



OFFICE OF THE PRIME MINISTER'S SCIENCE ADVISORY COMMITTEE

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New Zealand is at a cross roads because we have seen our relative standard of living slipping for at least two decades. As a society we need to regain that positivity and innovative strength that sustained us and allowed us to punch above our weight and to enjoy a remarkably high standard of living for a country with a rather narrow portfolio of economic drivers. The depressing state of our relative productivity has, with justification, become a point of political focus.

We seem to have forgotten that science and technology, particularly in the agricultural sector, played an essential role in getting this nation to the social and economic pinnacle it once reached, and in my view is absolutely central to us moving ahead again.

The question must be why this has not been obvious to all, why it has not been reflected in the organs of State, why the science system has become focused on survival rather than on ensuring outputs and societal and economic contributions, and why there is an unhealthy level of scepticism about science and scientists. These are questions that I have to address in my new role and one which all of you have a collective responsibility to think about and help address.

There can be little doubt that we live in a country that in recent years has developed more ambivalence towards science. You only have to read some of the recent columns in the media. That ambivalence has many sources but I will suggest to you that part of it has arisen because of how the science community itself has been constrained to act and operate. Scientists are fractious.

The science community has become increasingly focused on its survival rather than what it can contribute. The reasons for that are multiple. Part is inherent in the individuality of researchers, but in no small part it is a direct result of the system they live in. We face the consequences of twenty

years of a funding system that has had all sorts of perverse incentives that have harmed the capacity for science to make its appropriate contributions. I think the net effect of the system has been a focus on institutional health rather than outputs. But in turn scientists have exaggerated what they can do in an attempt to get funding and as a result created expectations they cannot meet. Many of our collective and individual behaviours have been driven by protective self interest, but playing at Oliver Twist is not the way to change a national attitude to what science can do.

My challenge to you is that it is unrealistic to see the solutions as solely other peoples' responsibilities — we also need to look to ourselves — I shall return to this theme later.

Science is at the heart of almost everything this country must do to meet the collective ambition of virtually every New Zealander — a healthy, socially connected community in a good environment enjoying a very high standard of living.

New Zealand cannot sustain competitiveness if science and scientists are undervalued and the role of science is misunderstood, and my appointment is a signal event. That I have been appointed should be evidence that these issues can and must be addressed and that there are avid listeners on the highest floors of the Beehive.

The new role I have has already had many expectations placed upon it from many quarters. I must emphasise that I am *not* in this role as a lobbyist for the scientific community or for scientists or for universities or CRIs. I can only be a lobbyist for New Zealand; I am in this role to help the PM and his advisors use science best to advance New Zealand.

My key stakeholder must be the Prime Minister, to whom I report and have regular meetings with. The establishment of the role by John Key suggests that there is a willingness on the ninth floor of the Beehive to explore how science can better help transform New Zealand to a socially, environmentally and economically stronger nation.

The other stakeholders are multiple: the scientific community, the scientific and academic institutions whose major focus has become survival, the media, the business community, officialdom, and politicians.

Let me just make one or two comments on the business sector.

Today the Minister of Science is speaking at the Beehive and emphasising the urgent need for science and business to be better connected. He will be arguing that New Zealand must lift its game in this regard. We have few large scale industries in New Zealand; we are largely a nation of small and medium sized businesses. But New Zealand business must be innovative to survive and thrive, and innovation is based on new knowledge — although new knowledge is not just about new scientific discoveries. Indeed it is more often about the passage of knowledge from one domain to another, or the combination of extant knowledge across two domains. Unfortunately the nature of the New Zealand business cycle means that most business is focused on short-term technology transfer rather than the longer term application of knowledge to produce quantitative shifts in our productivity. We also need to recognise that science leads to new industries, beyond just reinforcing the old.

There are a number of potential tensions in the public science–business relationship and the perspectives, depending on whether you are a scientist or a business leader, are very different: basic versus applied research, investigator-led innovation push or company-led scientific pull. There are different perspectives on the best ways to improve the translation of publicly funded research into the business community. I see I have an important role in acting as a translator across this divide — getting rid of the barriers — be it the PBRE, the lack of upside for CRI staff in inventions, research naïvety about how to or when to find the connection, the quality of technology transfer offices, the cost of public-private interactions, or the need for financial incentives to engage. My international experience suggests a major issue is that in New Zealand companies come late to researchers to solve problems, essentially just to be technologists, rather than come early to science to use the scientific brain help identify opportunities science can address. This is a major attitudinal difference. Every party: scientist, researcher, CRI, University, tech transfer group, venture capitalist, business, treasury and MED has different views on the issues and their relative importance. We need to understand the barriers and address them. In three weeks' time I will be conducting a workshop in conjunction with Treasury, MED, Royal Society, Business New Zealand, MoRST and FRST as co-sponsors, meaning that all the key skills in undertaking tech transfer, including successful and unsuccessful scientists and businesses, will be in the room to assist me in a report on this matter that I will be preparing for the Prime Minister.

So what is the role of the Chief Science Advisor and what is it not? There is both advantage and disadvantage in having to create a role where none existed before. I want to emphasise that I have no role in the operation of the science system and will not become a conduit to those that do. It is certainly not my role to get into the operational aspects of the Ministry of RST or indeed the many other Ministries that have science-related budgets: agriculture, environment, health, education,

social welfare etc. My primary role is different and must be distinct — that is to give the PM advice on areas of science and science policy as requested.

The Prime Minister and I have agreed on five primary domains of activity.

The first is to advise on matters of science policy in areas where the Prime Minister and I agree I can usefully contribute. If New Zealand is to use science transformationally, we need to have a collective understanding on what science can do, how it should do it and why. This needs to be reflected in policies that transcend individual agencies and ministries. Thus I see the need for an overarching and aligned science and innovation policy, one that transcends the ministries as science is far broader in its implications than the matters covered by MoRST.

A key part of the role of the CSA in the UK since the time of Lord May as Chief Scientist has been to promote the key role of science in informing policy development. This has received great impetus particularly in the UK, and there is now an independent and very competent science advisor placed in virtually every department of state. In addition cabinet protocol has been developed to ensure that tendered advice is independent and evidence-based. A select committee has just reported on ways to strengthen the nature of that advice. Next year I will be considering how we might develop the ways in which evidence should inform policy.

I hasten to say that science does not make policy, but that without a proper evaluation of the evidence, the efficacy of policy is likely to be more limited. We also are not good at using evidence to evaluate the effectiveness of policy. The fundamental challenge is to ensure that the scientific evidence is placed appropriately within this decision-making chain. This is why the UK and Obama's White House are putting so much emphasis on the role of science advisors.

The PM and I have agreed on a specific project to explore this matter. I will be announcing details in a few days of an advisory group that I am putting together to amass the evidence relating to improving the passage of young people through the teenage years. What do we know but yet do not employ to improve critical transition from childhood to adulthood? There is a large amount of empirical evidence that has not been collated, assessed scientifically and then given to policy makers to consider. Scientists, both social and biomedical, must assess the evidence first — too often there has been cherry picking of selected data by non-scientists. And yet we have extraordinary depth of expertise in this area in New Zealand — let's use it.

More generally, I will be building off excellent work done in the UK by my equivalent positions there to advise on general principles that might improve the use of knowledge across the state sector, most notably in the social ministries, not only in developing policy but in evaluating policy. I am delighted the PM has asked me to consider what could be done here.

Climate change illustrates the difference between the role of science and that of policy development. Science has demonstrated that we face a planetary challenge of unsurpassed consequences for our species and that that change is a result of human activity. The limitations of science are also illustrated in the inevitable uncertainties about temperature projections. Science also makes it clear that actions to reduce greenhouse gas effects are needed.

But then the discussion must shift to how much to reduce the emissions, although for New Zealand this is more of a policy rather than scientific issue, for whatever we do will be miniscule in its effect on global warming — after all we produce less than one 500th of global emissions. There is a cost, both direct and indirect, to New Zealand in reducing emissions; there is a cost, both direct and indirect, of the world of not doing so and we remain at the grave risk of experiencing the tragedy of the commons, where the collective activities of high emitting nations cannot be reduced because of understandable national self interests by the big emitters in the developed and developing world.

On Monday the Prime Minister announced the basis of the nation's response. His cabinet's decision had to be made in relation to how we see our positioning in the world. I use this example to point out that there are limits to what science advice can do; any policy decision has many other dimensions — public attitudes, cost, political perspective and so on.

Secondly, I have the role of advising on specific matters related to science. In general, this will be in the form of formally commissioned reports that will summarise the evidence base to suggest a specific mode of action, for example the report on methamphetamines currently under consideration by the Prime Minister, or where new scientific developments create either opportunity or risk. I will limit my role to situations where my independence and hopefully high public respect can add value beyond what can come from departmental or sectoral advice. I will be relying heavily on the Royal Society and its Academy for input and all my science reports will be subject to peer review on their scientific content, as has been my report on methamphetamines and the paper I will soon release on climate change. I particularly want to thank the new president of the Royal Society of New Zealand, Garth Carnaby, for his cooperative approach.

Third: I have been particularly tasked with promoting the public understanding of and engagement with science, with a particular emphasis on young people. I believe that the widening gulf between science and society is a critical issue. It is one that underlies many of the recent contentious debates such as stem cells and now folate. Science can be jargon ridden and sold wrongly by scientists (who, by dint of circumstance, often use the media for lobbying purposes). Scientific debate can be confusing, as typified by global warming, and it can be arrogant, often forgetting that there are other dimensions to understanding the human condition. If science is to be at the heart of transforming New Zealand, then its participants must do much better in this regard. Many of you may have seen President Obama's recent speech to the National Academy of Sciences. In this he challenged everyone of the academicians to spend time in the high school classroom. In common with this, a specific brief I have is to encourage more children to see science in their future. All I can do is persuade you that such a contribution merits your time although your employing organisations may not yet see that as a priority.

Compared to most advanced countries, we are not as well served by the media in New Zealand with respect to science. There is no coherent attempt to explain the issues of the day or to explore what New Zealand science is delivering. There is little true reporting of New Zealand science with the exception of National Radio and the profession of science journalism does not really exist here. A few top scientists persist in promoting public scientific understanding, and when they do so they are very well received.

We have to accept that the positioning of science has changed — we are not high priests pontificating on the world; we are people who use a ways of developing knowledge to build knowledge on which others can act. But not all knowledge will be accepted and I think the social contract between science and society is such that science is not only about obtaining knowledge, but also about assisting the acceptance of that knowledge. I cannot think of one challenge we face as a planet, as a society, as individuals in which science is not part of the solution. But much science is complex and the very process of science is about uncertainties not certainties.

With exceptions, such as the excellent article on climate change in last weekend's Herald, it is largely based on entertainment and controversy rather than informing the public appropriately. The media wants breakthrough stories when science is not really about breakthroughs — how many of you can honestly say you have ever made a paradigm shifting discovery? What we do is accumulate knowledge until a new understanding emerges — the paradigm shifts of Kuhn. Science is about repetition and confirmation and variability. And the very process of addressing complex problems

means that there can be different perspectives and understandings, particularly when different disciplines are involved. Then there are always the maverick, driven by whatever — a quirky idea, their philosophy and politics, or the media going to an individual non-expert in the area. Look at the disaster that ensued when some scientists, influential but not virologists, persisted for a long time in saying HIV was not the viral cause of AIDS —look at the air time they got, the bias it gave South African politicians and the tragedy that ensued. And given all the papers published every month, many never deserving to be published, it is very easy for the media or people with an agenda to cherry pick, to confuse. The use of bad metaphors does not help and it is easy to get into trouble as I myself have done. The philosopher-molecular biologist Lenny Moss once said that in science it is sometimes not the best ideas that succeed but the best metaphors: he was here referring to genetic determinism and the many metaphors that surround it.

We have seen examples of the misuse of science in the media, sometimes by the media itself, but often by people playing to the media's interest in controversy. And it is not always the mass media — our science media has done it too — the disgrace of the Wakefield affair which led to the false claim of a link between MMR vaccines and autism, appeared against objections of peer reviewers in the publication conscious Lancet, was picked up by the mass media and is directly responsible for the crash in immunisation rates which has devastated children's brains and lives. Now we face another measles outbreak in New Zealand.

I believe the issue of the public understanding of science is central to science being part of our national strategy for building. Later this year I am inviting all the relevant parties together to see what we can do to improve the quality and integrity of science reporting — but most of all its accessibility and utility. We face complex issues — global warming, new biological technologies, new medical technologies, nanotechnologies, environmental threats, biodiversity threats, new approaches to improving our productivity — the public have the right to a media that informs, not alarms, and allows science and society to work together. I will be convening a meeting of editors, producers, science communicators and others to see if we can improve the situation.

Science can often suggest approaches that are in conflict with conventional wisdom. In my view scientists must not only produce the science, they must also communicate to the public in a way that changes the conventional perspective. Often that can be hard, when that conventional wisdom is caught up with folk understandings of science — an issue that has been exploited many times. It will always be difficult for politicians and policy makers to move beyond conventional and folk understandings. It is even more difficult in the biological and environmental sciences where science is

dealing with the reduction in uncertainty rather than the production of certainty. Hence my belief that the public understanding of science is so important. Scientific progress can come into conflict with the mores, culture and even ethical values of society. However familiarity reduces the fear and improves the understanding of science. Science cannot best assist society where distrust exists.

This role is not political. The issues relating to science and its role must operate on a time-base that transcends the political cycle. Science is clearly a major component of the solutions to the issues facing this country — those of social, economic and environmental security. I would contend that our best asset — namely the collective brain power of New Zealand — is being poorly used to advance the country.

On the other hand, science and technology create challenges. Scientific advances can create uncertainty for those who do not live and breathe science and there is often also a credibility gap between the claims of science, at least as portrayed in the media, and its actuality. Scientific knowledge is not just facts; it is also the process of how those facts are obtained, analysed and digested.

Now I must turn to some really big questions.

The first is the most important — what is the purpose of public investment in New Zealand science? Or put another way, what should New Zealand expect from its investment in science — a matter that the Minister is also talking about today?

This is not as easy a question to answer in other than a very trite way, and you might find that comment surprising coming from an individual whose whole life has been committed to publically funded research in New Zealand, and has been both proud of his contribution and is absolutely convinced that science can do so much more for New Zealand's transformational future. But the science community has basically worn out its credibility in pleas to 'just give us more money' without addressing the question of why the State should invest the taxpayer's scarce money.

For various reasons, many scientists have reduced their advocacy to being simply about money rather than addressing the question that matters — why we do science. In turn this has resulted in a set of platitudinous bureaucratic responses with allusion to vested interests and institutional and job protection. Then there is debate over the balance of investment in different parts of the sector — public and private. Compounding this has been the argument that public investment in industry

support has more potential benefit than investment in public sector research. This rancorous muddle now has to be tackled head on and I see my role as raising the quality and clarity of the dialogue to a much higher level.

New Zealand has only four million people — remote in physical terms from the major intellectual powerhouses of the world — we are only the size of a Sydney or Melbourne. So to address the question: there are two extreme possible answers.

The first is nihilistic and sees research as intellectual enquiry that is primarily nothing more than a way of supporting scholarship in ensuring an educated population — nice-to-have, just like investing in museums and the ballet. Beyond this and providing a basic infrastructure to deal with some specific issues like ensuring the capacity to monitor the environment and to protect the population, indigenous research does not really add to the potential for New Zealand to develop. This view argues that a country like New Zealand can rely on imported knowledge and the primary investment should not be in science but in technological development. It is a view with surprisingly broad traction and I suspect is the basis of our historically poor levels of investment.

The second approach is what I absolutely believe, which is that science will and must be the mainstay of the transformation of New Zealand; indeed it is the only way we can make a quantum leap in productivity, it is the only way we can address the many challenges we will face. However this answer has many dimensions and we have to dissect these and build a non-rhetorical set of arguments that must inform a national consensus.

The problem is that most of the arguments that have been advanced relating to the transformational answer have been based on simple extrapolation from those used to justify the massive investment in American science. There is no doubt that for the USA and all the major industrialised economies, investment in R&D is directly linked to economic growth and also to political dominance. But is such an extrapolation valid for a little nation like New Zealand? We cannot compete in every domain of research on our own and expect to out-compete the global effort. But other small countries have manifestly been able to use investment in research to promote economic and social development — Singapore, Israel, Denmark, Sweden, Finland, Switzerland are obvious examples. Indeed, we have no other option — we are short on resources other than our intellect by which we can transform our economy and we need to learn from these small advanced economies and apply their approaches. This may not sit well with a number of beliefs and traditions of the scientific community. For example, we cannot expect four million people to be able to support good capability in every domain

of science. We cannot expect to have a very large number of true scientific entrepreneurs of international class, and the issues of how we prioritise in science investment can be uncomfortable and disruptive.

But science is much more than economic growth driven simply by transfer to extant or new industries. While the focus has increasingly been on direct transfer through patents and technology, because that is the easiest to understand, so much more benefit has been and will be via intentional transfer to common good. This is well demonstrated in agriculture where science transfers to the farmer not through patents and quantifiable exploitation but through common knowledge leading to changes in farming practice and know-how, be it new breed lines or new forms of husbandry, biological control of pests etc.

But examples go far beyond agriculture to all aspects of social development — research can greatly enhance the quality of return in our health, education and social welfare systems, to name a few. Science can have enormous value in sustaining our environment.

The Royal Society in London has just released a report showing that basic research has enormous flow-on effects to the service industry in areas as diverse as banking and retail, through disciplines as diverse as mathematics, ICT and social science. The leverage of this less quantifiable gain can be enormous — after all, 70% of our economy is inside the service sector.

There is an even more fundamental reason — we need to see a change in the whole attitude of New Zealand if national productivity is to rise, whether we are scientists or farmers or industrial workers. We need to see that a knowledge economy is not just something we should be proud of, but that the innovative culture it creates can pervade every aspect of our lives.

These issues of course raise the question of what extent research should push development or industry pull it. These operate on the different time-lines and we need to ensure clear thinking on this matter. The role of research in transforming New Zealand is a long game that requires both push and pull. In my view transformational research is generally built around individuals and we need a process to identify where research leaders who can make a difference will emerge and be valued as such not just within the science community but more broadly. Such a process must be competitive and not domain focused — who would have predicted we would have world class commercialisable research in nanotechnology. The lack of a career developmental path for entrepreneurial scientists is a clear gap. The real valley of death is in the late postdoctoral period. Companies need to see that

science can add value not just in an operational but in a strategic sense. Just as engineers have made a critical role as members of company boards, scientists can also provide a new way of thinking.

Science has many more upsides for New Zealand — it can transform how we approach problems of society, it can protect our environment, it can lead to new industries, some small, some perhaps large, it can add to our standing in the world, it can change our national psyche and in doing so reinvent us in a way that can improve our productivity.

But there is a second big problem. We have a complex internal geography — our public research effort is split over seven major centres and about 20 major research organisations with a poor history of collaboration and indeed an intense sense of unhealthy competition — this is reinforced by one of the most competitive research funding systems in the world. We have a funding system with a number of perverse incentives. The lack of an overarching innovation policy means we do not ever act as “New Zealand Inc”. If we do not start doing so, and if we persist with a set of processes which are more appropriate for the UK or the USA, our poor performance and the scepticism of the policy maker will be reinforced.

Any expert in economics, game theory or research funding strategy will tell you that small systems are riddled with vested interest, conservatism which destroys innovation, and a focus on competition at the individual level to the manifest detriment of a strategic approach. We must find strategies and models that get beyond these limitations and allow New Zealand research to really move forward. Centres of Research Excellence (CoREs) and perhaps to some extent the newly announced platform approach of FRST address some of these issues and while they are welcome, they are partial solutions to a deeper problem. I suspect we need a much more balanced approach — competition at entry in finding the best individuals, but more strategic decision making with true performance accountability where long term funding is applied. No public funding of research should occur without evidence of true scientific evaluation, but that evaluation may be on performance rather than entry. I find it extraordinary that CRIs do not have standing external independent high quality scientific advisory boards to provide effective scientific audits and suggest strategic opportunities.

Today the Minister is speaking at the Beehive and will be raising the issue of the need to relook at priorities. I suspect that there will be considerable debate on what the underlying principles should be but it is a matter that has to be discussed — we cannot be world class at everything. It comes back to the question — what are the reasons we invest in science? Getting a balance of perspectives is important. Science is generally a long game, but business in New Zealand is usually operating on a

much shorter cycle yet both elements along with government all have valid perspectives. Scientists are key to priority setting — no drug company would envisage priority setting with market pull completely isolated from scientific vision — they involve their best scientists. Companies cannot know what is possible if scientists are not engaged at the very outset.

While it is easy to blame the system perhaps we need to look to ourselves to see how we have collectively made it worse and we need to get our house in order. I want to leave you with some challenges where the solutions lie as much with ourselves as with others.

We have important national resources that are not made available to the whole research community because of our competitive attitude, to the obvious detriment of the enterprise. We have replication and duplication of effort where it is unnecessary, even within the same institutions. We are reluctant to focus the research effort. We insist on an egalitarian approach that gives equal weight to many disciplines and makes it hard for new ones to emerge.

We use scarce competitive funds to sustain efforts that have passed their peak and yet we also fail to see the need to sustain some areas of science that may not be sexy but are essential — an obvious example is our lack of ruminant physiologists at the very time we need them in the need to reduce methane emissions.

We have a research system that is more driven by review, some of it of doubtful quality and often not really by peers, than any other in the world. Peer review is essential but we need to decide where it is needed on entry and when post-hoc performance assessment is more appropriate. It is no accident that the greatest medical research endeavour in the world — the NIH — has a large intramural program.

We have too many funding sources and yet no ability to sustain research at the one place where New Zealand has a true competitive edge — that is at the interdisciplinary boundaries. Innovation arises at these boundaries — yet the funding system with its vested interests effectively makes such research impossible. Yet it is particularly in small countries that interdisciplinary research is possible — it is what brought me back to New Zealand. Only when we sort through these issues can we expect policy makers to have a clear view of how science will transform New Zealand. These are issues that the scientific community really has to engage in and own and not just be passive and importuning about.

We have a funding system that says new ideas may have to wait three years to get funded — innovative ideas must be lost in such an approach which was introduced to simplify a bureaucracy — there are better ways to do that.

The CRIs and Universities have different structures, ownerships and missions. But together they make up the bulk of the publically funded science system. We need to be certain that the system and their missions are aligned in such a way for maximal value of the Crown's investment. I know many of you would like to hear my views on CRIs but that is for another time. My first conversations must always be with the PM.

As President Obama pointed out recently, infrastructure is the core scientific capital and as yet we in New Zealand do not have a process for the coordinated development of infrastructure — our parochialisms can impede it. As the knowledge explosion grows, the role of advanced bioinformatics will become the key to use of biological information yet the system has delivered isolated and replicated capacity in this area. We cannot sustain competitiveness this way. How many supercomputers do we really need in New Zealand? We need national not institutional facilities.

Another key issue is how New Zealand should take research to scale. We have a very small capital community. We have already seen many lost opportunities, particularly in the biotechnology sector, because of the inability of New Zealand to invest to scale. It appears that generally our technology transfer activities are not working well, although there are some success stories — albeit very few — and the reasons for this need analysing. We will be addressing this in the workshop in one month's time that I referred to earlier.

In most domains we cannot go to scale on our own — that is why a greater investment of effort and, yes, dollars in stable international partnerships will be important. I suspect that for most of our scientific contributions, exploitation will require partnerships around the globe and I would suggest that we have a real advantage in seeing Asia as the key point of entry. Our investment, diplomatic and scientific communities need to work together here. But partnerships require effort, time, money, strategy, consistency and leadership — we do not have the elements either public or private in place to maximise our route to scale.

Only when we truly address these questions can we start to see operational ways to improve the contribution of science to New Zealand. The science community needs to reflect on these issues as much as the various arms of government. Science must be at the centre of any national

transformation exercise but this must be one that reflects New Zealand as a very special place. If we do it right then the potential is enormous.

Thank you very much.