

## **To be Frank: the Oppenheimer Brothers and Me**

**John Barker, PhD**

Northbridge WA, August 2023

*jedbarker@iinet.net.au*

*“Oppenheimer is best seen in 70mm IMAX – darn! We don’t have an IMAX in Perth, now, do we?”*

Reading of the ABC online preview of the much-anticipated new biopic on J. Robert Oppenheimer triggered within me an explosion of memories. J. Robert Oppenheimer. *The Bomb*. Frank Oppenheimer. Physics. Los Alamos. IMAX. OMNIMAX. Science Centres.. Scitech....

Although I never met the Oppenheimer brothers, we walked many of the same paths. Or should I say, I walked some way on the paths that they had pioneered. Those journeys still live in me. Let me describe those paths and the landscape through which they threaded...

### **In the beginning...**

First, as a 1945-er, I was born into the so-called Atomic Age. Some of my earliest memories were of my parents talking about *The Bomb* – like: “now-that-the-Russians-have-it-we’re-all-stuffed” and “what the hell – we’ll all be dead soon” and singing Vera Lynne’s ‘We’ll Meet Again’, and so on. I grew up in the shadow of *The Bomb* and the constant shiver of the Cold War and fear of The Red Peril.

I recall as a seven-year-old playing “bombs over Hero-sheema” in the school sand-pit – dropping gumnuts from stick-and-bark planes onto sandcastles.

Fast-forward to 1957. Between the lasting impression of *The Bomb* and the Soviets launching the first satellite, *Sputnik*, even country-folk like my parents were convinced that “science was the future” and their son, John, being good at arithmetic at school, could be part of that exciting future. “Work with your head – not your hands”, advised my shearer-stepfather. Surrounded by rural prejudice and mid-Century machinery, it seemed like good advice, although I liked being ‘hands-on’ as well.

And so, by a series of scholarships, I proceeded through high school with a science- and maths-laden course and thence to uni, majoring in physics and ultimately to a PhD.

### **The meeting of minds...**

J Robert Oppenheimer first showed up in studying the “Born-Oppenheimer approximation” in quantum mechanics in my Honours Year in 1967 – the year that he died. We knew that J Robert was not “the father” of *The Bomb* – that was meaningless. Dozens of physicists had contributed to the complex nuclear theories in the the two decades before he had even graduated and thousands of scientists and engineers and support staff had worked together to bring those theories into practice. Project Manhattan was a giant laboratory experiment to test these complex and evolving theories.

Other than the many theories, laws and equations that were named after their (arguably) first proponent, our crammed science courses didn’t include anything on the history or philosophy of science or the lives of these notable physicists – ancient or modern. That was left up to us, if we cared to.

There were some of us who “cared to” – beginning in our first-year at uni in 1964, a group of us saw ourselves as budding “Renaissance Men” (there were very few women doing STEM, then). We stayed up late analysing ee cummings’ existential poetry and the impact of the Heisenberg Uncertainty Principle, quantum tunnelling and Schroedinger’s cat on the idea of free-will and determinism. I painted Wassily Kandinsky’s *Small Worlds IV* on the wall of my college dorm. Others strummed guitars and belted out *Blowin’ in the Wind*.

The pantheon of great physicists were our role models – not just for their scientific genius, but for their integration of the arts and sciences into *wissenschaft* – ‘knowledge’, as my Honours’ Year science German course later informed me. Feynman played the bongos, Einstein the violin, Frank Oppenheimer, the flute, Murray Gell-Man named sub-atomic particles ‘quarks’, quoting James Joyce, and after the detonation of the first atomic bomb in New Mexico, J Robert famously quoted the Hindu *Bhagavad Gita*: “Now I am become Death, the destroyer of worlds”. For us, the mystical East wasn’t just The Beatles and Ravi Shankar! It was there to integrate with whatever entered our senses.

While I was obviously a ‘bright student’, I never considered myself any kind of genius. I was no Einstein or Oppenheimer. I studied long hours, unlike some near-genius students I met along the way, who seemed to ‘get it’ straight away and spent a lot of their time on extra-curricular activities, from reading widely to drinking heavily. Some succeeded impressively and received international awards; some crashed and burned, or ‘bombed-out’ as we called it. We learnt, from close association, that you can’t ‘understand’ genius – only witness it, if one is lucky. Genius always seemed to have a price.

### **Searching for ‘it’...**

That ‘not getting it straight away’ led me to wonder what ‘it’ was and how we constructed the narratives of scientific explanation. With a baby-boom market and science pervading the zeitgeist, there was an explosion of new science textbooks at that time, ranging from (Project Manhattan participant and Nobel Prize-winning) Richard Feynman’s *Lectures on Physics* to Robert March’s *Physics for Poets*. Some were good – at least in part – so we shared them around. The good ones usually had progressively abstract diagrams to accompany the terse text and prolific equations: a journey from the concrete to the abstract and back again. They were usually American books. Other textbooks, equally terse and less well illustrated were usually British and dull. We construed that there was a different in assumptions about students at Cambridge and Oxford where ‘it’ was all about the abstract destination, not the concrete journey that Americans and Germans preferred. Paul Dirac’s *Quantum Mechanics* was admired for its mathematical elegance and reviled for its inaccessibility to all but the elite. And, perhaps, the Brits, being much poorer due to the War, had less capability in the new offset printing which made illustration easier to reproduce. There were very few scientific films to aid us.

J Robert’s death in February 1967 was not noted by our physics lecturers, although the caption under the picture of the British Sir John Cockcroft (who was the first to split the atom), in the physics lecture theatre, was clumsily amended to reflect his passing, later in that same year. To my recollection, our lecturers never displayed the slightest interest in the role of physics in the wider world or in society, although a few years later, I learnt a little of the communism-related furor that had split the UWA physics department in the 1950s.

### **Prometheus ...or just a Firebrand?**

In 1970, as president of the UWA Postgraduate Students Association, together with the PGSA secretary Carmen Lawrence, we threatened – to the Deputy Vice-Chancellor – to take the

postgraduate tutors out on strike if their tutoring payments were not increased in line with the rampant inflation. We were successful – but this action undoubtedly marked me as a “radical” (“communist” was no longer a fashionable epithet in Australia). And soon after, my announcement that I had accepted the job as UWA’s Science Librarian was met with disbelief and possibly disdain by the physics department’s academic staff – as if I had decided to join a monastery or a hippie commune.

### **I Have a Dream**

Earlier, in 1964, I had been inspired by UWA’s biennial ‘Science and Engineering Exhibition’, which opened the university to the community. Two years later I participated in its physics laboratory demonstrations and in 1968 I was privileged to be the director of the whole exhibition, which was enormously successful. I said at that time that a two-day-open-days-every-two-years was not enough for community needs and that I envisaged that in future we would have a venue that enabled an ongoing, hands-on exhibition of local and global science. Over the next decade, I kept the dream to myself and a few others and noted that there were large institutions like the Smithsonian in Washington, the British Museum in London and The Deutsches Museum in Munich – but these seemed to be along the classic museum style of exhibits that were historic, but not interactive – strictly ‘do not touch the exhibits’.

“I hear, and I forget/I see, and I remember/I do, and I understand.” –Chinese proverb.

### **Riding High**

Another formative event from that period was the release of the Stanley Kubrick/ Peter Sellers movie ‘Dr Strangelove: or How I Learned to Stop Worrying and Love the Bomb’. This now-classic black comedy, which mocked the logic of both nuclear scientists and their political masters, soon became compulsory viewing for all ‘fresher’ (first-year) science students.

### **The Vietnam War**

The anti-communist fervour experienced by the Oppenheimers for two decades spilled over into my generation with the (Second) Vietnam War. Starting in about 1955 (when the First Vietnam War with the French concluded), it steadily built up, with a quantum-change in 1965 with military conscription by lottery. My marble was one of the first drawn out of the barrel that year. While I was exempt, being a student, I joined the youth-and-unions-led protests and demonstrations. Some of my friends were jailed and my best friend from fresher-year, Archie, was one of the several hundred conscripts killed in Vietnam. Only a handful of the senior academic staff participated in the protests.

The ‘Yellow Peril’ and ‘Reds under the Beds’ slogans seemed incongruous as I enjoyed a beer in a luxury golf resort in Da Nang in central Vietnam half-a-century later.

### **Brighter than a Thousand Suns**

So, onwards to 1977, after I had left the library and finally completed my PhD, I undertook a six-month study tour of Carter-inspired solar energy developments throughout the USA. We flew first to Boston, where I noted that there were still street-signs pointing to nuclear fallout shelters. I had scarcely appreciated how recent the terrors of the Cold War and the Cuban Missile Crisis were to the American consciousness.

During my US tour and at the invitation of a nuclear engineer-turned solar expert, I visited Los Alamos Scientific Laboratories (LASL) in beautiful New Mexico, which had been the main venue for the Project Manhattan. I had been informed that one building had an innovative large-scale solar-powered airconditioning system. It was impressive, working in a similar way to the Electrolux kerosene fridge that I grew up with – amazingly turning (solar) heat into cold air.

But it was the LASL visitors' centre's very modest-sized museum that really caught my attention. My wife, Diane, and I were the only visitors there at that time to its (then) few rooms of atomic research memorabilia, including, in a small glass case, mounted on a wall, the original letter from Albert Einstein to President Roosevelt, encouraging the development of *the Bomb*. And wow! In the courtyard enclosed by those rooms, were full-size replicas of "Little Boy" and "Fat Man" – the two atomic bombs dropped on Hiroshima and Nagasaki, respectively. I couldn't resist the opportunity! With no-one else to be seen, I scurried into the courtyard and mounted "Little Boy" in the style of Major TJ "King" Kong (Slim Pickens) in the *Dr Strangelove* movie, while Diane took the attached pic. Sometime over the years, something tore or ate part of the pic, but it has remained as an object of mirth for people of my era – and an item of dubious social-correctness for younger people.

A few weeks later, we visited Disneyland in Los Angeles, where I first experienced an IMAX theatre, with its wrap-around, cylindrical screen, flying through the Grand Canyon and along a roller coaster. A great experience for the senses – but of doubtful educational value.

### **A Meeting of Minds**

These odd strands of experience started to weave together in 1983, when, at the invitation of the new Labor Deputy Premier, (the Late) Mal Bryce, I left my academic position in UWA's Adult Education department to work with the WA State Government, first developing the Bentley Technology Park and then as Director of the State's Science and Technology think-tank, SITCO. At the first meeting of the 18-person Council in mid-1984, Bryce asked them to investigate, among other ideas, the prospects for an interactive Science Centre for WA – like the one that he had recently seen in Singapore. Fellow physicists, the Chair of SITCO, (the late) John de Laeter, Council Member Professor Phil Jennings and I were thrilled to have this level of endorsement of our long-held dream. As Director, I had the opportunity to give the Minister's request high priority.

In the style of the times, a SITCO sub-committee was formed to scope the idea, public meetings were held to assess community interest and consultants contracted to do detailed budgets. After investigating numerous possible (or plausible) venues, we targeted the refurbishment of the Old Swan Brewery, not far from the centre of Perth, on the banks of the Swan River. Our vision was to weave together the boat trip from the city, its proximity of Kings Park, Indigenous landmarks and the history of brewing into the fabric of the Centre. Unfortunately, the competing interests of a major building developer put paid to that idea. However, not long after that, in early 1985, another possibility arose, bringing in more tenuous Oppenheimer strands.

### **Serendipity**

I arrived home from work one night just as the evening news was announcing that a well-known shopping venue near central Perth – Parry's – was going to be redeveloped. The TV footage was of Kevin Parry in hi-viz, symbolically operating a wrecking ball tractor that was demolishing the old buildings, with the voice-over saying that the new centre would include a planetarium. What! Our visions of a science centre included a planetarium and we thought that our public meetings had identified everybody in Perth who had any interest in these matters.

## Theories of Everything

First thing the next morning, I rang Parry's and asked to talk to whoever was responsible for the redevelopment. Parry's project manager Peter Kaye informed me that yes – Kevin had a genuine personal interest in astronomy and had been encouraged to incorporate one into his shopping centre by Americans that he knew. But, further, the planetarium would double as a novel movie theatre – an 'OmniMax' where special lenses would be used to project dazzling scientific movies on the planetarium's dome's spherical surface, rather than an IMAX's cylindrical surface. And a place to park the kids while the parents were purchasing consumer durables.

But Kaye was super-excited to know of our ambitions to build a large interactive science centre. He said that it was intended that the shopping centre would have a two-storey profile and a dome – to increase its visibility to the nearby freeway and railway line – but only one-storey inside – apparently low ceilings encouraged purchasing. It was possible to cast a 5,000sqm concrete second floor that could accommodate our centre – if a decision was made soon, as the foundations were about to be laid. In those heady days of 'WA Inc', the value proposition for a synergy between government and industry was obvious. A Cabinet Submission with Bryce's endorsement was quickly developed.

(Paradoxically, later that year, SITCO of its own volition, advised the Deputy Premier that the proposed closure of the Perth Observatory would be counter-productive to his aims of stimulating interest in science and technology. The return of Halley's Comet in 1986 was propitious as Bryce was able to associate his name and policies with the open-nights of the observatory. Also paradoxically, although we had extensive undergraduate lecture courses in 'astrophysics' – much of which was about the evolution of nuclear reactions in stars – we never once looked through a telescope to witness these events. White dwarfs, red giants and (newly discovered) black holes were never observed by us as students.)

## To Mecca – and Beyond – in Thirty Days

While there are many other threads to the story of the development of Scitech – WA's interactive science centre – suffice for this present narrative is that, after several attempts, Cabinet approved its establishment and part-funding, with part of the funding from Parry's. With formal approval and funding confirmed, the Chairman of the Board, John Stokes, Kaye and I set out on a one-month-around-the-World visit to ten science centres in Australia, USA, Canada, UK, Europe and Singapore. In summary, it was exciting, informative and personally rewarding, but very arduous.

After visiting the newly established Powerhouse Museum in Sydney, we set off for the USA, where some of these threads came together at the Exploratorium in Bayside San Francisco. Briefly, the Exploratorium had been established in 1969, in an abandoned but cavernous exhibition building, dating from 1915, under the inspiration and guidance of Dr Frank Oppenheimer – the brother of J Robert Oppenheimer. Frank and J Robert were both physicists who enabled the development of *The Bomb*, whose careers, paradoxically, were destroyed after WWII by McCarthy and the House Un-American Activities Committee. J Robert's story has oft been told in books and movies, but Frank's less so. He (Frank) had been banned for ten years from even teaching physics due to his pre-War involvement with communists. After a stint of cattle ranching in Colorado, he eventually worked his way back into physics teaching and research and saw that a venue that combined the arts and science in hands-on experiences was essential to both enable students to gain a better understanding of science and to demonstrate its applications.

“Unlike Robert, he was good with his hands and loved tinkering with things, taking apart electric motors and watches and putting them back together.” From *American Prometheus*.

But when we visited the Exploratorium, all of the staff were still grieving Frank’s death, in his early 70s, only a few months before. In the Exploratorium’s own words:

“The qualities that made Frank so special are the same qualities that that make the Exploratorium special: an insistence on excellence, a knack for finding new ways of looking at things a lack of pretentiousness and a respect for invention and play.”

To me, as a physicist, the Exploratorium was, for these reasons, the ideal science centre – a ‘Mecca’ – a view not universally shared. While there was ‘something for everyone’ in its wide array of hands-on and interactive exhibits, it was clearly designed for high-school students – not pre-and-primary-school students like many such centres. We spent a whole day with the staff, who showed us how all their ideas and ideals were embodied in the exhibits. A brief, but profound experience for me – although less so for my fellow travellers.

Next stop was Minneapolis–St Paul, where we experienced a science centre with an OmniMax. I felt that while it was spectacular and would attract young people to the venue, it had limited value as a teaching aid, being both expensive and not interactive. The whole *raison d’être* of a science centre was direct, hands-on experiences with activities that would increase the student’s practical basis for understanding science and technology.

We went on from there to visit the Chicago Science Centre, the Ontario Science Centre, the British Museum, the (now-defunct) Philips Evoluon in Eindhoven, Holland, Parc de la Villette in Paris, the Deutsches Museum in Munich and lastly, the Singapore Science Centre, which had inspired the Deputy Premier a year or so before. Despite my extensive report and copious videos, much of what we saw and learned on that month-long quest was never successfully transmitted to others involved in the development of the Perth Centre, Scitech.

### **No Good Deed goes Unpunished**

So – Scitech was built and opened in late 1988. By that time, I was in a kind of exile (as a ‘Visiting Senior Fellow’) at the Institute for Science and Technology Policy (ISTP) at Murdoch University. I had run afoul of one of the apparatchiks of the new CEO of our recently amalgamated government department. Despite the demonstrable success of SITCO, I was now seen as someone who didn’t fit into the new, corporatist milieu. I recall a two-hour meeting with the new CEO, which gave me an inkling of the Oppenheimers’ inquisition by the McCarthyist HUAC. On my pointing to the progress of the development of Scitech as an example of my initiatives and capabilities, the CEO retorted that that “Science Centres left him cold.” He was a lawyer, who had visited only one science centre. The ISTP was to be an academic, outsourced version of SITCO, to be initially funded by the WA Government. As a permanent public servant, I couldn’t be fired, so a secondment to the ISTP was a synergistic solution. My three years there, followed by six months as a visiting professor at Penn State University was my modest equivalent of Frank’s years as a cattle rancher. And perhaps Galileo’s banishment to a villa for promoting his radical ideas.

### **Distance lends (Dis)Enchantment to the View?**

Thirty-five years later, Scitech is somewhat of an institution in Perth, still situated, with its distinctive dome above the planetarium, in what was Kevin Parry’s dream shopping centre, *City West*, which is

now mainly a Harvey Norman outlet. By now, multiple generations having visited it at least several times in their primary school years. Like all such centres that have been established for some time, its style and structure reflect the culture of its region and the market-oriented inclinations of its management. The vision of these centres' founders, invariably scientists of some kind, is often subsumed by the pragmatic considerations of the complex interactions of staffing, funding, sponsorship, relationships with schools, education departments, government and durability of exhibits, to mention some factors.

While I was, unarguably then (but by now, unknown), the 'father' of Scitech – and was briefly its acting director – its style was mainly set by its first full-time director, who opted for colour and movement over form and function and visceral fun over cerebral enjoyment. My dreams of a Frank Oppenheimer-inspired science centre like the San Francisco Exploratorium were never realised. Perhaps that was too much to hope for in the 1980s – in a relatively small, isolated place like Perth, with its primary industry hinterland – not the complex technology of Silicon Valley that we hoped to replicate in the Bentley Technology Park. Paradoxically, the minerals industry, which now dominates the WA economy, is now underpinned by sophisticated science and information technology.

### **The Book**

*American Prometheus: the Triumph and Tragedy of J Robert Oppenheimer* – the 700-page biography by Kai Bird and Martin Sherwin, is remarkable for its detail and its capturing of much of his complexity and the zeitgeist of the period from 1920 to 1960 – from the heady development of quantum mechanics in the 'twenties to the fearful rise of fascism and hopeful idealism in the 'thirties to frantic development of *The Bomb* in the 'forties to the mindless Cold War and anti-communist witch-hunts of the 'fifties. Much of this can never be conveyed in written words, particularly by those who did not experience it directly and to those readers who have not experienced scientific research and its institutional environments.

### **The Movie**

*Oppenheimer* – the movie – which has quickly become a significant box-office success, might have been better understood if it had been produced thirty years ago – at the time of the first three Star Wars movies. There are now only a few of us left who have any connection to those times with its high hopes and low insanities. Like many movies of the past few decades, it is a post-modernist melange – with alternating and conflicting perspectives in space and time, abandoning consensus and the linearity of the logic of scientific proof.

A film – even one that is three-hours-long in an IMAX theatre and performed by renowned actors, can only portray part of what is in the book, which is only part of that now-distant experience. The knowledge and experience gap between scientists and the general community is growing wider by the year.

The movie adds to the perennial exploration of scientific genius and savants, which include: *The Imitation Game* (2014), *Gifted* (2017), *The Man Who Knew Infinity* (2015), *The Theory of Everything* (2014) and *A Beautiful Mind* (2001), to name a few. While entertaining, none achieved any wider understanding of the basis of their achievements and very little understanding of the genius. Perhaps that is too much to expect from a presentation of two- to three-hours' duration and remains a challenge for the longer-format of streamed serials. The exploration of Walter White's character in the five seasons and 62 episodes of 'Breaking Bad' could serve as an example.

Perhaps the movie might serve as a metaphor for wider understanding of the struggle between spectacular scientific achievements and political hysteria in the face of global existential threats. The recent COVID pandemic, present climate change-related events and the forthcoming AI-era come to mind – and, of course, Putin’s veiled threat to use nuclear weapons in Ukraine.

Despite its box-office success, I doubt that it will leave a lasting impression, other than its spectacle. From Socrates to Galileo to the Oppenheimer brothers – and my own more modest experiences – *reason* has always resided ‘downstairs’ and has always been trumped by fear and superstition on the streets, encouraged by those ‘upstairs’.

As Winston Churchill, a very ‘upstairs’ person, once said: "scientists should be on tap, but not on top."

### **When Will They Ever Learn?**

In 1985, when I was director of the above-mentioned SITCO think-tank, about 20% of the student cohort completed physics, chemistry and advanced maths (‘STEM’) to high-school year 12 level. From a physicist’s point of view, this is the minimum level of knowledge on which to build a reasonably sound, ‘everyday non-expert’ understanding of scientific or technical issues such as climate change, energy sources, epidemics and so on. We thought that one-in-five students having a basic grip on STEM was alarmingly low for a technologically sophisticated community – less than a ‘critical mass’ to sustain scientific knowledge. Following a detailed review, SITCO made recommendations to the Deputy Premier aimed at improving this student participation level and the quality of science teaching. Those percentages have slid inexorably in the past almost-40 years and are now about one-in-ten. And even of that 10%, only about half do STEM at university level and undoubtedly most of the other half are glad to put the torturous and humiliating experience behind them.

The responses to the recent COVID pandemic illustrated the poor public understanding of even the most basic science and statistics. The frequent appearance of epidemiologists and medical scientists was never more than articulate talking heads and incoherent cliched images of test-tubes and laboratories. I watched all this attentively and imagined what Frank Oppenheimer might have done in the Exploratorium to reduce this public ignorance of these matters that were a matter of life-and-death. It was a remarkably rapid development of effective vaccines together with draconian regulation of public movement that saved many lives in Australia, rather than appeals to reason and science. There is little evidence that any of the expert explanations increased public understanding of the science related to the pandemic.

### **Share and Share – Alike**

Other than our training and education in physics, what is it that J Robert, Frank and I shared? A number of things, I believe. First, we shared a naïveté about the nature of the world. This is at the heart of physics – that with effort, all of the interactions between matter – both inorganic and organic – can be understood. That is, a complete and explicit description of the World is possible and should be aspired to by all. Even if some – if not most – people do not have the intellectual wherewithal for complete knowledge, then subscribing to this ideal and going as far as possible on the journey is everybody’s wish. While Heisenberg’s Uncertainty Principle put paid to that, we pressed on, regardless. *Rationalism* is more of an epithet than an aspiration for most people.

Secondly, we shared a view that descriptive knowledge must be accompanied by material evidence. This is the basis for “empiricism” – experience that confirms or refutes theory. *Full knowledge* is both “declarative” (the writing or uttering of facts) and “procedural” (the capacity to act).



Thirdly, we shared the view that we should speak out about our knowledge, even if our outspokenness is construed as an assertion, rather than a proposition that is amenable to refutation or verification. We all had our intended careers impaired by this compulsion.

Fourthly, we shared a sense of personal obligation to “act” on our knowledge. Many geniuses are depicted as nerds who are scarcely able to button their shirts, let alone supervise thousands of people to make *The Bomb* or create and manage the World’s best science museum, The Exploratorium. In my own way, my more modest ‘achievements’ of developing technologies, programs and organisations, including Scitech, have surprised many people who have seen me as just a dreamy scientist.

Fifthly, we share the attribute of being ‘innovators’ – people who do not necessarily ‘invent’ an idea, but people who ‘transform an idea into something that works’. As terrible as it seems, J Robert was the ‘innovator’ of *The Bomb*, not its ‘father’. If the planting of that seed can be attributed to anyone, it would be Einstein. Frank’s enduring innovation is the Exploratorium, essentially a fusion of active laboratory experimentation with static museums of technological artefacts. Similarly, from science libraries to solar ovens, from technology parks to Scitech and from e-books to photo-books, I wanted to be hands-on in getting these ideas to work.

Sixth and lastly, we were fundamentally ‘outsiders’ to the mainstream of society and its institutions – essentially ‘in it, but not of it’. Physics, with its requirement for detachment, suited us – it was familiar territory to us. But, as if to confirm Freud, we repeatedly tried to win approval through our deeds and achievements, both large and small.

### **To Infinity – and Beyond**

The *post-carbon-era* is also likely to be – paradoxically – a non-nuclear era, if, for no other reason than ‘tamed’ nuclear power is far too expensive, compared with electricity from the sun and wind.

We also live in a *post-scientific era*. Certainly, there are many scientists, in academe, industry and other research institutions. But ‘scientific thinking’, which J Robert Oppenheimer exemplified and Frank Oppenheimer brought to the public in the Exploratorium, is now a curiosity to most. Public discourse is dominated by anecdote at best and is mostly unverified opinion and accusation, punctuated, infrequently, by sound-grabs from experts. Interactive science centres are numerically popular, but most are essentially theme parks of tenuously science-related oddities – hardly distinguishable from many IT-laden arcades.

To this day, most people recoil in feigned terror when I say that I have a PhD in physics. They declare that they never got ‘it’, at least partly because of inadequate teaching. Many, in Perth, say that they loved Scitech as a kid and they now take their children or grandchildren there as a treat. Physics, with its integration of mathematics with observation of worldly interactions remains a mystery to all but a few. But many people, following the success of *Oppenheimer* – the movie, now know that ‘we’ built *the Bomb*.

A half-century after my heady undergraduate days, I came to grips with ‘it’ the structure of scientific explanation – writing a 250-page, interactive e-book in the form of a Socratic, or Galilean dialog: *Warming to You – Falling for Me*. I made it free at the Apple Store. It was my contribution to two-and-a-half-thousand years of failure by Rationalists to explain themselves to the wider world.

Many know that it was Albert Einstein who declared that  $E=MC^2$ . But very few know that he got the Nobel Prize for the photoelectric effect – the physical principle that makes solar (photovoltaic) panels work – not for his seminal work in special relativity that gave rise to that famous equation that underlies all nuclear transitions, not to mention enabling accurate GPS in our cellphones. He also developed the theory underlying lasers.

But, as Galileo said: “Eppur si muove” – “yet it turns”.

Or, finally, in the words of Richard Feynman: “Nature doesn’t understand public relations.”

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