Editorial

This issue of *New Zeland Science Review* contains the papers presented at the 21 October 2010 conference, *Re-setting science and innovation for the next 20 years*. When planning the conference we were motivated by perceptions that government messages about the nature of innovation and its role in the economy lack coherence (OECD 2007). We also felt that there has been insufficient explanation of why emphasis on innovation as a driver of economic growth justifies the apparent policy neglect of environmental, health and social sciences.

We decided to read around the subject of 'innovation' and the 'innovation system' and on the role of science and research in order to get a feel for where the debate sits in different parts of the world and the relationship to different policy settings in these countries. As scientists, we are immediately struck by the often ambiguous evidence on cause and effect in the innovation literature. In much of the social sciences it is almost impossible to run experiments to test theories so we must rely on hindsight and inference since we are dealing with human behaviour, complicated interactions, and sets of circumstances that differ from country to country.

To put the role of research, science, and technology into perspective we have as background a very useful framework for thinking about the New Zealand productivity problem. Rick Boven and co-authors (Boven *et al*. 2010) take a 'diagnostic approach' to analysing the five drivers of labour productivity (entrepreneurship, innovation, skills and talent, investment, and natural resources (Kidd 2008)). Key points that arise from their analysis, relevant to improving New Zealand's labour productivity are:

- there are no silver bullets;
- the level of entrepreneurial activity and training for international business success should be a core concern;
- more needs to be done to convert inventiveness into productivity gains;
- there is much detailed work needed to improve school completion rates, school-to-work transition, and further improved literacy and numeracy skills and financial knowledge;
- we need to increase domestic savings and improve capital formation; and
- the use of natural resources should be carefully analysed to ensure opportunities are in New Zealand's interests.

The above analysis shows that economic improvement is likely to come from advances in a number of sectors among which research, science, and technology are but a part.

The conference

A key aim of the conference was to give participants an opportunity to appreciate how far current thinking about 'innovation' and the 'innovation system' has developed in New Zealand. We also wanted to identify what might be entailed if New Zealand really wants to raise its labour productivity and improve the role of scientific research in this. This is why we invited not only government representatives, but a range of other individuals who might have relevant perspectives. We chose representatives from the education system and those who have points of view about the characteristics of a system that values its knowledge people and how they might interact together to make a vibrant knowledge economy. We also invited a few speakers who are at the coal face, trying to turn knowledge into businesses. We also wanted to allude to global resource limitation or as one conference attendee put it 'the elephant in the room' and what this might mean for innovation policy.

The conference gave an opportunity to evaluate the coherence of government plans. The Hon Dr Wayne Mapp, Minister for Research, Science and Technology, reconfirmed the Government's vision of science and innovation as being at the heart of the economy (p. 5). He laid out the Government's economic growth agenda and current areas for action and alluded to Denmark, Finland, Singapore and Queensland as inspirational models. He stressed that we must build a 'third pillar' that focuses on high-tech manufacturing and services. Struan Little, a Deputy Secretary at the New Zealand Treasury, reinforced the Minister's vision of innovation as being central to economic performance and growth (p. 8). He developed the theme that we need to understand how innovations arise, noting that technology diffusion and adoption is a weakness for New Zealand. He presents evidence that New Zealand's research institutions are only a small part of the sources of innovation that businesses use, and stressed this is where gains could be made. Although the first two speakers focused almost entirely on innovation for economic growth, Professor Sir Peter Gluckman emphasised how important it is that we recognise that a science and innovation ecosystem reflects the intimate links between economic prosperity, social development, and environmental protection (p. 49). The quality of our future as human beings living on a rapidly degrading planet will depend on how well we develop new knowledge and use science and technology. He noted that those countries that have increased their investment in both the science and innovation in the last thirty years are now much more productive than New Zealand. These scene-setting presentations acknowledged that, at the moment, the Government is grappling with the impacts of the global economic downturn. So, with this as the context, we received just a hint that there might be further moves afoot in next year's budget. We presume that the Government will have noted that some of our comparator countries have increased public sector R&D expenditure to 0.8% of GDP (compared with the 0.5% that New Zealand spends) and have produced rates of productivity growth far greater than ours.

To explore elements that might be hindering technology diffusion and adoption in New Zealand the conference dipped briefly into subjects related to personnel management, occupational cultures and what might hinder interconnectedness.

Dr Garth Carnaby, President of the Royal Society, contrasted the cultures of scientific research and technological development and analysed some of the attitudes that might impede technology transfer (p. 12). A failure to fully understand and value both of these cultures in New Zealand will lead to a sub-optimal innovation system. Professor Jacqueline Rowarth considers important workplace and cultural characteristics that are necessary for high productivity in 'knowledge workers' by reviewing the literature and seeking parallels to the New Zealand situation (p. 19). There are many insights in this paper that will be useful in the reorganisation of the New Zealand science and innovation system.

Interconnectedness is a very important characteristic of a successful national innovation system if technology diffusion is to occur. Professor Shaun Hendy of Industrial Research Ltd

and the MacDiarmid Institute, Victoria University of Wellington, used evidence of interconnectedness (using patents as a proxy) to reflect on New Zealand's productivity paradox (p. 28). He presented evidence to show that, in order for New Zealand to diversify its economy; New Zealand should probably take its economic geography into account and be concerned to build a number of networks of highly connected people. The Centres of Research Excellence were given as good examples of how this model may be developed. In other words, New Zealand must begin to behave like a city of 4 million people.

To broaden out the context in which we consider 'innovation' Dr Bob Frame and co-authors, of Landcare Research, scoped issues and opportunities for innovation (in the sense of new thinking) on subjects such as sustainable use of natural resources or reducing the use of damaging materials and processes while keeping economic prosperity on the agenda (p. 24). There is considerable scope for science to adopt new ways of engaging with its peers, policy and business communities as well as with public stakeholders.

At the organisational and institutional level, technology diffusion occurs in a number ways and may have a number of characteristics. New Zealand universities are supporting the government's priority to generate more high technology industries through their commercial arms. Sophie Howard of VicLink reflected on her role at the interface between the university culture and the external business world (p. 33). Commercialisation offices have a particular problem in finding enough people with the right skills and are now concentrating on training and development of commercialisation managers. She also highlighted the conflicting incentives that university staff have as they balance their teaching, publishing, and outreach activities. This paper supports the notion that the university has a wide role to play in addition to scientific research in improving human capital relating to improving New Zealand's productivity. She also hints at the effectiveness of 'modelling by doing' in fostering on-the-job training of commercialisation managers.

Magritek, New Zealand's Magnetic Resonance Imaging (MRI) Company was started in 2004 as a spin-out from Victoria and Massey Universities. Dr Andrew Coy, CEO of the company, stressed that the intellectual property and research underpinning Magritek products comes from two decades of world-leading Magnetic Resonance research carried out by Prof Sir Paul Callaghan and his team (abstract, p. 42).

Dan McElrea, chief executive officer of Puku Ltd, presented the characteristics and innovative ideas, but not necessarily new ideas, of a small specialist fastener company which has invested heavily in intellectual property (IP) with a particular emphasis on helically based connections (p. 42). Their strategy is focused on developing and licensing promising ideas. Puku Ltd benefited from TechNZ grants, a NZ Trade and Enterprise travel grant (now discontinued), and networking opportunities from the TechNZ Innovation Forum.

An example of creative people working together using a pathway from scientific innovation to end-users who adopt the 'new ideas', was presented by Dr Michael Uddstrom of the National Institute of Water and Atmospheric Research (p. 37). He shows how prediction of weather-related hazards is translated into a form readily assimilated by enterprises, which have weather derived risk that contributes to efficiencies in their operations. He notes that an innovation system is only as good as the quality and quantity of research and technology that underpins it and that funding alone is not enough. Investors must be willing to sustain effort over a long period especially if the innovation is likely to be disruptive to existing technologies or capabilities.

Dr Linda Sissons, chief executive of Wellington Institute of Technology, led us through the strong role that the Institutes of Technology and Polytechnics, especially the Metro group, are carving out for themselves in education, research and technology (p. 15). This involves a close connectedness with large and small companies and an emphasis on training and technology transfer.

Associate Professor Rod Dunbar, University of Auckland, similarly emphasised the role of universities in New Zealand (abstract, p. 18). These universities play an important training role and are a source of future technology and technology-savvy business managers able to operate at the level needed for large, sophisticated export industries. They also produce well-educated innovators and individuals who know about a range of markets, speak other languages, and understand the culture of the markets into which we aspire to export. It is important to protect diversity in the academic community and to accept that an innovative country is built on more than scientists and engineers.

The low participation of Māori in the science and technical areas and resulting lost opportunities was highlighted by Garth Harmsworth (p. 45). New Zealand is largely missing out on the cultural diversity and the differing world view that Māori bring to the New Zealand economy.

Member of Parliament David Shearer (talk not published here) reflected on some of the exciting new companies he has visited recently that epitomise some really good ideas approached using offshore partnering. He believes that added-value enterprises, especially clean, green, clever, low-carbon, weightless, export-driven companies, will be the future where Government environmental and economic policies are driven together.

Finally, Murray Bain, the newly appointed chief executive of the Ministy of Science and Innovation summed up by defining 'innovation' as converting knowledge and competence into value, a definition that is inclusive of environmental, social and health research. He drew on themes coming for the presentations to make several points (p. 52). Both innovation and science are processes – journeys that need to work seamlessly well together right across the chain. There is a need for balance, whether the balance relates to primary industries versus high-tech or applied versus not-yet-applied research. There is room and a need in the innovation chain for a range of 'excellent', differently-skilled people.

Political journalist and analyst Colin James summed up by reflecting on the complexities around the subject of government support for science (p. 53). We have to acknowledge science's potential for good and evil. Scientists need to be advocates for excellent science that is applied for human wellbeing. He was critical of the Treasury's narrow approach to the subject of innovation in the economy. He concluded that New Zealand is going to have to make the same kind of investment as its comparator countries, foster ways of increasing the amount of interconnectedness among all players in the economy, and not

lose sight of the fact that climate change impacts will create a lot of uncertainty around any attempt we make to 'pick winners'.

Reflections on outcomes

It was inevitable that discussion threads and observations did not always link coherently. The main point we can distil from the conference is that different players use the word 'innovation' with different shade of meaning. For some presenters, 'innovation' means thinking creatively to employ existing technologies, e.g. to improve products or services. Others use the word to mean 'invention' that creates new possibilities, ideas, products and services and which may overtake existing technology. For 'innovation' to be a useful word that contributes to clear communication it must be defined whenever it is used.

We did not locate a presenter who could make an innovation system-wide analysis. Such a presentation would have been very useful in that it would have:

- detailed what is meant by 'innovation' and 'innovation system',
- defined the elements of a New Zealand innovation system,
- analysed the strengths, weaknesses and relative alignment of each part of New Zealand's innovation system, especially the education system, and
- in the research sector, would have evaluated the relative value the Government places on all parts of the innovation system (not only those parts that are directly related to the economy) and defined how they will be thought about.

The Organisation of Economic Co-operation and Development (OECD 2007) report on New Zealand's innovation system contains an uneven evaluation of parts of the system. We note that the OECD sees innovation purely in economic terms and has no framework for evaluating outcomes in environmental, health, or social sciences other than as means of commercial exploitation of resources. Despite mentioning shortcomings in educational achievement and a mismatch between fields of higher educational attainment and demand for labour, the section on the Ministry of Education dealt only with the tertiary sector, did not appear to contain much evaluative material, and drew few conclusions relating to education in the overall assessment. Yet, the Building and Construction Sector Productivity Taskforce (Anon. 2009) identified leadership and training problems at all levels in the construction industry that are impacting the efficient use of labour.

Despite the increased attention being given to entrepreneurial activity, and training for international business success (OECD 2007, Boven *et al.* 2010), there is mounting evidence that improvements in these activities might not have the desired result if effectiveness in the education sector as a whole is not also addressed.

There is an obvious role for the new Ministry for Science and Innovation to create a framework for communicating the value and the level of investment that should go into all parts of the research, science, and technology investment, especially those that are truly public good in nature, i.e. related to sustainable use of natural resources and social wellbeing. There have been several shifts in definition of 'public good' over the last 15 years, most of them not very transparent. The New Zealand Association of Scientists judges this type of communication to be a very important part of the overall 'innovation system', in that it transmits knowledge to the potential workforce about the principles by which Governments make their decisions. Armed with information on how resources are to be assigned, students can make good decisions and align their choices with what is deemed to be needed from the education system and for the economy and society.

Clearly, scientific research is only a part of the whole capacity of any society to 'innovate' in the broadest sense of the word. We need to compensate, through education and training at all levels, for our cultural weaknesses that handicap our ability to convert inventiveness into productivity and sustainability gains. We need to increase savings, improve capital formation, and devise ways of coordinating strategies across the whole innovation system to achieve the Government's national goals. We look forward to engaging with the staff of the new Ministry of Science and Innovation in defining their role and how it might relate to the larger national innovation system. We also look forward to engaging with policy analysts in all parts of the science and research system to help to identify any unintended consequences of policy interventions.

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