

Policies for achieving science excellence

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Introduction

Achieving excellence in scientific research is a goal for many countries, resulting in a considerable amount of well-meaning research, policy setting and commentary around funding, education and management. Much of this has originated in New Zealand and, indeed, has been published in this journal. The history can be tracked through authors such as Edmeades (2004), Weir (2006) and Rowarth (2009), plus many editorials and initiatives such as the *Science Manifesto* by the National Science Panel (2008). Despite these efforts, the science system in New Zealand is not flourishing, and the ramifications are in the schools: assessment of school students' attitudes to science/mathematics via the international comparisons TIMSS (The Trends in International Maths and Science Study) and PISA (Programme for International Student Assessment) indicates that New Zealand students do not like learning science/mathematics as much as their international counterparts, and see less value in learning these subjects (Bunting *et al.* 2013).

Science and mathematics are, however, increasingly regarded as the foundation for employment. The Brookings report on the Hidden STEM (science, technology, engineering and mathematics) Economy makes the point clear: 20% of all jobs require a high level of knowledge in any one STEM field; half of all the STEM jobs are available to workers with sub-degree qualifications (Rothwell 2013).

This article was prompted by the announcement by Minister of Science and Innovation, the Hon Steven Joyce, on Saturday 26 September 2015 that 'Crown research institutes are about commercial science – that's why they're there. The pure science tends to be done more at universities'.

This statement was followed by a public response from the President of the Association of Scientists, Dr Nicola Gaston, indicating the wider operational principles of Crown research institutes (CRIs) to undertake research for the benefit of New Zealand and pursue excellence in all its activity and not simply narrowly defined commercial science¹.

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The Act

The Crown Research Institutes Act 1992² states that

1. *Every Crown Research Institute shall, in fulfilling its purpose, operate in accordance with the following principles:*
 - a) *that research undertaken by a Crown Research Institute should be undertaken for the benefit of New Zealand*
 - b) *that a Crown Research Institute should pursue excellence in all its activities*
 - c) *that in carrying out its activities a Crown Research Institute should comply with any applicable ethical standards*
 - d) *that a Crown Research Institute should promote and facilitate the application of*
 - i. *the results of research, and*
 - ii. *technological developments*
 - e) *that a Crown Research Institute should be a good employer as required by section 118 of the Crown Entities Act 2004*
 - f) *that a Crown Research Institute should be an organisation that exhibits a sense of social responsibility by having regard to the interests of the community in which it operates and by endeavouring to accommodate or encourage those interests when able to do so.*
2. *Every Crown Research Institute shall, in fulfilling its purpose, operate in a financially responsible manner so that it maintains its financial viability.*
3. *For the purposes of subsection (2), a Crown Research Institute is financially viable if*
 - a) *regardless of whether or not it is required to pay dividend to the Crown, the activities of the Crown Research Institute generate, on the basis of generally accepted accounting principles, an adequate return on shareholder's funds; and*
 - b) *the Crown Research Institute is operating as a successful going concern.*

¹ <http://www.scientists.org.nz/news/2015/09/nzas-press-release-redefinition-of-the-purpose-of-cris-a-serious-concern>

² <http://www.legislation.govt.nz/act/public/1992/0047/latest/whole.html%23DLM265150>



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'For the benefit of New Zealand' and 'excellence' (points 1a and 1b in the Act) are not precluded in commercial research. Experience, however, reveals that 'commercial' means 'near to market' in order to achieve sales and hence show value to shareholders and owners. The 'benefit of New Zealand' is not always clear.

Of note is that, in an attempt to ensure 1d(i) and 1d(ii) (the application of results of research and technological development), the government has established funds in the Primary Growth Partnership (business-led, market-driven, primary sector innovation) and Callaghan Innovation (helping businesses to succeed through technology). The former has been criticised by the Auditor-General because 'the public reporting of the results of individual partnerships started late and, to date, has not been suitable for a public audience because it is inconsistent and too technical'. The Auditor-General also commented that 'it will be at least five to 10 years before we see the extent to which New Zealand's primary industries achieve the anticipated economic benefits' (Rutherford 2015). The Callaghan Institute has been in the media because the foreign-owned companies it has reimbursed for doing research in New Zealand have produced intellectual property of questionable value to New Zealand which they have taken offshore (Bradley 2015).

With these initiatives particularly focussed on commercial research, the role of pure and applied research was thought to be that of the universities and CRIs. Although Minister Joyce suggested that 'pure research tended to be done more at universities', the Performance-Based Research Fund (PBRF) which assesses individual researchers as well as the universities' performance in research and higher degree completion, includes research funding in the scoring. Of importance is that the sources of research funding for the universities are the same as those for the CRIs and constant bidding and reporting is detracting from the ability to focus and innovate (see Edmeades (2004), Rowarth (2009)).

The ideal

The challenge for New Zealand, the government, policy personnel, every research institution and most researchers is to achieve excellent science and innovation.

The final report of the OECD Working Party on Research Institutions and Human Resources (OECD 2014) presented evidence on how governments have been directing and funding public research in higher education and public research institutions through 'research excellence initiatives' (REIs). The objective of the report was to provide information on the workings of REIs and on the functioning and characteristics of institutions that host REIs that would aid future government policy directions. The OECD concept of REIs is an instrument that encourages outstanding research by providing large-scale, long-term funding to designated research units. REIs were considered to be particularly important for 'ambitious, complex research agendas', such as where inter-disciplinary and co-operative research is required. The report emphasised the importance of REIs for high-impact, high-risk research (e.g. basic research) and noted that the REI approach could lead to broad changes in the structure of the research system by 'pushing research centres to continually prove and develop their strengths, show their ability to build interdisciplinary networks, create links with the private sector and abroad, and generally enhance a country's overall research capacity'.

REIs in the OECD concept operate within Centres of Research Excellence (CoREs), which New Zealand has created. However, long-term funding for large-scale complex research agendas is hard to identify. The Marsden fund is certainly aimed at blue skies research, and has increased of late; however, its full potential, at least in some disciplines, has not yet been achieved (Bryan & Lowe 2014). Denmark, Germany, Japan, Norway, Portugal and Slovenia were examined by the OECD as case studies; New Zealand was not considered in depth, although the CoREs, with maximum funding of 6 years, were mentioned as having resulted in improvements in research quality, as measured by outputs such as citation rates and postgraduate completion rates or external research income. This was not differentiated from the effects of the PBRF.

The advantage of the REIs was reported to be greater flexibility in managing resources and hiring researchers than other forms of funding. This was fundamental in the 'disruptive innovation' achieved in the Lockheed Martin 'skunk works'³ (discussed in Rowarth 2009) and is also key in 'lean innovation'. Tuck Business School professors (Govindarajan & Trimble 2010) have identified that innovation is best served when teams focussed on innovation have freedom to recruit and operate but maintain integrations with the main company. (They also advised that the innovation team should be held accountable for ability to learn from mistakes rather than ability to hit budgets: lean innovation is about learning not punishment.). Lean innovation creates the opportunity for 'innovation by design' (Blank 2014).

The New Zealand equivalent is 'Better by Design', a specialist group within New Zealand Trade and Enterprise⁴. Its purpose is to 'inspire and enable New Zealand businesses to succeed through design' by becoming 'more innovative, efficient and internationally competitive while fostering a more dynamic and purposeful culture'.

As scientific research is innately about innovation, challenging the *status quo* and competition, the concern for New Zealand is that increasing resources are going to business rather than the fundamental research required to fuel ideas.

Harnessing innovation certainly requires policies that go beyond science and technology, but the basis is still a strong and efficient system for knowledge creation and diffusion (OECD 2105a). The Innovation Imperative (OECD 2105a) recommended 'strengthening investment in innovation and fostering business dynamism' as priority 1 (of five). The second priority was 'invest in, and shape, an efficient system of knowledge creation and diffusion, in which investment in basic research is the top priority' as 'most of the key technologies in use today have their roots in public research'. A strong and efficient system for knowledge creation and diffusion was described as 'investing in the systematic pursuit of fundamental knowledge, and that diffuses this knowledge throughout a range of mechanisms, including human resources, technology transfer and the establishment of knowledge markets (OECD 2015b). There is a risk (OECD 2015a) that public investments in research become too focussed on the short-term commercial gains, rather than the long-term benefits. This is despite the policy research that

³ Corporate 'skunk works'® were used to develop disruptive innovation separate from the rest of the company.

⁴ <http://www.betterbydesign.org.nz/>

recommends research excellence as the investment criterion for all government-funded research (Lillis 2006).

Priority 3 (OECD 2015a) is seizing the benefits of the digital economy; and priority 4 is fostering talent and skills, as two out of three workers are considered not to have the skills needed to succeed in a technology-rich innovation. The fifth priority is considered to be governance and implementation of policies for innovation – pointing out that trust in government action is required: evaluation of policies needs to be embedded into the process and should not be an afterthought.

Evaluation and change

Evaluation of the science funding system in New Zealand was reported in 2008 by the National Science Panel (discussed in Rowarth 2009) and in 2010 by the Crown Research Institute Taskforce (Jordan 2010).

Cabinet endorsed the CRI Taskforce's recommendation 'that the Government provide each CRI with core funding to deliver outcomes for the benefit of New Zealand' on the basis that it gave CRIs greater financial certainty, thereby enabling them 'to contribute to the outcomes in its statement of core purpose'.

This year the Ministry of Business, Innovation and Employment (MBIE) announced a new Contestable Research Fund directed at 'excellent science that has potential impact for New Zealand, economically, environmentally and socially'. Key features of the new contestable fund have been outlined as:

- *The contestable fund will remain one of the Government's main mission-led investments.*
- *It will support research with the potential to challenge and transform New Zealand's economic performance, how we strengthen our society, the sustainability and integrity of our environment, and give effect to Vision Mātauranga.*
- *This fund will use competition between scientists for funding to drive an increasing focus on excellent research with impact in areas of future value, growth and critical need for New Zealand.*

For scientists this is yet another new fund directed at transformation, without addressing the very nature of competition and management that were raised as problems (e.g. Edmeades 2004; Rowarth & Goldson 2009; Rowarth *et al.* 2014).

Transformation

It is important that transformation occurs in order to achieve innovation and response to the new MBIE direction; an important point of the CRI Act (1992) is that the CRIs are good employers.

The two are linked, but the CRIs are struggling (Rowarth *et al.* 2014).

Much has been written about how to achieve transformation and, just as innovation has moved from 'disruptive' to 'constant', theory is suggesting the same for transformation (Hemerling *et al.* 2015). Root causes of transformation failure have been identified as short-term, top-down approaches to implementation, failure to build capabilities to work in new ways, and a focus on particular aspects (e.g. the 'road map' approach) rather than the whole company. In contrast, thriving companies put people first (Hemerling *et al.* 2015) which averts the risk of loss of capability and motivation (Jahn *et al.* 2015).

Financial viability

Financial viability is the focus of points 2 and 3 in the Act.

The fundamental problem for the CRIs is that funding is in many pools, and is not keeping up with inflation; a further problem is that criteria for success change.

Budget figures this year indicate that Core Funding has remained at \$201.7 billion for the last three years. This is the funding to 'create and maintain capability that is required for their core purpose and strategy'.

Biological Industries Research funding was reduced in the last budget from \$94.92 million to \$92.15. This funding is 'limited to research and research applications to support productivity growth and sustainability of New Zealand's primary industries, and the development of premium food and industrial biological products and technologies responsive to global consumer preferences'.

Technologically competitive nations spend 'close to 3%' of their GDP on research and development (Cimini *et al.* 2014); New Zealand is still below half that (1.17% for 2014). Professor Sir Peter Gluckman, the Chief Science Advisor to the Prime Minister, indicates that, at a public sector spend of 0.8% GDP on R&D, private sector spending takes off. He argues that, because of New Zealand's history and geographical position, plus dearth of multi-national companies, 'we might have to go even higher'. Statistics New Zealand reports that for 2014 the Government expenditure on R&D was 0.63% of GDP (including Higher Education at 0.36%, leaving only 0.27%).

Attempts to operate 'as a going concern' and meet the new direction signalled by the government have resulted in considerable reorganisations at, for instance, AgResearch. It has been estimated that the science capacity has been reduced by 50% in 5 years due to the relocating of roles, and budget changes.

Conclusions

Underfunding of the basic research required as the platform for developments has resulted in increasing dissatisfaction, reorganisations, and redundancies chronicled in this journal through the years. This leaves New Zealand in peril as it is reflected in decreasing interest in science in schools.

Changes that are occurring overseas are within a stable research system; no other country adopted the competitive model that was established in New Zealand in 1992. Since then, the various new funds that have been created have resulted in more management and administration; they have not liberated good scientists to create and innovate for the ultimate benefit of the country.

In order to recreate a vibrant science system, the scientists must be put back at the centre of decision-making, and scientists with a track record of success must be funded to develop teams and push back the frontiers of understanding. Addressing the perception of school children is a matter of restoring scientists to the ranks of other professionals – medical practitioners and veterinarians, for instance – and ensuring that they are rewarded appropriately for the long years of study required to develop discipline expertise. It also means removing university fees in the sciences to show prospective students that their efforts are valued by their country. Reciprocity suggests that those students will then want to be involved in public good research.

Commercial research has a place, but not at the expense of public good research, and the best outcomes are achieved when top researchers work together, whether at a CRI or a university.

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