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'The importance of science communication to the public's understanding of science'

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Thank you for the opportunity to speak to you. I want to talk frankly about a number of topics. The issue of how scientists, media, policy makers, politicians and the public interact is now more important than ever, and yet more problematic than ever. The reasons for the importance are obvious.

First, science and technology clearly have not only changed the way we live our lives but they are at the heart of every major challenge we now face – both by contributing to causation but more importantly, as part of dealing with those challenges by mitigation and adaptation. The challenges include food security, water management, biosecurity, dealing with terrorism, adapting to growing conurbations, coping with mental health issues in an increasingly complex world, addressing issues of the internet and brain development, the potential for regenerative medicine, the obesity epidemic, and the matter I shall largely leave until tomorrow when I speak at the meeting of the New Zealand Agricultural Greenhouse Gas Research Centre in Palmerston North, climate change.

Secondly, the very nature of science has changed. Yes, traditional linear science still exists – we now know that birds evolved from dinosaurs, that there are five not four species of kiwi, that stomach ulcers are caused by bacteria not stress, that a virus causes AIDS, and that we can design buildings that will withstand magnitude earthquake 7 shocks. These are all examples of traditional linear science which follows the Popperian and Baconian approach of idea, experiment or observation, hypothesis testing and reformation until knowledge is developed.

One of the most important things that we have failed to communicate well is that even this kind of science is not just about facts. Indeed science is not facts – science is a process by which we make our best efforts to understand what is going on in the universe, in the natural and social world, and in ourselves. But science is more than simply mathematical modelling or access to experimental data – there is much more to the process of science than that. To think scientifically one needs many tools – ideas about cause and effect, respect for evidence and logical coherence, curiosity and intellectual honesty, the willingness to create hypotheses

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which can be tested, the willingness to refine one's ideas in the face of evidence: these are the core skills of science and scientists[1].

And scientific process is key to understanding the new form of science, which some people think is sufficiently different that they have given it a new name – post-normal science. I think it is a somewhat unfortunate term in its implications and I would prefer to simply call it the science of complex systems. But whatever we call it, it is important to understand how the nature of much of science that impacts on the public has changed. The scientific method is now being increasingly applied to complex non-linear interacting systems. This type of science almost never produces absolute answers; rather it serves to elucidate interactions and reduce uncertainties. Precision cannot be the outcome of such research, rather it seeks an assessment of probabilities and generally a reduction in the level of uncertainty. And all those grand challenges I spoke about a few minutes ago are about complex systems: obesity, water security and quality, biosecurity and climate change, to repeat but a few.

And there is another feature about these systems, one I shall dwell on in depth tomorrow. In each of these systems there is an important interaction with people's values. There is an enormous difficulty in this intersection; it is easy for scientists to forget that the scientific process is designed to try and overcome individual bias and belief; it is easy for those focused on values to demand something of science it cannot address. The most obvious example is with abortion – no scientist can address the question of when does life commence in a way that can narrow the inevitable divide between people with different value systems.

Look at recent scientific debates – where does the science end and where do values emerge as the key determinant? In a narrow sense, GM foods are safe, as is food from cloned animals. A different set of scientific issues surrounds the ecological impacts of GM crops, but even if this were to be robustly addressed the values argument remains, at least for many New Zealanders, dominant; science will not address that issue around 'natural' processes and scientists should not be arrogant enough to think that their view outweighs that of the community – it doesn't. Issues around the use of nuclear power in a world worried about carbon have similarities, so do matters relating to assisted reproduction, or to tolerating tobacco at some level in our society, or to dealing with adolescent behaviour, or to dealing with climate change.

And so we come to the third reason. Governments have to make multiple decisions about these and many similar matters, and in a democracy governments do not and cannot move beyond the public consensus, unless exceptional circumstances prevail.

And so we come to the focus of this address – how can we ensure that the public has the information necessary to reach a consensus on matters where science has something to contribute? The public clearly loves science – the syndicated stories acting as fillers around the advertisements packing the middle pages of the *New Zealand Herald* attest to that. Parenthetically, the sad thing about such stories is that it would be very simple to give them a New Zealand angle as almost always there is activity that is relevant here – a simple box would

[1] Modified from a definition by Sam Harris in *The Moral Landscape: how science can determine human values*: Bantam press 2010

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be so informative and help our population understand how much New Zealand science contributes to the global effort to understand our world. But to return to the main theme, science and technology stories are some of the best read on newspaper websites and the scientific blogosphere is very active, albeit often compounded by the interplay with other agendas. But the content of most local media stories about science is one of hype and breakthrough and unbalanced reporting.

Now, I hasten to add, I do not think this is the fault of the media alone. Clearly, many scientists overplay their hand and overstate the implications of their work – they have their own motives for doing so, whether it is to get attention or to impress a potential funder or donor. Likewise the media have their own motives – which is to sell stories or in many cases in the blogosphere to influence opinion.

So what should we do about this miscommunication of science? We could ignore it but I do not think we can. For the reasons we have already talked about, the public has a right to know what science is going on. Whether the system studied is linear or complex, the public has a right to understand what are the bases for claims, predictions and risk assessments. The nation needs its public to understand why an investment in science and innovation is critical for our economic, social and environmental futures, and then the public has a right to know where their expenditure on science goes and what it is achieving. The public needs to understand why there is consensus about climate change, albeit with varying evidence about particular observations, and why predictions of the future come with a range of uncertainty. The public should be taking pride in its scientists when they make contributions such as those made by Paul Callaghan or Peter Hunter.

But you are here because you also do not think we can ignore the issue of how science is communicated.

Let me take it in two parts: first from the scientist's perspective and then from the communicator's perspective.

First the scientist: scientists are not trained to communicate except with other scientists, or at least most were not until recently. In the era of linear science they were taught largely to think in reductionist terms, requiring a high level of jargon. The need for science to be understood by the public was not appreciated. Popularisers of science like Carl Sagan or Robert Winston were generally not appreciated by their colleagues – they were seen as breaking the tradition of the disinterested scientist. Or were those colleagues just jealous? Scientists generally appeared in the media only when they captured public imagination, such as Richard Leakey or Werner von Braun – fossils and rockets.

For many scientists that still remains the culture. They forget that public funding is exactly that. While many more scientists may appear to be media savvy, there is still a tendency to link engagement with the media to funding – in the belief it drives funding priorities or philanthropy. But in the last decade, perhaps helped by an important essay by Tony Giddens in the millennium issue of *Nature* in December 1999, the importance of the social contract between science and the media has become apparent to many science leaders. We have seen

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an increasing number of scientists engage constructively with the media, rather than simply using it for advocacy. Those with skills in translating jargon and explaining the scientific effort have become important to society. The popular science book has become an important genre. Gradually, programmes to assist the scientist in learning how to talk to the media have emerged. But should all scientists receive at least some such training?

But when it comes to complex science, the problem is even greater. The need to explain that science is now about reducing uncertainty, establishing the multiplicity of direct and indirect interactions and making predictions in terms of risk and probabilities is very different to communicating about a simple scientific finding. Further, understanding the limits of science becomes even more important. Science cannot provide certainty in many situations. Science cannot be used as a sole proxy for more complex discussions involving community values. For issues such as genetically modified organisms or climate change, if scientists wish to act as advocates for a value-driven or belief-driven position, they cannot act as true scientific communicators with any more validity than when a non-scientist advocates with certainty on a scientific matter.

Scientists have not done well at communicating the limits of complex science, and the media has in many ways not given them the opportunity to do so. With that I shall segue to the media perspective.

The media are of course not monolithic – there are the traditional media outlets, but even they have a broad range of agendas, from those of a popular science magazine such as *New Scientist* and many broadsheets to those of the *News of the World* and the tabloids. The electronic media span the same range of approaches and to that we must now add the capacity of every person to communicate information – or pseudo-information – via Twitter, blogs and other social media. The traditional media are of course driven by revenue, these newer forms simply provide a way for many agendas to be spread.

Whereas 30 years ago the traditional media took on the role of filtering the increasing mass of information into reliable and unreliable categories through investment in investigative reporting and seeking confirmatory sources, the new realities make that investment less likely to be part of even the traditional media's role. It may however, have to resurface to distinguish the role of the traditional media from the unfiltered mass of the internet. It is interesting to speculate on how reliable and non-reliable information will be defined on the net in the future. Open access peer review in science and Wikipedia-style group editing in the communal media may represent the future.

In the era of complex science the media really have an enormous responsibility. How do we communicate the processes of science and the limits of science? How can the media meet their commercial objectives but also play their important role as the fourth estate? I am optimistic here, I do believe that the public will value reliably filtered information made easily accessible.
The limitations on the modern media are obvious but the market is clearly there – the science community is better prepared to help but the media must reach out and enlist valuable and reliable filterers. That is what you are here for.

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Where are the problems?

- Scientists who are afraid to admit that they do not know something, or that their science has limits.

- Media who want to turn science into a series of breakthrough stories, when science is almost never like that. We have all seen the poorly handled 'breakthrough' stories, but the other side of the coin is that I could tell numerous horror stories about how innovative New Zealand science has not been publicised because the media say it is nothing new, even when it is, or because neither side could communicate to the other what the importance of the activity was. Despite there being a thousand interesting stories about New Zealand science, few ever make the media – be it the development of hapuka farming by NIWA, or Lanzatech's work in clean technology, or the digital adventures of Peter Hunter and his team in medical science. Actually, the public really does want to know.

- Scientists who over-hype the implications of their findings – how many cures of cancer or diabetes are claimed?

- Media who force the scientist to over-hype directly or indirectly by their over-commentary.

- We really have to get more mature on both sides: climate change is complex but it is happening, obesity is complex but it could be addressed, and so forth.

- Perhaps the biggest fault I find with the media is the tendency to cherry-pick in complex science. To not understand the various conflicts of interest that can be in play, to think that every scientific argument is a grand controversy, to not recognise when a scientific argument is being conflated with a values argument – as we saw with the debate over genetic modification and now with climate change. Tomorrow I will talk in some depth about climate change and the issues that surfaced, both within the climate change community and in the media. It is now clear that this issue exposed flaws on both sides – among the scientists in the way they communicated the science, but also in the way the media handled the story. The media either failed to understand what was going on, or decided that controversy was more important than information transfer. That tension of objectives has manifested itself in general confusion that does none of us good.

Finally, I want to turn to the role of science advisor. Why do I do that? Well, because what is now apparent after my first 21 months in the job is that a major function of the role is to try and communicate – not just to the Prime Minister and his colleagues, but to officials and to the public. And the role of the science advisor has to be cognisant of these very issues that I have raised.

Again the same dichotomy appears. Where science is linear and the information is needed by the government, the role is relatively straightforward – review the evidence and draw the conclusions. But one does not need a science advisor at the centre of government to do that. That role belongs to those providing scientific advice and information to agencies and

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ministries. Beyond the other parts of my role in assisting whole-of-government activities around science and science policy, such as the science/innovation/business nexus and the science diplomacy relationship, the most important is to assist policy makers with the interpretation of complex science. I have already canvassed the issue earlier in this talk when referring to the importance of alignment between politicians, policy makers and the public.

And the key issue is to understand what is the role of the science advisor in this regard. It is not to be an advocate of a particular position or to attempt to be the know-all about everything. Rather, it is about ensuring that policy formation is informed by science – what can science tell you, is it good science or bad science, what are the risks and probabilities, what is the likely magnitude of the effect? This approach has been termed that of an 'honest broker' who presents the full range of possibilities in ways that allow the possible benefits and harms to be appreciated.

Science in this setting is about exploring and informing about options. Science alone cannot make policy – it is but one factor, along with political, societal and fiscal values that must inform any decision. I will be releasing a discussion paper on these issues in the near future as we seek to enhance the way government uses evidence in policy formation and evaluation. Perhaps achieving progress in that direction is the most important thing a science advisor can achieve.

Thank you.

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