Re-setting science and innovation for the next 20 years

The wider roles of science and innovation

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The title of my talk is a little disconcerting, for I am not certain that we can or should try to dichotomise between the various roles of science and innovation in our society. A healthy and smart nation needs knowledge to pervade every aspect of its activities, and no society can meet its citizens' objectives without greater economic prosperity. Indeed economic prosperity, social development and environmental protection are intimately intertwined. It is nonsensical to think in terms of a science and innovation ecosystem that does not recognise these intimate linkages. Those countries that have increased their investment in both the science and innovation ecosystems in the last thirty years are now much more productive than we are.

However, let me make just a few brief remarks to put the remainder of my talk into perspective.

For the last two decades New Zealand's science spend has been essentially constant at about 0.5% of GDP on public sector R&D, whereas all our comparator countries have increased spending to at least 0.8% and are heading towards 1% public spend. In our comparator countries we have seen a steady growth of private sector investment in R&D so it now averages 1.5 to 2% and continues to increase – we sit somewhere around 25–30% of that number. Those small countries that have invested more in becoming smart nations have withstood the global financial downturn remarkably well – look at Israel, Denmark, and Singapore – and they have seen rates of growth in productivity we are still dreaming of.

We have a 20- to 30-year investment gap to fill, and if we examine our assets we have little choice but to use our untapped capacity to generate knowledge to do so. I say this because we look as if we are close to maximal with regard to the efficiency of dairy production and in any event we need to get well beyond commodity exports. We are already arguably the most efficient country in the world in turning science into papers, and indeed science into patents. The deficit is not in our capacity to generate knowledge, but rather in our lack of a sufficient volume flow to build the knowledge-based and added-value-based industries and support structures that flow from it. There are other challenges which I will return to later in this talk.

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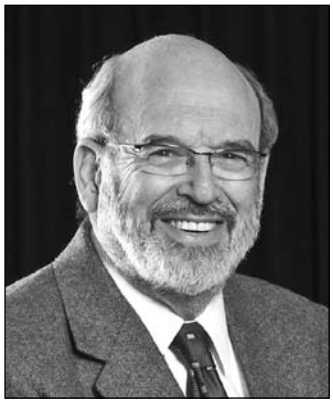
Science and policy

In the last two budgets we have seen the start of a process by which we are starting to adjust our settings to improve the potential for growth off the back of being smarter as a nation. While it may sound pious, every one of us strives for a better life, whatever that means in our personal ideological framework. All of us want an inclusive, positive, ambitious and safe society. However, whatever we want, the way we live our lives is intimately linked both to the economic prosperity of our country and to our increasing knowledge of the natural and built world. Unless we are an exceptional Luddite, we rely on the benefits of science in so many ways. Our whole society is built on science, from the EFTPOS machines that underpin our retail sector to the environmental science that determines how to conserve our biodiversity to the extraordinary engineering that saved so many lives in Christchurch.

Why is all this so important? For the first time in more than a generation I see real opportunity and promise. Globally, the role of science and technology has become central in all forms of policy making. In New Zealand we have had a fundamental shift in mindset – science and innovation are now recognised as integral to the future of this country. Commitments are being made, structures are being changed with a real purpose, and new ways of working are being considered. Science and innovation are at last acknowledged for what they are – an investment, not a cost, an investment which is understood to be a key pillar in an economic growth and social development strategy, and this country sure needs one. Do not underestimate the challenges this country faces over the next century.

The science system is changing. We have hard questions to ask. We are a small country; we cannot operate a science



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system as if we were a big country. The funding tools we use, how we prioritise, how we link science to impact through real business growth, through impact on social development, through enhancing our environment, will differ for a country of 4 million from those found in jurisdictions 10 or 100 times bigger. Innovative thinking is needed. So we need to be imaginative. Because of what we are, where we are, New Zealand science cannot assume that we can or should continue doing science in the way we have been for the last 50 years.

The scientific process

Before going much further it is useful to reflect on what is science. Science is not a set of knowledge or facts. Science, as we now know it, is an iterative process of observation, experimentation and concept formation whose purpose is to understand the natural world.

The key word is **process** – science is not just about facts, it is the **process** by which the validity or otherwise of knowledge about the natural world and the universe is established. In the absence of science, knowledge about the natural world can only be acquired via anecdote, belief or dogma. Innovation can be seen as the process of using this knowledge to generate new stuff, new technologies, new processes, new ways of doing things, new constructs. The other point I want to make is that we have to get beyond simplistic definitions of the types of science; how science gets applied can be quite unpredictable – that is the history of innovation. In the words of Lord Porter, a former president of the Royal Society (of London) – there are only two types of science, applied and not yet applied.

Challenges for science

The quality of our future as human beings on our rapidly degrading planet will depend on how well we develop new knowledge and use science and technology. The challenges of population growth, resource depletion, environmental degradation, food security, water, and demographic change are creating, to steal the expression used by my UK colleague and friend Sir John Beddington, a 'perfect storm'. We cannot put our head in the sand. New Zealand is part of this world.

These are issues affecting 7 billion people, many disempowered. Increasingly the global science community is focusing on the North–South divide – it has to. Radically new forms of relationship between science, business, government and society will be needed both on a global and national scale.

At the same time science cannot deal with these issues from within its traditional silos.

The social and societal dimensions of science are becoming much more important. Nothing can happen without public acceptance – addressing the need for society to understand science and addressing its inevitable concerns regarding scientific progress is a real issue and is a challenge for the scientific community. I shall return to this below.

This country has been diminished by a lack of intellectual discourse – the complexity of the issues we face requires depth of interrogation and comment. A more intensive investment in science can drive that discourse. Climate change, water quality, life course issues such as adolescence and aging, suicide, and ethnic variance in health, how to protect biodiversity, the impacts of an electronically connected world, dealing with challenges of regenerative medicine, the marine estate, informed comment rather than polemic about nutrition, biosecurity, inappropriate health claims, these are all issues the public are confused about or where the science is complex and the public and policy makers could be better informed. Most science stories in the media are still mostly about hype and promotion, but the science community has a different responsibility to educate. And underlying this is the need to communicate about risk and probability, about certainty and more commonly uncertainty. How do we explain complexity and nonlinear systems without trivialising them? There is a big challenge for scientists here.

Moreover, New Zealand has unusual challenges. We are small, we are distant, and we are one of few advanced nations that are not part of the major international club, the G20. We need to be part of the global world of science and technology, because science and technology are increasingly essential parts of being connected to the world in other ways.

Science and diplomacy

Increasingly we have seen the emergence of science as a core part of diplomacy. Every major nation now sees science as having multiple diplomatic purposes. Foreign offices now have chief scientists and science advisors, governments are appointing science ambassadors. Recently we had the first meeting of the Prime Minister's international science and innovation coordination committee co-chaired by John Allen and me. The Prime Minister and the Minister of Science, Research and Technology attended the first meeting. They are keen to ensure that we have a coordinated approach to positioning New Zealand through science. Why is this important?

As I have said, New Zealand has a particular challenge to make ourselves relevant to the world. However, beyond that there are at least four dimensions to science and diplomacy.

First, diplomacy plays its role in science – look at how many international agreements now have science within them. Diplomacy has allowed New Zealand science to get access to EU funds, and bilateral initiatives have been developed with Germany, China and Singapore, to name but a few. The science community has benefited. At the extreme, diplomacy and science come together in very large science projects such as the International Space Station or hopefully the Square Kilometre Array radio telescope.

Secondly, science assists diplomacy. Science is to a large extent politically neutral and opens doors – it is perhaps the modern equivalent of ping-pong diplomacy for those of us who remember the tentative contacts between the USA and China in the 1970s. That science leads to trust and innovation and that innovation leads to economic opportunities through trade and investment.

Thirdly, science operates within diplomacy. The most obvious examples are in arms control verification, but science is also playing an enormous role in the diplomacy of climate change – not just in creating measurement approaches and identifying the problem but in helping the community towards solutions. New Zealand can be truly proud of its role in leading the work on the Global Research Alliance to reduce agricultural emissions – one that meets several diplomatic objectives.

Lastly, science is the glue that holds the real and virtual ungoverned spaces together for the global community. It is science that essentially governs the Antarctic, the internet, space, and the ocean deeps.

The recognition of science as a key part of diplomacy is new worldwide, and New Zealand is not being laggardly in this space.

Every challenge we face is in part based on science and technology and has its solution embedded in science and technology. A modern society must be scientifically literate and informed. Democracy requires this. While we should not expect every citizen to understand the complexities of quantum physics – who does? – we would hope that our community is literate with what the scientific method is, how science approaches complex issues, and how it addresses probability and uncertainty. This is not possible without a critical mass of scientists and science within society, but that is not sufficient – we need to ensure scientific literacy in our schools and in our media. Later this year I shall be releasing a report addressing these issues.

All this is made more acute by the rise of the internet. No longer can information be easily divided into that which is likely to be reliable and that which is not. In the past, that was perhaps the role of the specialist journalist, but now anyone can put so-called information on the net. Much of that information is misleading or plain wrong and improved scientific literacy is needed so that our citizens can make best use of the new world of information overload. This is a real challenge and I wish I had time to go into it in some depth.

Science brings with it a spirit of adventure, of enquiry, of innovation, of looking ahead. It can be infective – and we want it to be infective, for these are the very attributes that this country needs to have if it is to succeed. We need the ambition that science brings.

Science is about gaining new knowledge, and we need to use knowledge better in so many ways. Again I am limited in my time, but the importance of the social and environmental sciences in the development of policy is obvious. Without knowledge we fall back on dogma, and while science cannot and should not make policy, we want our policy makers to have the evidence base that they need against which decisions can be made and evaluated. This is something I am working on and is a speech for another day. However, I will make a quick point here: even data and the scientific process can be politicised. The events surrounding NIWA and the impending legal action have worrying implications for the relationship between science and policy formation. This is something we should reflect on.

A challenge for New Zealand's scientific community

In 20 years, what will New Zealand be selling to the world that can sustain real growth, that will earn hundreds of millions of dollars and not just a few million? We cannot get rich off the latter. The answer must be that we will increasingly be selling added weightless value, the added value that comes from clever minds. We will sell food not as a commodity but because it has real added value, because we will have developed foods that have undoubted health benefit. We will sell electronics and manufactured goods, not because they are cleverer than someone else's version but because we add value through clever design. We will sell services because of the added value of our earthquake engineering skills or the skills of our environmental scientists. We will be a real contributor to addressing the challenges of planetary degradation.

This is what our future must be. To do this will require shifting our comfort zone. Increasingly our knowledge economy will not stand alone, but will be partnered with those of other nations, nations closer to market and the capacity to go to scale.

We will need far more scientists in government agencies, far more in business. Hopefully, careers will involve rotation across these domains, but this will require different thinking about how careers in science are recognised and developed, and how academia responds.

We still think of science, innovation, business, and society as disconnected. They are not, especially in a small country. Two weeks ago in Kyoto, Sir Paul Nurse, Nobel laureate, basic scientist and President-elect of the Royal Society (of London), talked about the big challenges for science, and identified two in particular. The first was trust – getting the trust of the public, which requires a true dialogue, not just patronising communication and we have already talked about that. Secondly he identified permeability. By permeability he was talking about a genuine seamless interaction between business, government, academia and society. He proclaimed academic snobbery as a particular challenge to that permeability – basic scientists look down on applied scientists, university promotions and grant systems cannot handle people who step out into business and try and come back, impact factors favour basic science, the pure academic CV drives rank and grant success, and here in New Zealand the Performance-Based Research Fund reinforces it. Science cannot do what it must do if the academic silo remains dominant. We urgently need to get more sophisticated in evaluating an academic's career and not penalising him or her for spending time in business or the public service, with the inevitable gap in traditional performance measures that thus arises. We need more scientists rotating to government, rotating to business, and even rotating to the media – not just at the end of their careers, but as an integral part of their careers.

New Zealand can become a smart nation and a smart society. I believe it can grow on the back of science and innovation. That is your challenge.