including tidal and geothermal - which would enable real time generation to meet demand, lowering the need for storage.

58.45 – 1.02.00
Peter reflects on the huge advances in science during his career. Examples are the Big Bang theory of the formation of the universe, continental drift of the Earth’s landmasses, reversal of the Earth’s poles, pattern recognition. “It was a most interesting time.” In the early 1950s at the Weapons Research Establishment he recalls much excitement when a researcher created what he called a decatron: “He had worked out how to make a binary thing count to 10…so how far have we come eh?.”

Peter Carden in conversation with Simon Grose
Session 5
December 14 2014
6 Wynter Pl Hughes, ACT

00.00 - 02.10
Peter outlines the improvements they made to the Berry property, extending the house, planting fruit trees, raising goats.

02.10 – 05.00
Discusses the beginning in the early 1980s of the Canberra Organic Growers. Shirley was inaugural president and Peter was treasurer. Shirley instigated the first community gardens in the ACT, now there are 13.

05.00 – 08.00
How his engineering background informed his plans and work at the Berry farm. Frame of the house was made by BHP which then did custom-made house frames. Water heating by a fuel stove/solar system. Water supplied by a natural spring. Self-sufficient apart from grid electricity and some food, including meat. They had their goats killed but Peter couldn't eat their meat.

08.00 – 09.20
Shirley recalls the "beautiful little abattoir on the top of a hill surrounded by manicured lawns".
No other animals in sight and a man in a white coat would ask which parts of the goat they wanted for themselves. Mostly they sold the meat to local restaurants. They would have up to 5 milking goats at any one time.

09.20 – 15.30
Peter discusses how he got into beekeeping earlier in Canberra when he took over a hive from one of his sons. Discusses the threat of Varroa mite entering Australia, and increased interest in beekeeping. Membership of local beekeeping group growing quickly. Discusses hive collapse syndrome in US and Europe, US beekeeping practices. Angry bees from South America.

15.30 – 17.40
After both had health issues they decided to return to live in Canberra where three of their children live. They sold the farm in 2005 and moved to Hughes.

17.40 – 28.30
In the late 1990s Peter got involved in the republican movement. "I love this country…I don't mind the Queen…I think it's just a bit archaic." He made a submission to a Parliamentary inquiry, proposing a system with an elected president who would have no power to appoint or dismiss governments (federal or state and territory) but would appoint Governors General and State Governors. Peter discusses the issues and discussions with republican campaigner David Latimer, constitutional lawyer George Winterton and others to develop a model which would be acceptable to the public but would not create an elected president who could come to dominate the

Parliament. In his proposal the president would have the same power in Australia as the English monarch. The Irish president's role is a good template.

28.30 – 33.30
He believes the 1999 referendum on the republic failed "because people wanted to elect the president". This is not a matter of regret for Peter because he does not favour an elected president with more power than the Governor-General now has. Further discussion of potential balance of powers between the roles of president and Governors.

33.30 – 35.30
Peter puts the view that the constitutional change to move to a republic should be undertaken at the same time as constitutional recognition of Australia's First Peoples. Both would be enshrined in a new preamble to the existing constitution. He agrees that is an ambitious aim, but says it is logical because the current preamble strongly mentions the role of the English monarch.

35.30 – 38.40
Peter discusses his views on the status and future prospects for the engineering profession and scientific research in Australia. The nation has a strong tradition of inventiveness and technological progress to solve problems in agriculture and other fields.

38.40 – 42.40
Education is the key to maintaining and recharging that tradition. Peter discusses the low level of interest in maths and science subjects from school students. He believes this due to failures in teaching and curriculum development. One of his grandchildren chose nutrition as a career and chemistry was a first year subject in 2013. "I was astounded at the way they teach chemistry, they take all of the fun out of it and all the delight. In the first year they do all this stuff about precision measurements…if anything is aimed at crushing you it's doing all that sort of stuff."
He believes that level of knowledge should be taught to people who are going to work as career researchers. "If I was teaching chemistry I'd do the fun stuff first, do the basics…like acid+base gives salt+water…interesting experiments with things going green."

42.40 – 44.42
Early stages of teaching chemistry and other scientific subjects should not aim at winnowing out those who are not interested or capable. "I think you've got to have more of a come-on to start with - come on and try this - it naturally gets more complicated and gradually starts winnowing people out."

Biographical Notes

Early Life

Peter was born in Melbourne on January 28, 1930. His father, Condell O'Neil Carden, from the Lakes District in the UK, had emigrated to Australia with a young son after his first wife died in Paris after giving birth. He and Peter's mother, Hilda Isobel Green, met in Sydney where they were married in 1929. He was working in real estate but the onset of the Great Depression ended that. They moved to Melbourne where Peter was born, but they separated two years later hoping to reunite when circumstances improved. Peter and his mother returned to

Sydney to live with her parents In Rose Bay. His grandfather died when Peter was about 10, his mother died three years later. He and his grandmother then moved to Ipswich to live with his uncle's family.

Schooling

Peter attended Rose Bay Primary School and Randwick High in Sydney. In Ipswich he attended Ipswich Grammar where he matriculated as dux in 1948 and gained a Commonwealth Scholarship to study Engineering at the University of Queensland.

Qualifications

1953 - Bachelor of Engineering – Electrical in Communications, University of Queensland
1963 – Master of Engineering, University of Queensland
1976 – PhD, Research School of Physical Sciences, Australian National University

Career

1954 – Experimental Officer, Weapons Research Establishment, Salisbury SA.
1955-62 – Research Officer then Research Fellow at the ANU's then Research School of Physical Sciences. In a team led by Sir Mark Oliphant he had several roles in the project to construct a homopolar generator to power a synchrotron and other research apparatus, mostly concerning developing bearings and instrumentation.
1962 – Sabbatical year at Massachusetts Institute of Technology working in the magnet laboratory. Main project was to devise and implement instrumentation to track the performance of superconductor magnets.
1963-70 – Returned to the ANU to establish and lead a magnet laboratory. Devised a nested coil design which, using power from the homopolar generator, achieved a magnetic field in excess of 30 teslas.
1970 – Sabbatical year in Oxford where he worked for the Oxford Instrument Company to design a nested coil magnet that would sit inside a superconducting magnet.
1971-72 – Formed a company with ANU staff to build the nested coil magnet he designed. This was completed and exported to Oxford where Peter spent time to help install it.
1972-81 – At ANU instigates research into large scale solar thermal power generation using sun-tracking parabolic reflectors and ammonia as the energy transfer and storage medium. This work informed the White Cliffs solar thermal power station which was commissioned in 1981.
1981-88 – Various projects at ANU, retired 1988.

Peter Carden beside a display at the ANU Research School of Physical Sciences and Engineering which includes a coil from the nested coil magnet technology and sets of carbon brushes from the Homopolar Generator