Scientists and policy makers; why are they incompatible?

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Experienced volcanologists say there is a 20% chance of a huge eruption on Santorini this coming summer. The last eruption, which produced the beautiful harbour some of you may know, 3,500 years ago, was one of the largest ever recorded on Earth and spewed out about 60 cubic kilometers of rock. Why can't the damn volcanologists be more definite in their forecasts, think government officials. I can't close 20% of the shops and hotels. I have to decide how to react and what advice to give to citizens of my country. I could say nothing, or little; and if then an eruption occurs, killing thousands, maybe even tens of thousands, including many of my countrymen on holiday, there will be a big damning enquiry. On the other hand, if warnings are issued and tourism drops, the island will suffer financially, maybe even terminally, and the Greek government will be furious. Why can't the scientists give definite answers?

Science and scientific thinking play an ever-increasing role in our lives. Simple everyday decisions, such as whether to enjoy white or brown bread, full-cream or skimmed milk, well-cooked or raw meat, should be made not only according to particular taste, but also by what is 'good for you' meaning increasing the likelihood of your surviving healthier and for longer. On longer time scales, an individual should make decisions on diet, exercise, the taking of preventive medicines, such as statins, for example, on clear scientific evidence and not on intuition, fashion or taste.

Governments, on the other hand, need to make very large-scale decisions. They need to decide how to provide their people with sufficient energy, whether to support and encourage mass immunisation and how best to reduce crime, for example. All these decisions are best supported with firm scientific evidence. From this one might conclude that scientific researchers, with a keen knowledge and understanding of newly developing science, would be in much demand and constantly consulted by policy makers. This is true in part. For example, many chief scientific advisers have played essential roles in formulating government policy. The great names of Lindemann, Lord Cherwell (adviser to Winston Churchill

during World War II), Lord (Solly) Zuckermann and the Australian (Lord) Bob May immediately come to mind.

In general, however, good, flowing communication between these two groups is unusual. Why? One of the aims of this article is to describe the differences between these two camps and suggest ways that members of both groups could improve communication with resulting benefits to both groups.

Part of the problem arises from the different timescales envisaged by the two camps. Present a difficult, involved problem to most top-notch research scientists and their imagination runs off into how to solve it: what careful, innovative experiments to design and run; how to possibly analyse the data; and how the interpretation of the results will not only answer the question suggested to him or her by the policy maker but will initiate a new area of research as well. Good, the scientist thinks, this should all be manageable by my small, but creative, group in the fast time of approximately three years. But of course the policy maker wants the BEST available answer IMMEDIATELY.

Part of the scientist's difficulty in intellectually connecting with the policy maker is that the latter learnt his or her science mainly at a rudimentary level where all is facts and absolutely certain and definite. Hydrogen, Helium, Lithium, Beryllium…. and so on is the order of the elements, and will ever remain so. To every reaction there will always be an equal and opposite reaction. The human gestation period is 42 weeks and commences by a male sperm encountering an egg from the female to produce a foetus.

But, at the coal face of evolving science, we still cannot be certain that high usage of mobile phones by youngsters before their brain is finally developed is not deleterious to later development. We do not yet know how to efficiently capture incident solar energy although we have been trying to achieve this for at least fifty years, yet we do know that the solar radiation arriving on the surface of the Earth is approximately five orders of magnitude (a hundred thousand times) what we currently use. Neither do we know how to quantitatively describe most turbulent flows, although Leonardo da Vinci understood the importance of such flows and incorporated turbulent flows in his sketches more than 500 years ago.

Politicians believe in democracy, at least in free countries. A majority of votes -- in the country, in the House or in Cabinet -- is sufficient. Science is not a democracy. At the extremes, everyone can believe something without it being correct. Most people thought the sun revolved about the Earth before Copernicus. It was thought for some time that one could not exceed the speed of sound (though the end of whips, for example, had done so for ages). Will there ever be a total cure for cancer, heart attacks and strokes? Peoples' current thoughts, even those of scientists, are close to irrelevant.

Added to these different interpretations is the concept of statistics and risk. The unknowable nature of Santorini mentioned at the beginning is one of many where the scientist can only, at the moment, give probabilistic answers to questions of great interest to policy makers who seek definite solutions.

Many other such examples can be given where the scientist can only, at the moment, give probabilistic answers to questions of great interest to policy makers who seek definite solutions.

This leads to the difference between forecasts and predictions – different concepts not even understood by many scientists. A forecast is a description, maybe quite accurate and copious, of an event in the future. A prediction is a statement of exactly when the event will take place.

It takes not much ability to forecast the occurrence of earthquakes on the Californian coastline, the Japanese shoreline or in New Zealand. But when will the next one occur? Who knows? In my opinion we will never be able to predict earthquakes, even a few seconds in advance.

This scientific perspective can be very disturbing and problematic for the policy maker. For example, Tehran in Iran has experienced violent earthquakes in the 4th century BC, 855 AD, 958, 1177 and 1830. Another in due(ish) when? No idea. What is known is that each earthquake in the past killed approximately 90% of the population of Tehran, which is currently around 10 million. The next earthquake under the city is likely to again kill 90% i.e. around 9 million if it occurs soonish. However, in contrast to previous earthquakes, the occurrence of this one will be known around the world within minutes, if not seconds, and will have an effect on the global world economy, though no-one really knows what the actual effect will be.

Similarly Campi Flegrei, some twenty kilometres from Naples, Italy will 'soon' erupt, possibly killing tens, or even hundreds, of thousands of people. When? No scientist can give a useful answer to this question that is an essential ingredient for the Italian civil protection agency.

A standard way that a research scientist proceeds is to make or suggest a hypothesis and, maybe after many tests, experiments, scientific analyses later, s/he may find the hypothesis is false. S/he retracts and pursues another line; and his or her reputation may even be enhanced. Changing your mind, even if based on new evidence, is seen in a politician as a U-turn, dishonourable, disingenuous. Many parliamentarians, however, may not understand the role of hypotheses making and testing. In response to a question about a UK government policy, a minister gave the answer and then added: and the government is just initiating the research project to prove it. Even worse is David Tredinnick a Conservative member of the British Parliament and member of its Science and Technology Committee, who said: "It is well known that doctors cannot operate during a full moon because blood clotting is not effective" No truly scientific research will prove that.

Although numerous Civil servants have scientific experience and knowledge, few parliamentarians do. In the UK only one member of the House of Commons at the moment has research experience beyond the Ph. D. level. If there was to be proportional representation of professional scientists and engineers in the House, they should occupy 13 or so seats. In Congress in the US the only scientist of comparable experience is the member for Princeton. Residents of this city often sport the bumper sticker: my congressman really is a rocket scientist. No current member of the Australian Senate or the House of Representatives has a Ph. D. in science. In a recent survey a large number of British parliamentarians were asked what the probability was of two unbiased coins when tossed in the air coming down with heads on both coins. Only 47% knew the correct answer (1 in 4), which is known to most school children (though some of my colleagues opine that I am wrong and a 47% correct rate is surprisingly high!) Yet all these legislatures decide on numerous complicated and sophisticated scientific issues, such as whether to build nuclear power plants costing billions, whether to authorise the immunisation of all the children in the country, or how to obtain sufficient energy for the need of the country for the foreseeable future.

From statistics we move to the closely associated area of risk. We take risks all the time in our daily lives. We cross the road in anticipation that the bus will not yet have reached where we are. We leave it until the last minute to start a task, or buy a ticket, or decide to hit a drop shot with the aim of fooling our opponents. Some of us buy lottery tickets. Yet proper evaluation of many of the risks we often face is scientifically invalid. Generally, people are more scared of plane travel than car travel, especially when they are driving. But the risk of dying in an automobile accident greatly outweighs that in a plane. For example, around 45,000 people die each year in the US on the roads, while the air-related deaths worldwide on US commercial airliners recently has been 1, 51, 2 and 0 for the years 2008 -- 2011, (and most of us do not travel in the relatively small, often one-engined, privately flown aircraft which account for most of the deaths, 460 on average over the same four years ; 486, 470, 451 and 433).

There was a spectacular rail accident at Hatfield, UK in 2000, killing four people and injuring a further 70. The immediate response was to curtail train speeds, in some places to as low as 20 mph from 125 mph. Why? To increase safety and save lives, as required by the voters. But what were the consequences? Many people took to the roads because the train journeys took too long; and there was an increase in deaths on the roads of about a dozen over the next year. Roughly, the accident rate per road kilometres is 12 times higher than per rail kilometre. The 'correct' decision by the UK Government might (?) have been to run the trains faster, get more people off the roads and reduce the number of accidents. It would take a brave government to follow this line; and a brave policy adviser to suggest it. Similarly, I have a colleague who will only take the train from Cambridge to London, or back, if he has a rearward facing seat, because it is safer. But he is a busy,

important scientist, so as he cycles to the station he dictates to his PA into his dictaphone held in his hand!

A different view of risk as taken by possibly the greatest Australian scientist, Howard Florey, who started developing penicillin in October 1938, subjected it to its first clinical trial in February 1941 and it was already widely in use a year later. It is inconceivable today that a completely new medical cure could be put into practice without years of clinical trials on animals, and then people, all demanded by unimaginative, careful and litigation aware, government administrators.

Secrecy and trivial "need to know" concepts can also get in the way of real understanding. The great British Nobel prize-winning immunologist Peter Medawar often said, based on his experience, that by shutting the laboratory door you stop far more from coming in than going out. I once was asked to give a presentation to a government committee so secret that its existence is not allowed to be mentioned in Parliament – though all parliamentarians know of it; what nonsense is that? As part of my line I told them of Medewar's dictate and said I would like to illustrate the stupidity of some secrecy by recounting an experience I had maybe thirty years previously.

I have a quite high level security clearance and was asked to attend a meeting at the Ministry of Defence Headquarters. I was ushered into a room with about thirty individuals and it was immediately clear to me that there were no tags with names or affiliations; this was to be a "secret" meeting. We spent a few hours talking about the waves generated and the wake left behind by a long, slender body propagating through a stratified medium. When we seemed to have said all we could think about, and there was a deathly silence in the room, I piped up with: we have spent the whole time talking about the response when the submarine moves horizontally. Should we not spend some time considering the response when it rises vertically through the water column, when the generated waves and the wake will have a totally different signature.

A embarrassed hush fell over the room and I was thrown out a few minutes later. As the man who invited me showed me the door, he said: how dare you mention the word submarine in these circumstances.

As I said to the government committee some time later: did the people in the room think we had been talking about Australian Rules footballs being passed through the air? I concluded by saying this was an old story, and no doubt out of date, but it illustrated the idea. I was shocked that at lunch three members of the committee came to me separately and said they had very much liked the story of the "secret meeting", and took the point, but I was wrong in thinking the view was now obsolete. They could each tell me of a (different) recent incident that was pretty similar!

Government officials could benefit enormously by telling some academic scientists of their real concerns; even if telling the scientists to keep all the information to themselves. There could be a very useful exchange of opinions and indications of how to solve problems.

All this notwithstanding, there have been some successful interactions between scientists and policy makers. During World War II, sometimes referred to as the physicists' war, Albert Einstein (because of his eminence) signed a letter written by Leo Szilard (because of his political acumen) which was sent to President Roosevelt pointing out the recent discovery of chain reactions which suggested an atomic bomb of unimaginable power could be built, and hinted further that the Allies must do so before the Germans. The Manhattan project was quickly set up and supported by both scientists and government. However, it pitted the imaginative and broad-thinking scientist Oppenheimer against General Groves, the head of the project. They often clashed in their opinions of how to proceed. In particular, Groves insisted the bomb be deployed in anger against Japan, because otherwise he would have spent a huge amount of government money and overseen a vast operation for nothing. Oppenheimer's response to the use of the bomb, its necessity still debated today, was "I have become death; the destroyer of worlds".

Of course there can be very effective and useful interactions between scientists and policy makers. For example, Professor Sir Michael Marmot, of University College London, who was educated and trained in Sydney and is now a world renowned Public Health expert, studied UK Civil Servants, for which he reported that, on average, there was a strong correlation between longevity and rank - higher status, longer lives. This result was counter-intuitive. He expected higher grade Civil Servants to live less long because of greater stress and responsibilities. He ascribed the results obtained to higher grade Civil Servants having more control over their jobs, and their lives; and suggested, further, that control of what we do is a key parameter to life satisfaction and health. Later he initiated a series of strategic investigations into health inequalities, building on work he has masterminded for almost forty years. He assembled teams to investigate: world inequalities, supported by The World Health Organisation; European inequalities, under the auspices of WHO Europe; health inequalities in the UK, supported by the British government; and to make recommendations for action on the social determinants of health. Many of his scientifically-based recommendations of how to build a fairer society, and reduce inequalities in health, are slowly being put into place.

In contrast, the possibility of hurricane Katrina and its devastating impact was forecast sometime before it happened and even written about at length in the journal *Scientific American*. The decision makers did nothing to make New Orleans more secure. A report on the definiteness at some time in the future of the eruption of the Soufriere Hills on Montserrat and the devastation it would cause languished on the desk of the Governor of Montserrat and nothing was done either to warn the population or mitigate against the outcome, even though the report, based on fine

geological field work, had been specially requested. I know of one Chief Scientific Advisor (CSA) in the UK whose Minister said to him, on hearing some science he did not like: please withdraw that opinion; after all, I could always engage a new CSA.

Of course a decision that is scientifically sensible and correct may not be the best way to proceed politically, which immediately pits the scientists and policy makers against each other. For example, in 2002 the Royal Society released a report entitled "Making Britain Safer" dealing with how to defend Britain from terrorism. I was the chair of the working group that produced this report and in that capacity went to see a Junior Minister of the Home Office. After an hour and a half's extensive discussion I said: I think, Minister, you totally understand the scientific points and recommendations the report makes; indeed I think you would well argue cogently the case presented by the Royal Society. I agree totally with you, Professor, the Minister replied. Then, why will you not implement the suggested decisions, I immediately responded. Because it is not politically possible, was the answer; the PM (Blair) would not allow me, because it would involve expenditure on a new initiative at a time when he wants to decrease public spending. (Two years later the government introduced many of the recommendations of the report claiming they were all their ideas; and after 7/7 it was said that the implementation saved many lives on that fateful day.)

As a scientist, and an Australian, I would say that not enough science is undertaken, especially in Australia, in contrast to that undertaken in the US, the UK or Europe for example. The current CSA to the Australian government, Ian Chubb, agrees with me. When an Australian batsman, for example, hits a ton, especially against the old foe England, the success is cheered on the front page of every newspaper and we are reminded that he is joining the 'club' populated by amongst others by Bradman, Border and Chappell. When an Australian scientist is elected to the Royal Society, joining the 'club' whose members include Newton, Banks, Darwin and Einstein there is not even a mention anywhere in the newspapers.

Another interesting and greatly important example of different attitudes is the area of climate change. Most scientists believe there is a high probability that the average atmospheric temperature will continue to increase with devastating results for many, including increased severe storms and flooding. The political response: nothing. Part of the problem is that it is unlikely that there will be severe, world-wide consequences in the relatively short time span of the politician, but scientists suggest that the inertial time for the atmosphere to recover could be of order of fifty years – by when most of the current policy makers will not be around. Australia is in an interesting position here. It releases such a relatively small amount of carbon dioxide, only approximately 1% of the current world-wide emission rate of 32 billion tonnes per annum, that the complete shut down of Australian emissions would have virtually no effect. Yet Australia, for which 2012 was the hottest year on record, is encountering severe droughts and possibly even highly damaging fires due to current climate change. It is a global problem – the second in time after the CFC releases, which were easily and quickly curtailed. The

attitude and response of China, India, the USA and Europe will determine Australia's future.

Scientists, starting with Richard Doll, argued that cigarette smoking caused cancer and shortening lives. This was put forward quite forceably by Doll in 1950. Little was done to persuade the public to stop smoking for many decades. Part of the reason was the powerful lobby of the tobacco industry, keen to defend its highly profitable business and part was the pleasure of governments in collecting taxes from the industry. A similar situation occurs regarding alcohol. Drinking too much has severe health consequences and shortens lives considerably, say the scientists. Increase the cost of potentially lethal alcohol to deter drinking they say. Rather little is done in response. The argument here is however more complex and extended. Problems associated with imbibing too much alcohol, such as riotous behaviour, criminal activity, family break ups and liver disease may cost more in hospital, police, and community care than the taxes collected. To my knowledge no one has made a careful study and evaluated the balance realistically.

This article has concentrated on the interactions between scientists and government policy makers. A very similar critique could be written on the interactions between academic scientists and industry. Both groups could benefit enormously from closer discussions: academic scientists could research into more relevant and worthwhile questions, of great interest to industry, which (almost) all academic scientists would like; and industry could benefit financially from greater scientific input, to increase their profitability, which (almost) all CEOs and shareholders would like. This sort of interaction in Australia is generally abysmal; in the UK is bad; while it is quite healthy in the USA – and it shows.

An area in which there is good and immediate connections between scientists and users of the science is sport. Sailing has its scientific experts, who along with their wind tunnel tests are heavily involved in the design of the "secret" keels for the America Cup yachts and the best form of sails. English cricket uses machines which scientifically reproduce in minute detail the form and motion of Australian bowlers. English batsman go to the crease with much previous experience of the run up, over arm motion and swing of a bowler, even though they may never have met before. Very detailed, and secret, wind tunnel tests were used to design the bikes and the way they were ridden by cyclists representing Britain during the 2012 Olympics in London. The scientific efforts were reflected in Britain's spectacular success in the Velodrome – coached by an Australian!

But back to the main theme: how to bring the unrelated groups of scientists and policy makers together?

Superficially the answer is obvious: each group needs to learn more about the attitudes and aspirations of the other. Policy makers need to learn more science; scientists need to understand better the immediate needs and political constraints imposed on policy makers. The scientifically-trained British MP mentioned above

suggested crash courses in science for his colleagues. They were not interested; though the excuse was that they didn't have the time.

Some of the material above has outlined the satisfying success in some cases and the disturbing lack of understanding in others. Please excuse my not ending on a positive note but I recall Lord (Walter) Perry FRS, the super pharmacologist and one of the initiators and the first vice chancellor of the Open University in the UK, telling me that many of the peers in the Lords would often say with pride that: they read Ovid, in the original (which he doubted); and that they knew no science (about which he despaired). Both groups would benefit by closer understanding and interactions with each other, as has been demonstrated many, many times.