



OFFICE OF THE PRIME MINISTER'S SCIENCE ADVISORY COMMITTEE

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Thank you for the invitation to speak.

The world is changing at an exponential rate. Knowledge and technology are a major part of that change, and whether New Zealand remains of relevance to the rest of the world will depend on transformational strategies that will in turn depend much on how we develop and use knowledge. New Zealand has a limited number of fundamental assets, and how we use these over the next decade will determine what we will look like for the next five decades or more. What are these core assets?

First and foremost is our reputation based on a stable, honest government and a physical environment that is both beautiful and relatively pristine. Second, a potentially very good education system which can generate outstanding graduates who are wanted by the world talent market across most disciplines, particularly in science and engineering. Third, the practical and economic base on which to further develop the 'cultures' — agriculture, aquaculture and so forth — but here we must have a strategy that gets beyond the immediate to what the world will really want in 20–30 years, namely food for quality of life. Talk to any of the majors in food and they will tell you that added-value food 20 years out will be that with well proven benefits on health. We must also recognise our considerable strengths in the service sector and increase in some niche high technology products. Last is our umbilical cord to Asia, where successive governments have positioned us well to have effective relationships with the growth population and economic superpowers. It may be that we will be increasingly seen as an exporter of ideas more than only an exporter of widgets and food.

We are only four million people — less than a medium sized city in Europe or North America or Asia. But our obligations in Research, Science & Technology (RS&T) to support the nation are so much more. However our commitment to research is in fact much less. Why is that? Is it our history as a nation which has put relatively low value on thinking *vis-à-vis* making money or playing sport?

There is an international consensus that investment in RS&T links directly to productivity. However, our private sector expenditure on RS&T is very low and our public sector investment is relatively low — even more so when one sees that the public science system in New Zealand is, in relative terms, already disproportionately directed towards the pull of the private sector when compared to other small economies such as Denmark and Singapore.

So on to the question of how should we undertake public science.

Our system is now the most internally competitive in the OECD, but it has a feature which looks superficially compelling — the FRST system essentially requires end-user involvement right from the start. While this sounds good, it is a system like no other in causing more worry about a business and implementation plan than a science plan. My bias is that that may be counterproductive. At the end of the day, second rate research is a waste of money. The New Zealand system is now full of small buckets of narrowly defined and varyingly administered funds, which are over-competed for. The result is that strategic decisions about the science that can and should be done are often made remote from those best placed to do it. Virtually everywhere else in the world, the so-called Haldane principle applies whereby science direction is driven by scientists, and market pull drives technology transfer.

Our science system has many agencies involved; it is complex, it is bureaucratic, and it is compliance heavy. There is now a commitment to simplification, and that simplification has to reference what is needed. Our science system has lost the career development focus of past generations. We have no ready way of supporting the best intellectual entrepreneurs, and the post-postdoctoral period is now a valley of death. We have a system that is so competitive that what we have done in many places is create a model where the best scientists spend their time competing for funds to support other scientists, where the focus of science has become one of institutional survival over scientific outcomes, and where enforced competition over-rides spontaneous attempts at collaboration. Science is after all about nurturing innovative minds and giving them an infrastructure and signals of direction, namely a high level strategy. Contrary to this we currently have a system with little focus on individuals, none on infrastructure and with a tendency to micromanagement activity rather than drive of the vision.

New Zealand with its four million people has about 20 major research providers — the CRIs, universities and a few institutes such as the Cawthron. For all of them RS&T is now a matter of survival and institutional health, not about the national interest. We can end up with three groups within one CRI competing for funding in the same science area; we can also end up with eight universities and three CRIs duplicating low level infrastructure rather than creating national centres of expertise. Even where there is new opportunity, we find institutions battling rather than collaborating to get to scale. All said and done, if we

combined all the faculties in any one discipline over the eight universities we would only approach the size of that in a major US university.

The exception to this, and perhaps a harbinger of the future, are the Centres of Research Excellence (CoREs). They delegate funds to the science community following a well defined high level competition under the aegis of a high level strategy, they require non-institutional focus, exploiting the latent synergies across institutions, and they are delivering well. The Bio-Protection Research Centre is a good demonstration of this. Perhaps the platform approach of FRST is a potential move in the same direction, but we need to allow for bottom-up input into potential platforms as well.

While I do not have time to go into detailed explanation, over-competitive systems lead to very conservative bids and conservative research — research that will not in itself lead to innovation. It is this matter of individual competition versus collaboration that is at the heart of the issue. Recognition of some of the perverse incentives at play has been avoided. Because our system is so competitive, the capacity to go to scale, to develop the infrastructure and to exploit synergies has been crippled. Australia sees value in national research infrastructure, yet we get worried about what it will do to enhance the reputation of one institution at the expense of another.

Do we need to change some of the signals in NERF and in the PBRF to work better? The fractured approach just cannot work for New Zealand given its size and geographical position. We need to get the balance right. Peer review and quality review can be based on entry in academia so that we ensure the next Paul Callaghan is identified. But we also need to be sure that such people have a chance to flourish, and that clusters, physical or virtual, are formed. It is hard to see that happening easily in the current system. The best are leaving and we cannot afford that.

Most nations put a significant proportion of their funding into strategic allocative processes — Singapore puts about 60% in that way. The funds are allocated to super-CoREs and CoREs in the University sector and block-granted Institutes. What they depend on is the most rigorous process of external review and evidence that there is a strategy and a path to exploitation — this is highly effective and highly accountable.

Where are strategies set in the CRIs? The Boards have little capacity because they control little of their funding — the use of public sector funds is set by the FRST process with little buckets, and this can lead to very unfavourable outcomes. For example, we now have little capability in ruminant physiology at the very time that ruminant physiology will be key to our contributions to reducing emissions. Another example is our soil science being diminished. CRIs are not required to have external scientific advisory boards and the ministerial letters are not based on scientific outputs or expectations.

So the challenge is how do we get a better NZ Inc approach? How do we get the incentives in the science system better so that it works for New Zealand? Because it has to if we are to thrive. How do we shift the equation so that we move from having only 180 Agricultural Science undergraduates and over 2,400 in Film and Media?

But all this leads to another contentious question: how do we set priorities? We need some because we cannot do everything. We need to do a few things well but we cannot always predict where it will come from — Weta workshop, TradeMe, wire-free artificial hearts — any number of other outcomes do not necessarily arise from an over-planned approach.

Priorities must be based multi-dimensionally on excellent minds, an appropriate human and physical infrastructure, quality of science, New Zealand's particular sectoral interests (already largely defined by the shape of the CRIs), the potential for a full value chain from discovery to exploitation, and long-term investment returns. Priorities should not become a long list driven by special interest lobbying.

Let me put a few more priorities on the table: firstly that of competitive advantage. Where do we have advantage? The answer to this may in turn depend on how we exploit it — a matter I shall soon return to. My own bias is that small countries have one major advantage — they can work quickly across disciplinary boundaries, but the funding system needs to be responsive to this.

Secondly we should be asking the question of what futures are transformational for New Zealand, and making sure that we have the research capability and capacity to back such transformation because one thing is certain — any transformational strategy will depend on knowledge, and science is in the end simply the only way we have to gain new knowledge.

But beyond that the system must be flexible and responsive as science moves fast. This is why I have concerns about a portfolio approach on a three-year cycle. In a world of parallel discovery nothing waits for three years.

Finally, given what I have already said should we be thinking about giving priority to where an NZ Inc approach is possible, that is building on the latent and real synergies across partners?

Priorities also have to reflect the different types of research providers. They have different drivers and while it is essential to develop incentives for both to work with each other, they will always be somewhat different. Universities are a mix — a mix of individuals doing individualistic research to support their scholarship, mixed in with applied and not yet applied (to use Michael Porter's classification) activity in larger groups, some of which look very much like activity in CRIs except often in other sectors. CoREs in a sense are another form of a mini-CRI with a more educational focus.

In my view CRI missions need clearer definition — they were originally designed for sector support but due to the lack of clarity regarding their mission, the extent to which they should support the private sector or compete with it has become confused. A primary need is to review the understanding of the roles of CRIs and put in place accountability structures relevant to that mission — in my judgement, that includes the need for scientific advisory boards. Furthermore, we must give the CRI boards and management enough flexibility through strategic funding for them to make accountable decisions rather than just act as research hotels. Part of that requires that they are able to get closer to both the Universities and the private sector.

We should be alarmed that our biggest scientific resource, the CRIs, play little role in human capital development — they need to get closer to Universities. I hope that we can find some innovative ways appropriate to NZ Inc to do better across these interfaces.

In the interests of time I want to move on to the other big question: how do we grow New Zealand through knowledge? That is, how do we take science to scale and how do we exploit it? There are multiple users of science and evidence, and each has different needs in terms of drivers.

First there is the government itself. It is a large sector of the economy. It undertakes a large amount of analytical work but unlike the CRI and University sector, there is no oversight on its quality and its value for money. Secondly the business of government is the business of policy-based decisions. To what extent are those decisions informed by evidence, and to what extent are interventions assessed for effect? How good is the operational research done within Ministries and agencies? Evidence is only part of the process of policy development; public acceptance, societal values and fiscal priorities are the other domains the politicians must judge but without evidence we fall back on dogma and vested interest.

But there are related issues, such as the role of the media. If evidence is to be given more weight in policy formation, then it confronts the political reality that no political process can move faster than with public acceptance. And we have seen issues here — the folate in bread situation being merely one example; climate change another. The quality and capacity of our media to represent science and evidence is patchy at best. Peter Griffin is doing a great job with the Science Media Centre, but the media is still hell-bent on reporting science as a series of breakthroughs — which it is not — and failing to illustrate well somewhat complex issues, and wanting to create controversy with a moral equivalency approach that leaves the public confused and the politician unable to act. Climate change represents a giant challenge here and I suspect clean water will soon be as well.

The second domain by which we use knowledge is through common good. For example our farming strength is not primarily based on patented products, but on the strengths of

knowledge of breeds and husbandry and pest control, which have come through our scientific community over several decades. That oil is now our biggest export to Australia comes because of public knowledge about our offshore shelf leading to major companies being interested; that we have a sustainable fishery comes through the work of NIWA and its precursors. Is our challenge of reducing pastoral emissions best done through open or closed innovation? Concerns have already emerged about the premature move towards the latter. We have a society based on individual responsibility, but is that responsibility expressed if people do not have the knowledge that can lead to healthy behaviours and sustainable environments?

I have left to last the issue of knowledge transfer to the private sector. There is of course not one private sector but many — we have a large service sector, a significant manufacturing sector as well as our pastoral and food sectors. While we think a lot about R&D with respect to the last two, it is perhaps in the service sector that some of the most obvious effects of basic mathematical and ICT research have come to the fore. Those interested in the service sector should look to the recently released Royal Society of London report entitled “Hidden Wealth”.

As I said earlier, New Zealand has a very private sector-focused research system yet private sector RS&T itself is very low. Clearly this has become a major focus of any government interested in improving productivity, and so it should. Earlier this week I chaired a workshop on this issue in advance of producing a report to the PM on strategies going forward.

We have a science application process dependent on business plans and private sector associations from the earliest stage. A project does not even have to have any preliminary data to get funded — no other country has gone this far, yet after 18 years of this approach, our private sector R&D commitment remains dismal. To ask some hard questions: have we in fact simply taken the funds needed from basic research and effectively shifted responsibility from the private sector? Do we not have the volume of basic research needed to drive innovation, or do we not have the business skills to take RS&T to scale? Or is it simply that as a country we have never really seen value in intellectualism, and that with an economy dominated by SMEs and short term investment gains, the capacity and incentive to take research to scale is just not there? Other small countries have done it so size alone is not an excuse.

The cultural barriers between scientists and business are real. In contrast to what I see elsewhere, industry often comes to science just to find a late-stage solution to a problem; it rarely comes early to find what opportunities science might have. While application of most basic science may be uncertain, the reality is that such basic science of today is innovation in a decade, and as such our scientists need to understand more about where exploitation opportunities lie.

Time-scales are a real issue. Few New Zealand businesses look beyond the short-term, and even our largest businesses such as the farmers' collectives do not — look at what has happened to the wool levy. In general, we need to recognise that early stage RS&T is delivered by scientists; decisions about it need to be made by scientists aware of the sector, and late stage decisions by those who understand technology transfer, business and so on. Conflating all this, as we tend to have done here, can be most counterproductive. We should examine what happens in other small innovation-intensive economies.

How do we get the two cultures — scientist and exploiter — to know each other better? Perhaps through some programme of assistance to rotate academics, researchers and business people? Perhaps through some process of assistance to put active and/or very experienced scientists on Boards? If one looks at New Zealand versus the US and Europe, one of the most obvious differences is the almost total lack of scientists on both public and private boards here. Offshore they need not be from the discipline or sector relevant to the enterprise, but the scientific way of analysis has been found to add enormously and help traverse the cultural barriers. Should directorial skills become part of the career development of our most successful scientists, and would the private sector respond?

And what happens in the universities — are the signals from the PBRF helpful or harmful, and can they be re-jigged to do better? Is the PBRF used as an excuse by academics to avoid the real world? Maybe, but in my experience entrepreneurial academics are usually also business focused, but with this there are dangers and damage is done. I know of a number of examples where a researcher working full-time on a corporate project has found their CV damaged for life with a large publication gap, particularly as the project shifts from research to development, and this has then hurt promotion and grant funding opportunities. The excuse that “the gap in my CV is because I was doing private sector focused research” may be real, but it is never accepted and younger researchers see that.

Twenty per cent of New Zealanders live overseas but in terms of scientific leadership and entrepreneurship, the ratio must be closer to 60% or 70%. We have to work out what to do. I opened a New Scientist magazine recently to see an advertisement from the University of Queensland for a research professor in cancer. The package included AUD\$400K per annum plus a negotiable research support package which I know will be of similar size. I am prepared to lay a bet that there will be New Zealand applicants for that position. The world market for New Zealand talent is real. A similar person in New Zealand would be lucky to be making 35% of that, and yet would also be facing a much more competitive funding system.

The issues within CRIs are real and confounded by uncertainty as to whether they are competing or collaborating with industry. We have seen inappropriate closed innovation hurt whole sectors, and this again suggests an immaturity of understanding of how to manage technology transfer. I worry about prematurely closed innovation. The drivers have

led to the tying up of public IP too quickly at the expense of what might occur downstream or through more open systems. We have to do better.

And what about the business sector? Should R&D incentives be discretionary through grants like TechNZ, or primarily non-discretionary through vouchers or tax rebates? In New Zealand we have very few companies with the infrastructure to undertake their own research, and in many cases even development. We need a better NZ Inc approach whereby the facilities of the CRIs and Universities are available. But beyond interpreters and awareness, the real issue is one of exclusion through high cost. CRIs and Universities have to charge full costs and these are substantial — indirect and overhead costs can be 150% of direct costs. Other countries subsidise these directly or indirectly. If we addressed this issue, could we incentivise universities and CRIs to go to business early and vice versa? In times like these, getting incentives which achieve what they are intended to do, rather than those that are uncertain or compliance heavy, becomes even more critical.

Perhaps one of the most difficult areas is that of technology transfer. This is not a space for amateurs, yet with exceptions, we have few professionals in this area. Should we do what Denmark has done and coalesce our expertise? Have we got the pre-seed, seed, and venture capital space right, or can we do better here? The trans-Tasman fund is an example of how we can use structured arrangements to go to scale quicker — scale in terms of sector expertise and dollars. Indeed, should we do more and recognise that going to scale might require new strategies? Such new approaches may be where we undertake international partnership from the discovery stage onwards, thereby making international funding at the transfer stage much easier. I would contend that we are better to own 50% of something large rather than 100% of something which fails because we cannot go to scale. We have obvious partners in Asia to take things to scale. In general I think that we have underestimated our capacity to be partners in ideas generation and thus in capturing value — I have a suspicion that our most valuable export will be ideas, but we need to be clever about capturing their value. It would require rethinking our science funding if this becomes a core strategy.

To be relevant in this world we have to keep on punching above our weight. The rate of increase in knowledge is exponential and we risk the danger of becoming irrelevant. We are going to have to become much more ambitious as a country — ambitious in valuing and using knowledge. Scientific process is in the end the only process we have that gains new knowledge about the world — it is a process, not just a collection of factoids. I worry immensely — the quality of scientific understanding, the quality of science education, and the commitment of this society to science are all dangerously low for us to have a smooth path ahead. A key part of my role is to help to change the place of science in New Zealand society. But all academics and researchers, be from the humanities, the social, the natural or physical sciences need to play a role.