OFFICE OF THE PRIME MINISTER'S SCIENCE ADVISORY COMMITTEE

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'The authority of science'

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Earlier this year I released a report on adolescence entitled *Improving the transition, reducing social and psychological morbidity during adolescence*. That report represented the culmination of 18 months of work by an academic and professional taskforce working with my office. But it is not the content of the report I want to highlight – rather the unusual pathway to its release as it has important implications for what I do want to focus on in the main part of this talk.

The report was commissioned by the Prime Minister on the premise that there is major public concern about adolescents and young people in New Zealand, that it is clearly a complex problem, and that it is not clear what pathways should be followed to address it. The traditional New Zealand route would have been to set up a committee with multiple vested interests on it which would inevitably produces a compromise report reflecting political, ideological or self-interests. But the Prime Minister asked me to consider how my Office would address it. I suggested the appropriate route was to establish a panel of academic experts, who would intentionally not come up with recommendations but would consider the published literature, interrogate the evidence and by summation provide the knowledge base on which subsequent policy formation might follow. This was the path that was followed.

I created a taskforce of about 15 academics and professionals from across the range of disciplines and invited them to join a task force with the following rules. We would only use the peer reviewed scientific literature, not the grey literature, and the discussion would be kept objective and not biased by value based outcomes. We identified a number of chapters to be written by experts from within the task force supplemented by other authors as appropriate, and peer reviewed from within the group. As gaps were identified more chapters and authors were added. From that a synthesis report would be written and subject to external international peer review. The comment from those experts was that this represented the most comprehensive discussion to date of what is a critical issue for all western societies.

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That report has been the subject of wide and positive comment and is being responded to. It is an attempt to have an unbiased and relatively value-free (and I will explain what I mean by that later) summary of the issues from a scientific perspective. On purpose it does not attempt to make specific recommendations. That is not the purpose of scientific advice, except with respect to relatively uncomplicated issues concerning what I will call 'linear science'. Scientific advice provides base knowledge on which other perspectives need to be overlaid – that should be the basis of policy formation.

This example represents a new approach recognising that in complex areas of policy formation, an unbiased analysis of the knowledge base is a desirable if not essential starting point. The challenge is then for the policy maker and the politician to use that knowledge in policy formation –a process I shall return to later in this talk.

It is interesting therefore to note that in Minister Bennett's recent announcement of a green paper to look at the issue of vulnerable children, which will be released next week, she established a process by which a scientific reference group would independently review the work being done by officials. I chair that reference group and I can tell you that its meetings to review the work done by officials was constructive but robust in ensuring that the appropriate questions are asked in dealing with this particularly challenging issue. But equally I think the officials found it very refreshing to see a group of scientists looking at the issue from a knowledge base perspective rather than coming with an established ideological perspective or a predefined direction of travel.

Again, the issue emerges of what do we know that is effective and what do we know about what is not effective? What elements make a programme effective and how are those elements are assured?

These related examples reflect a refreshing approach and relevant to a discussion paper I released a several months ago entitled *Towards better use of evidence in policy formation.* That report arises from the first discussion I had with the Prime Minister after taking up my role and in turn following discussions I had with past and recent chief scientists and science advisors elsewhere. For example, when I had asked Lord Robert May, formerly chief science advisor to both the Blair and Major governments and a former president of the Royal Society of London, what was his most important achievement as chief scientist he said it was starting a process that his successors continued of improving and formalising the way in which science advice is incorporated into policy. He had the challenge of moving those governments away from the misuse of science in the way the mad-cow disease outbreak and the first foot and mouth epidemics were handled. This created opportunities which he grabbed.

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The way science is incorporated into policy is a more complex issue than meets the eye.

There at least three questions that need to be asked:

- Does science and knowledge have a privileged place in policy formation?
- Does the changing nature of science affect the way in which science advice is provided?
- How should science advice be incorporated into the policy and political framework?

In this talk I shall address the first two of these questions. The discussion paper I mentioned just now considers the third question.

So to start with the question: Does science and knowledge have a privileged place in policy formation?

Democratic societies make decisions and policy based on many inputs, including fiscal considerations, societal values, prevailing public views, and the ideology and ambition of the government of the day. But underlying all of that is the question of what kind of decisions do governments want to make. I think we can assume that in modern social democracies, subject to staying within their ideological framework, governments want to make good decisions.

My view is clear – to put it quite simply, the use of high quality information and evidence should be at the core of such decision making. Decisions made in the absence of informed background material are, by definition, made on the basis of belief and dogma and are less likely to be effective and less efficient and can entrench policies which may be of little value. This is of course making a statement about what is the position of scientific knowledge. I hope we are beyond the post-modernist argument and can accept that as defined by Jonathon Marks, a distinguished biologist and science philosopher, science can be defined as "the production of convincing knowledge in modern society".

The only other sources of knowledge are ultimately those of belief or dogma. This is an important if not essential point, for the particular authority of science is intimately associated with the particular nature of science. I will expand on this later in addressing the second of my questions but let us continue at this point in my talk with the traditional Baconian-Popperian view of what science is, namely a iterative process of experiment or observation, hypothesis testing and reformation until knowledge considered to be reliable is developed.

The key point is that science is not the facts themselves -- 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. 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 which can be tested, the willingness to refine

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ones ideas in the face of evidence and to understand probability and uncertainty: these are the core skills of science and scientists.

This is emphasised in the way Sir Peter Medawar presciently defined science … "Science is a means by which we analyse the many things that might be true about the universe and pare them down to the few that are probably true." Examples abound of the essential role of knowledge in policy formation. It would appear intuitive that formal driving education within the school curriculum would reduce the high rate of road accidents that teenagers experience. Indeed there has been much advocacy for such programmes over the years in various countries – from politicians, families of road victims and insurance companies. But when such programmes were introduced in both Europe and the US, it became evident that these initiatives either had no beneficial effect on, or even actually increased, the accident rates of young people.

Formal evaluation with controls showed that driver education does lead to earlier licensing, but provided no evidence that driver education reduces road crash involvement and suggested that it may lead to a modest but potentially important increase in the proportion of teenagers involved in traffic crashes. An earlier study from New Zealand in the 1980s reached similar conclusions. This negative view of such programmes was initially vehemently rejected by some advocacy groups, but the scientific view became compelling and has been integrated into policy. The data do not even support driver education as a rationale for accelerating the passage through graduated licensing systems. Why does this counterintuitive outcome occur?

In part because it leads young people to wanting to get their driver licence at an earlier age, and in part because it can lead to over-confidence in people who are already at a stage of their lives when they are most likely to engage in risk-taking activities. This is a classic example of why an evidence base is desirable even when what seems like 'obviously sensible' new programmes are introduced, and of why programmes should be introduced in a pilot fashion capable of evaluation. The assumption that formal driver education would be of value led to investment in programmes which in fact did more harm than good.

To take another example which makes another point: without evidence as to whether policies are working, governments can become constrained by earlier policy decisions that are not easily reversible because there may be a popular or political perception that that they are effective when in fact they are not.

A recent OECD report notes that
"New Zealand spends considerable amounts on single parent benefits which last until children are into their teens with the notion that this promotes child well-being. There is an international consensus that there is little to no evidence that these benefits positively influence child well-being"

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This is of course a reference to the DPB. This statement may well be correct. But it could also be wrong because we just do not know within the New Zealand context whether this prolonged payment is of value to the child or not. The research has not been done. The programme was never set up to be evaluated *de novo* and thus any decision to extend or contract it has to be belief-based. Given that, it becomes untouchable, because the default position of most people seems to be to assume that it does help despite the OECD analysis suggesting otherwise. Yet a policy that is expensive would be better placed if the public saw unequivocal evidence that it worked and was value for money. Or, if the opposite was correct and there was unequivocal evidence that extending the payment for so long had negative effects, the public would be more supportive of a review of the policy. This is the problem – without knowledge we fall back on dogma, and rational decisions about scarce resources cannot be made.

These examples make another important point: while information and evidence do not and should not themselves make policy, good information and evidence provide an important base for a rational assessment of options weighed up against those other criteria that politicians and their supporting policy advisors should consider.

Those other considerations – I will remind you of them in a moment – are valid for the policy maker but are values-based and therefore I think that it is reasonable to conclude that scientifically derived knowledge does sit within the policy framework in a different way to other claimed forms of knowledge. I think that in the 21st century one must be very wary of decision-making processes that are not prepared to look at the knowledge base before decisions are made.

But science and knowledge alone do not make for policy. There are perfectly valid other components to policy formation and these can lead to quite different outcomes. Those other components include societal values, public opinion, affordability and diplomatic considerations, and of course the political process must also be accommodated. So let me turn to the second question: Does the changing nature of science affect the way in which science advice is provided?

We are in danger of underestimating how much the nature of science has changed; it used to be focused on linear questions, those aimed for reductionist precision. For example how much weight will this bridge take, are birds descended from dinosaurs, what are the side effects of this medicine? As a result science was authoritative, definitive and largely accepted by a very different public. In general, science advice on such matters is issue-specific, linear and can be provided by an expert without an interlocutor.

But science now increasingly deals with complex non-linear phenomena where certainty is not possible, there remain many unknowns, and answers are defined in terms of probabilities and levels of uncertainty. Much science can in that sense no longer be considered authoritarian. Yet these are often issues of high public concern and indeed the very matters on which governments turn to science advisors.

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This is a big shift and one that many scientists caught in the reductionist detail of one particular element of a system have failed to recognise.

More importantly, most of the public and many policy makers have also failed to recognise it, although it must be said that sometimes failure to admit this big change will suit the agenda of some pressure group. The biggest effort I have put into my engagement work is making this point time and time again. And the problem this creates is obvious. Uncertainty – that is not what scientists want to be the outcome of their work, and it is certainly not what policy-makers want to hear. But often policy makers cannot wait and decisions have to be made on the basis of uncertain evidence, or even absence of evidence – there are many situations where the government must act. Here is a major point where values and science begin to interact – a matter I shall soon return to.

The nature of science in changing in other ways as well. Disciplinary boundaries are being removed. This is leading to dramatically new paradigms of doing research. Larger research teams, multiple disciplines, increased reliance on rapidly changing and expensive technologies. My own lab contains mathematicians, evolutionary theorists, molecular biologists, cell biologists, physiologists, clinicians, epidemiologists and economists, all working on the same problem and all talking to each other.

But there is a much more important issue at hand; the questions that science is addressing also create real challenges for society. The conflation of the biological with the physical will lead to new forms of neural implants, regenerative medicine which could create impossible demands on the health sector, predictive biology will become more robust, the potential use of geoengineering in mitigating against global warming, the role of bioengineering in dealing with issues of food security are all examples of whether rapidly emerging science will be in potential conflict with societal values.

Parenthetically, I think that we have grossly underestimated the impact of technological developments such as the internet on our social structure, on how people get information and relate to each other. How do people select between relatively reliable information, less reliable information and frankly misleading information on the net? These issues are real and change the nature of the relationship between the scientist and the community she or he lives in. A matter I shall return to later in my talk.

But the biggest shift is one about the nature of the issues involved, and this has direct relevance to the role of the public scientist or science advisor.

Typical examples include food security, the use of genetic modification, dealing with adolescence or the aging population and of course climate change.

Such science is intimately linked to and intertwined with the values and concerns of the public and therefore the body politic. While many scientists deny it, philosophers have pointed out that values have always played a role in what and how scientists choose to study, in research ethics, in funding decisions. Of course the process of obtaining the results

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and interpreting any set of observations must be value-free. This kind of science is sometimes called post-normal science: which is defined as the application of science to public issues where facts are uncertain, values in dispute, stakes high and decisions urgent. I think that is a compelling summary of the space in which I find myself much of the time.

And these concepts lead to a major challenge – one highlighted by the philosopher of science Heather Douglas in her outstanding book *Science Policy and the Value Free Ideal*, and this is the issue of how much uncertainty is acceptable when deciding whether the science should form the basis of an action or policy. Such decisions are never value free. Values do not compete with or replace evidence, but determine the importance of inductive gaps left by the evidence.

In her view the key question becomes: When is a particular body of scientific work adequately "sound" to serve as the basis of policy? One must ask how much evidence is sufficient, how reliable are the studies underpinning the evidence? How much uncertainty is acceptable? What are the risks associated with an erroneous conclusion in either direction? These are the challenges governments and their advisors must deal with.

Thus as science plays a more authoritative role in public decision-making, its responsibility for the implications of inductive error in either direction – premature action or persistent inaction - increases.

Climate change provides a good example of the asymmetry of this challenge of when does a particular body of scientific work adequately "sound" to serve as the basis of policy? What are the risks associated with an erroneous conclusion in either direction? Let us look at the question of anthropogenic climate change through the lens of that question. If the scientific conclusion on the question is that there is a significant risk to the human and planetary condition through global warming is followed, actions are taken and it turns out to be incorrect, what are the costs of the incorrect decision? A change in the economic picture with costs incurred but there are collateral benefits in terms of moves to sustainable energy, new technologies, and less environmental degradation. If on the other hand the conclusion reached from the science was that no mitigation was needed because anthropogenic climate change was of minor significance then the consequences of error if the conclusions turned out to be wrong would be so much higher – the human condition as we know it would be threatened.

Clearly the outcome of which decision is taken is asymmetrical. So if we take this example of post-normal science, given that the view of most scientists is that the world is warming at a rapid rate due to anthropogenic climate change, the decision to advise action is unequivocal. There remain values components to the matter which are not for the science advisor but for the politician and policy maker – how to balance intergenerational equity, although here the view might be influenced by advice as to the likelihood of successful mitigation by technology but again one suspects that is largely used as an excuse to avoid decisions and for political confusion, and secondly the far more complex and real issue for the global community of how to avoid the tragedy of the commons.

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Because of this intertwining of values with knowledge a further complexity arises. Science can become the proxy for a values debate which is essentially independent of the science. The most current example is the apparent debate about whether or not there is anthropogenic climate change. Most of that debate is not really about the existence of climate change – rather it is a proxy for a public and political values debate about economics and intergenerational equity. As scientists get drawn into such a debate, they can lose their role as unbiased advisors and risk loss of public trust.

Complicating the matter, complex science is based on variable data and advocates for any one position may choose selectively from this to make a point. The potential for values, beliefs and science to thus become conflated is almost inevitable and the public and policy debate becomes confused.

In these matters of post-normal science the role of the science advisor as a communicator with both the policy maker and the public becomes critical. Science advisors must be explicit about the assumptions, limitations and uncertainties underlying the evidence and present technological options in ways that allow the full range of their possible benefits or adverse effects to be appreciated. Remember no science advisor is expert in everything they must advise on, indeed that is not their role. They must act as a broker between the science community and the policy framework. It is how that brokerage is conducted that is itself a key issue.

Roger Pielke in his book *The Honest Broker* distinguished between two kinds of advice about complex science – that of being the issues advocate and that of being the honest broker. The former is what it sounds like – the advice is proffered with the scientist having the goal of getting a specific outcome, and in general that is an inappropriate role for a person like myself. Issues advocates abound in science on either side of many complex debates – genetic modification is safe, genetic modification is not safe.

Such advice is already conflated with the other dimensions that policy makers must deal with and diminishes the authority of the advice provided, for its knowledge and values components cannot be separated. I should emphasise here I am talking about issues of post-normal science, not the role of the scientist in more linear matters even if there is more uncertainty – is this drug safe or not safe, what design constraints are needed on a building, what risks are there for an earthquake – he there may be uncertainty but there is not a values component.

The honest broker on the other hand takes another approach. The evidence is summarised is a values-free way, in so far as that can be achieved. This is what genetic modification means, this what we know and do not know about GM food from the perspective of human health. This is what we know about the impact of genetic modification on ecological systems, and so forth.

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Values perspectives of what is natural or organic or clean or green and so forth are not directly matters for the science advisor, although how science is communicated to the public will influence the values the public consensus reaches at any point in time.

The science advisor must be honest in admitting the limits of knowledge but also be informative about the implications of what is known and unknown. This must include definition of the limits of knowledge and where biases could exist in evaluating and defining the range of options that arise from the analysis. The advisor must be conscious of where values can enter into consideration and when they do not. In the end the key is to provide the scientific basis for options and provide the basis for the policy process to proceed.

The science advisor must also acknowledge that many decisions that governments have to make are developed in an environment of limited available information or where the use of science is unable to resolve competing policy options. There can be a seductive trap of being drawn into matters where science cannot provide answers. A classic example is the US debate over stem cells, that has got conflated with a debate about perspectives on when life begins – not a matter open to scientific answer, at least in the framework in which that debate occurs.

The advisor must remember that science cannot be authoritarian and does not make policy, it informs policy making. A purely "technocratic" model of policy formation is not appropriate in that knowledge is not, and cannot be, the sole determinant of how policy is developed. In a democracy, governments have the responsibility to integrate into policy formation the other dimensions that I have already discussed, including societal values and public opinion. Advice must be phrased in such a way to give confidence and authority to the policy advisor without usurping their role.

The science advisor must be honest about the values dimension and act as an "honest broker" providing options. It is how that is done that determines whether the advisor has the trust of the public and the policy maker. It requires skill from the advisor, and good understanding and integrity from the bureaucrat and politician as well. But it must be achieved, for at the end policy formed in the absence of knowledge or without considering relevant knowledge is simply dogma and cannot serve the public well.

Thank you.

ENDS.

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