The Institution of Professional Engineers New Zealand Inc
Pūtahi Kaiwetepanga Ngaio o Aotearoa

Growing Smartly

A Review of National Policies for Fostering Research, Development, Innovation and Entrepreneurship in New Zealand

Policy

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The Institution of Professional Engineers New Zealand Incorporated

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Review of National Policies for Fostering Research, Development, Innovation and Entrepreneurship in New Zealand

Executive Summary

New Zealand currently has a policy environment which is not that conducive to fostering research, development, innovation and entrepreneurship (RDI&E). This is because our national policies are probably neutral or, at best, mildly supportive of the activities and new behaviours to build a nation in which all New Zealanders can benefit from improving national prosperity while living in social equality and in harmony with the natural world.

- Government must seek to create a policy environment in which the collective efforts of New Zealanders grow our prosperity faster than the OECD average, thus restoring our OECD ranking. It is equally important that we foster sustainable development by ensuring we improve our resource efficiency (GDP per unit resource used) at least as fast as our prosperity (GDP per capita).

Over the last decade, a major weakness in the New Zealand RDI&E system may have been undue separation of decisions on the use of research investment funds from market intelligence. This resulted in the system for research-based innovation being developed too much according to the technology-push model. We must also foster the complementary market-pull mechanism, building strategic technology transfer partnerships between industry and the research sector.

- Government may need to take the lead in initiating specific programmes to overcome industry's current low absorptive capacity (research receptiveness) – probably the worst shortfall in New Zealand's research, development, innovation and entrepreneurship system.
- Such programmes would operate in parallel to Government's commitment to basic research; as industry develops greater capability the Government might shift the balance of its investment in favour of spending on basic research in both science and engineering.

We need to examine the means for funding R&D in the tertiary sector and Crown Research Institutes (CRIs). Better results may be achieved through greater differentiation in the method of funding: CRIs, as specific agents of the Crown, could be specifically directed to improve private-sector capability and commitment to market-led, research-informed innovation.

- Whereas a contestable model on a project or programme basis is reasonably effective for funding university research, a better model for CRIs and similar research associations may be substantially increased devolution. This would entail aggregated investment and the application of outcomes-based performance criteria (such as the level of private sector co-funding). The level of aggregated investment would be contestable according to performance.

There are too few New Zealanders with the skills to develop and nurture intellectual property-based businesses. Attracting capital to projects that are characterised by uncertain and distant markets and some level of unresolved technical risk, as well as managing the start-up risks associated with planning permissions and compliance constraints, requires a high level of expertise.

- New Zealand urgently needs to develop human resources and leadership capability to make better use of innovation in existing and sunrise industrie. The key people need knowledge of R&D, technology transfer and business processes. Transferring skilled people through the public-funded R&D sector may be an important and under-utilised measure.

- We may need to review broader economic instruments, such as company and R&D tax, planning regulations and the compliance environment, to ensure they do not discourage capital investment nor hinder the channelling of research, development, innovation and entrepreneurship into real economic development.

Any public sector investment in RDI&E must be focused on achieving clear outcomes that contribute to the meeting of long-term national goals.

- A well-designed National Research Priority Statement, and related outcomes-based measurement statements, might help to ensure that public sector R&D investment is aligned with relevant public policies in a whole-of-government approach.

- There could be benefits from classifying and measuring R&D spending according to the nature of the outcome sought rather than the industry sector involved, to better inform public-sector investment.

IPENZ, the professional body for the engineering profession in New Zealand, offers this review as an independent commentator. The review takes a long-term perspective and concentrates on the ongoing needs of New Zealand, rather than the short-term performance of any particular government. As a professional body, IPENZ does not have the research capacity to fully examine all the proposals made in this review. We hope that others will be motivated by what they read here to take up this task.

1. Introduction and National Goals

Most New Zealanders share an often tacit goal – that we all have the opportunity to benefit from improving national prosperity, while living in social equity and harmony with the natural world. To be able to invest, as a nation, what we want in social services, health and education, our national prosperity must continue to grow at least as rapidly as other countries. A recent survey by the Growth and Innovation Advisory Board (GIAB 2004) showed that New Zealanders support business development in line with their values. A worrying finding was that a significant proportion of New Zealanders believe that better social and environmental performance may be possible without improving our mean prosperity (GDP/capita). While such people may not view long-term economic prosperity as necessary per se, they may accept prosperity as a goal provided the means to achieve it are sustainable (in social and environmental terms).

Economic wealth or prosperity is most commonly measured as GDP per capita (on a purchasing-power parity basis). In economists' terms, GDP/capita represents the product of labour productivity (GDP/hour worked) and labour utilisation (hours worked/capita). A recent Treasury paper (Treasury 2004) showed that the major advances in our GDP/capita over the last five years have been in improved labour utilisation, largely through reduced unemployment. Working harder may be laudable, but it may not be the best way to advance national prosperity wwwwin the longer term!

Labour productivity, which is growing only slowly according to the Treasury paper, represents the net effect of economic efficiency and value creation. By international standards, our economic efficiency is reasonable as a result of our open-market economy reforms of the last 20 years.

Thus, our challenge is to grow national prosperity (primarily by increasing the value component of labour productivity) to return us to the top half of the OECD in a way that is consistent with our social and environmental aspirations. In the past, increases in labour productivity were often accomplished by increases in resource use, so resource productivity (GDP created per unit resource use) often tended to decline.

For the worldwide economy to be sustainable while giving all its people the potential to live in reasonable prosperity, humanity must improve its resource productivity – some commentators suggest by a factor of 10 to 50, and within the next 50 years. In the New Zealand context, we take the goal of sustainable development to mean a commitment to grow prosperity (GDP per capita) while improving resource productivity (GDP per unit resource use) at least as fast.

As one way of meeting this challenge, successive governments have chosen to invest tax income on behalf of all New Zealanders in fostering research, development, innovation and entrepreneurial activity. This review examines the way in which government spending is directed, and whether the current policies for fostering research, development, innovation and entrepreneurship (RDI&E) are effective.

It is appropriate to conduct a review in 2004. It is more than a decade since the "science system" reforms created the Foundation for Research, Science and Technology (FRST) and Crown Research Institutes. It is five years since New Zealand first looked at the experiences of other small countries and recognised that governments cannot rely entirely on free markets to make progress. It is about two years since the Government sought to promote the development of venture capital markets. It is more than a year since the launch of the Government's Growth and Innovation Framework (GIF) in response to the work of the Science and Innovation Advisory Council (SIAC). It is a year after recently-launched Industry New Zealand was amalgamated with the long-standing Tradenz to create New Zealand Trade and Enterprise.

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detailed research to others. Our goal is to provide a systematic overview of the RDI&E system. We resist the notion that the system is inherently complex, and seek to establish simplifying concepts that will allow the policy environment to be better aligned and understood.

2. The Long-term Performance of New Zealand

Before World War II, our country was mildly prosperous, but as a result of the war's impact on other nations, by the 1950s we sat at the top of the prosperity rankings (as indexed by PPP GDP/capita) in spite of having an economy dependent on primary industry. Since then, we have gradually slid down the ranking list. Ranked just under the OECD average in 1970, by 1999 our GDP/capita on a purchasing-power parity basis had fallen to 20th ranking (at 82% of the average value). While the Government's Growth and Innovation Framework predicted that New Zealand's growth rate would exceed the OECD average between 2001 and 2003 (New Zealand Government 2002, page13), 2002 OECD statistics show that New Zealand's GDP/capita still lay 13% below the OECD average (OECD, 2003). A five-year, moving average over the last 30 years indicates that we seldom have matched or bettered the average.

The most recent Treasury report (Treasury 2004, p19-21) shows that, for about a decade, we have been sitting at about 85% of the OECD mean, after bottoming at 80% in 1993. In the last four years there has been a significant improvement in labour utilisation, but labour productivity has been growing at only about 1%. To return to the OECD top ten, we need to grow labour productivity at above the OECD average rate for many years. The Treasury report shows that our capital to labour ratio has deteriorated compared to Australia. Capital is normally needed to improve productivity in industry, and low rates of capital investment are therefore a serious concern.

Social and environmental indices provide no comfort by way of compensation. Ranked 11th in 1975 by the Human Development Index, New Zealand fell to 20th by 2001 (UNDP, 2003). Similarly, New Zealand's ranking by the Environmental Sustainability Index has dropped from 6th in 2001 to 19th in 2002 (Environmental Sustainability Index, 2002). In the long term, we will achieve only the environmental and social performance that we can afford.

The New Zealand Institute for Economic Development (Briggs et al. 2001) examined the reasons for the nation's poor economic performance. It concluded that the problem was low growth in the export sector. When it examined each export industry it found that New Zealand performed reasonably according to the international industry norm, but that we were not significant players in the areas of trade where rapid growth occurred.

3. Sources of Prosperity in an Economy

Worldwide, the dominant wealth-creating activity of the 20th century was industrial mass production, but this may not be so for this century. For much of last century, creating wealth relied on competing on price for the supply of processed materials and goods. Competitive advantage came from some or all of:

- access to cheap resources (minerals, biologically-based materials, energy, water)
- economies of scale (mass production)
- a sufficiently skilled workforce
- innovation for efficiency.

Whereas the basis of New Zealand's national prosperity as recently as 1975 was the low-cost bulk supply of commodities to export markets (dominated by meat, dairy and wool), that of 2000 and beyond is rather different. We might still derive significant external income from the materials that we can produce cheaply, but the products of traditional industries sent to international markets might be quite different. An example is the dairy industry's development of a market with high returns per unit volume for functional food ingredients. The need for increasing diversification into different industries was reinforced by the NZIER research previously quoted.

Irrespective of the mix of our production base, it will still be vital to innovate to lower the costs of production. However, increasingly, the empowering intellectual property (IP) is knowledge – not of low-cost production methods, but of ways to create value. More and more, a key driver is likely to be the ownership of empowering intellectual property, and prosperity will come from its exploitation.

The internationally successful New Zealand company of the 21st century recognises the vital importance of developing and nurturing its key empowering intellectual property to give it true international advantage. It is normally highly specialised around that intellectual property. If it makes consumer products it has a very large market

share in its niche (e.g. Jade software products, Gallagher electrified fencing products); or, it may be a preferred supplier of industrial products (e.g. Fonterra's ingredient business). These approaches help the company overcome the problems of distance from market and the small domestic base from which to launch its product overseas. Marketing is highly important to its success, and its marketing and R&D are closely linked.

The internationally successful company recognises that its competitive advantage (and pricing premium) arises from keeping ahead of its competitors in intellectual property development. A competitor superseding its intellectual property will probably cause the company to fail. While it will often keep much of its intellectual property confidential, it may choose to disclose and protect key, clearly defined items of intellectual property if it can withstand the cost of defending the patent or its equivalent internationally. The company is likely to make products or supply services that have fashion/entertainment/convenience or health/well-being/safety advantages, because such products and services can attract price premiums. The empowering intellectual property is just as likely to be involved with shape and form (design) as underpinning functionality.

The internationally successful company may not manufacture at home. If the labour costs are significant, the required skills not highly specialised and the materials transportable, it may out-source its manufacturing to cheap labour overseas.

The internationally successful company pursues four types of innovation to maintain the value of its portfolio of empowering intellectual property:

- innovation at the fringes: looking for major steps toward new products and services not yet envisaged in the market, including harnessing new process development to make radically different products to those currently available
- innovation at the margins: spinning-off from existing intellectual property (sometimes called technology platforms) to extend or retain existing markets
- innovations in process: cost reduction in making and supplying existing products and services thus retaining their profitability
- innovations to retain market access: overcoming legislative barriers at home or at borders, or barriers imposed by consumers, that drive companies toward better environmental and social practice or to improving product quality.

One difference between the internationally successful company of this century and the industrial company of the 20th century is apparent in the R&D spending pattern. The former will often spend much more (5-15% of turnover) on R&D heavily weighted toward the first two categories. The commodity-marketing industrial company often spent less than 1% of turnover on R&D, weighted towards the latter categories. The reasons for this are clear. Even if a product or service enters the market with a technology advantage, over time competitors will introduce their alternatives. This tends to eventually lead to oversupply. Price competition then escalates, driving the product or service to commodity status. Given that the return on investment in existing plant and machinery must be maximised, there are incentives to stay in the market as long as possible. It is, therefore, prudent to research cost reduction to secure process advantage in manufacturing costs, and to take steps to overcome market access barriers. However, the benefit of these advantages to the company and the nation decreases with time.

The internationally successful company must increasingly seek to maintain intellectual property-driven advantage in its products and services (rather than its processes), and to command premium prices by keeping ahead of its competitors. This price premium allows a larger R&D spend. There are many follow-on impacts, particularly in the make-up of the company's workforce.

A successful national economy is not entirely composed of businesses that can compete in export markets in the manner described. There are export companies selling what have become commodity products who are seeking market retention through cost reduction – they need commitment to new product development as well. Maintaining economic efficiency also needs organisations operating nationally and in local communities to be innovative. While their intellectual property may be simpler – often only tacit knowledge for supplying efficient service – they can be innovative by being the first to adopt new overseas technologies or by providing up-to-date quality service to go with their brand.

In summary, we need both value creation (increasingly delivered by the development of IP-based products delivered into non-traditional overseas markets where we can sell at premium prices) and innovation-delivered efficiency (in both the domestic economy and the exporters) to drive up labour productivity, and achieve the prosperity improvements the country needs.

4. The Role and Agencies of the Public Sector

The key role of the public sector is to create – through legislation, policy and other instruments – an environment in which the private sector can develop national prosperity, in a way consistent with New Zealand's social and environmental goals. In broad terms, government seeks to fulfil its role by creating a fair, corruption-free, competitive market-place in which the private sector can operate. Where government intervenes it is either to regulate the private sector so that the market-place is consistent with national social and environmental values, or to foster behaviours considered vital for the nation that would not necessarily develop in the competitive market-place without intervention.

In respect of its direct investment in R&D, the public sector spends for two purposes:to inform the development of public-sector strategy, policy, legislation and regulation and to assist the implementation of public-sector policy. Regarding the first purpose, the "owner" of the research is the ministry or department concerned – such research is often termed operational research. Research for the second purpose may be owned by a particular ministry or department but, in recent years, with the move to centralised investment, the owner of this research has become less obvious.

In addition to the direct purchase of research by ministries and departments, the Government has established the Foundation for Research Science and Technology to invest the bulk of its research funds and deliver the Technology for Business Growth programmes. It has also created New Zealand Trade and Enterprise for investing more widely to facilitate development, innovation and entrepreneurship by the private sector. The Tertiary Education Commission invests in the Performance Based Research Fund and Centres of Research Excellence (CoREs) in the tertiary sector. Other Crown agencies making research investment include the Health Research Council. The Government contracts the Royal Society of New Zealand for investment of the Marsden Fund.

Universities exist for the nation's benefit and have longstanding governance that is largely independent of the Crown. CRIs are much more direct agents of the Crown and are governed by government-appointed boards. Their primary purpose is to contribute to implementation of government research, science and technology policy. They can be expected to change as required to remain efficient delivery agents. Both universities and CRIs are important instruments for the delivery of services towards the achievement of the national goal, but because of their very different governance there is potential for different forms of engagement with them.

In the remainder of this paper the term university is taken to include other parts of the tertiary education sector performing research.

5. Research for Informing Policy Development

Before the reforms of the late1980s, research for informing policy development was largely commissioned directly by the ministries or departments concerned. There was fragmentation and some inconsistency. At the time of the reforms, an attempt was made to combine this type of research funding into one fund and allocate it through a single agency so that it would be applied consistently.

Our observation is that this approach did not work, and that small research funds for operational research have re-emerged in many departments and ministries for several reasons:

- the ministry concerned wants direct control over the work
- the nature of the work is often variable, including elements better described as consultancy and measurement than as research (e.g. fishery stock measurement)
- the timetable for allocating such funding needs to be highly flexible.

The counter-argument for maintaining a centralised approach to funding allocation is the need to ensure a whole-of-government approach is taken to issues, and that different government agencies are not duplicating each other's efforts. It seems that research ostensibly undertaken to inform policy development which has been funded by centralised agencies, has been too loosely connected to the needs of the host department or ministry. This lack of alignment is wasteful.

A renewed whole-of-government approach to research for policy development is badly needed, and should include:

- clear separation of the research funds for policy development from those for policy implementation
- the appointment of a single agency (MoRST) to gather information on the actual and intended research engagement by other ministries, departments and agencies
- co-ordination of research plans facilitated by the appointed

agency to avoid gaps and duplication

- acceptance that research for policy development will largely be commissioned in consultancy-style contracts or conducted in-house by the primary owner, ministry, department or agency, rather than purchased from a centralised pool of funds
- possible retention of a small fund for multi-faceted research serving a number of parties within government.

IPENZ suggests that this approach might be adopted immediately.

6. The State of Private-sector Sustainable Development – Indicators and Observations

6.1 Innovation, Entrepreneurship and Business Growth

At a macro-level, the evidence in section 2 suggests that our performance as a nation has not been as good as others over the last three decades. At a micro-level, there is also compelling evidence that things are still far from right. Recent surveys show that New Zealanders may well be innovative and entrepreneurial; for example, the Global Entrepreneurship Monitor New Zealand Report released by the Centre for Innovation and Entrepreneurship at Unitec shows that New Zealand has the highest rate of early-stage entrepreneurial activity and existing entrepreneurial firms among developed countries (GEM 2004); the problem is insufficient carry-through to new economic activity.

While it is important that we do not confuse improvisation (the old No 8 wire syndrome) with innovation, there is no evidence that we do not start enough ventures. Perhaps the critical question is whether they are of the right kind.

If New Zealanders are forming the wrong kind of venture, the rate of failure would be high. There is some debate over the acceptability of our present failure rate. Our view is that the present failure rate of our SMEs might be tolerable, but their inability to grow is not. For example, the ICT taskforce recognised the inability to grow businesses to a critical size as a crucial problem for that sector.

We are still weak at staging young companies through the transition from start-up to early growth to substantial size/maturity, particularly when it comes to successful penetration of export markets. We also do not have a strong record in facilitating the merging of synergistic small companies into larger enterprises that can acquire/provide and sustain the necessary investment in R&D, and business and market development.

There is also a tendency to "cash-up" new ventures. The difficulties of getting to the international market from New Zealand are such that medium-sized businesses sell out to larger overseas companies who can transport products to market quickly before they lose value.

The issues restricting the development of new enterprises seem to be as follows:

a. The empowering IP on which the businesses are based provides some competitive advantage in the local market-place, but insufficient to create and sustain export markets, or to displace sophisticated imports on the local market, which dooms the enterprises to remain small.
b. Where there is potentially sufficient empowering IP, the businesses lack the skills in IP development and implementation and remote market development to realise the benefits.
c. The cost of carrying products to market is too large a burden for the company when it is supported only by the small New Zealand market.
d. There are few incentives for private-sector investment to further develop innovation at the fringes or margins.
e. Due to badly designed regulations, the business environment is hostile in that it deflects business efforts away from development towards compliance.
f. The business environment is hostile in that there is a strong fiscal incentive to relocate the business to a more favourable environment overseas (enterprise transfer).

As a lightly populated country wishing to grow in economic size, New Zealand needs the balance of enterprise transfer to favour inbound transfer much more strongly. Recently, the film industry has complained of too little incentive. New Zealand has largely avoided reverse taxation (incentives).

It must also be remembered that, in other countries, new enterprises comprise only a small fraction of new economic activity – typically more than 90% of new intellectual property is taken up by existing enterprises. We would, therefore, expect that large-scale economic development would involve growing existing businesses to a much greater extent than starting up new ones. However, New Zealand private-sector R&D spending remains low, although improving a little, and both public and private sector spending is still skewed towards process innovation and innovation to retain market access. This suggests that we do not have the processes in place to develop new business opportunities.

There is an urgent need to collect new information, tracking the trends in R&D expenditure by the private and public sectors on innovation at the fringes, innovation at the margins, innovations in process and innovations to retain market access. We need to understand better where the gaps and imbalances are.

6.2 Research and human resource indicators

At first glance, data published in the European Report on Science and Technology Indicators, which show that by international standards per researcher we have high rates of publication (European Commission, 2003, pg 283), appear promising. However, this may hide another problem. There is no reason to suggest that modestly-funded New Zealand researchers are more productive than the international norm (and the first Performance Based Research Fund results tend to confirm this), so it is possible that our high publication rate is at the expense of low rates of development of high-quality, confidential know-how. The latter is vital to industrial development because the purpose of private-sector R&D is largely to further develop such know-how into the trade secrets on which many businesses are based.

Whilst our tertiary education participation rates are high we fail to develop or retain enough specialists in some key knowledge areas. By international standards, our pay rates for the people who undertake the role of IP development and realisation (e.g. engineering and technology graduates, holders of research degrees) are not competitive.

The job prospects of PhD holders in New Zealand are modest – there is little movement of researchers from CRIs and universities to industry, so openings are not created for others to start or develop their careers. Whereas a US PhD in engineering has an expectation of moving into industry with his or her technology and then working up through that industry to a senior management role, this is less common in NZ.

The ICT Taskforce recognised a lack of leadership training as a limitation on the growth of its industry. We consider that the problem is more widespread. Governance and senior management of IP-based (as distinct from service-based) industries in other countries (e.g. Singapore) is dominated by technical professionals, especially engineers. The UK's Engineering and Technology Board found that the education of Directors of FTSE 100 companies was in order of importance: engineering (16.4%), science (15.0%), and economics (14.5%). History at 9.9% and languages at 8.4% came in ahead of commerce at 6.7%.

We do not suggest that business compliance skills are not needed on boards, but rather that a technology-based business can only make good decisions if it is fully aware of the vulnerability of its IP to obsolescence and/or its potential for improvement. We are concerned lest the backlash from Enron-like events leads to greater caution and an even greater proportion of compliance-oriented senior personnel, which would be detrimental to business development.

Not surprisingly considering all these indicators, work by the Ministry of Economic Development showed a low absorptive capacity for using research in almost all industries in New Zealand (Tullet et al, 2003, pg 47). The ICT sector and the dairy industry have a policy of employing graduates and of substantial private-sector R&D spending – of which at least part pays the graduates' salaries. These industries have the kind of absorptive capacity or research receptiveness that is needed more widely.

7 Impact of the General Economic Environment on RDI&E in the Private Sector

This review does not seek to discuss general economic policy. Rather, some observations are made regarding the way that the general environment impacts on the levels of RDI&E in the private sector.

7.1. Company tax

High company tax rates compared to our nearest trading partners mean that a business that is not reliant on proximity to materials supply (and few high technology companies are) will move to a lower company tax environment. The 2004 KPMG Corporate Tax Rate Survey shows that

New Zealand's 33% corporate tax rate is well above the Asia Pacific, OECD and European Union average, and goes against the global trend of corporate tax rate reduction (National Business Review 2004).

Low company tax leads to larger profits. A profitable company is more likely to retain some of that profit for reinvestment in R&D, or for capital works projects based on implementing innovations.

Lowering company tax does not tend to reduce revenue to government. Profitable companies will often have high staff remuneration levels, and with the marginal tax on personal remuneration well above the company tax rate, the personal income tax take might increase. When profit is paid out to shareholders, the associated imputation credits to avoid double taxation are also reduced, so the tax paid by New Zealand-based shareholders increases to balance out the lower company tax take. Further, with lower company tax rates, there is less incentive for companies to spend on tax avoidance. Finally, multi-nationals will be more inclined to make a profit in New Zealand than in other economies.

A problem with reducing company tax is that, as it is set at a different rate from personal tax, the incentive for "gaming" increases – rather than focusing on productive economic activity, effort becomes deflected into tax avoidance. Reducing the personal taxation rate at the same time as the company tax rate, however, could have wider consequences.

We therefore suggest that lower company taxation rates are an important dimension if private-sector RDI&E are to be encouraged, but note that there are much wider implications from such a move.

7.2 Private-sector research and development tax incentives

The tax treatment of R&D expenditure by industry is a concern. Things have certainly improved in recent years since the removal of the requirement that all R&D expenditure be capitalised. The present system requires R&D expenditure that creates an "asset" to be treated in the previous way, but allows unsuccessful R&D expenditure to be written off as a current-year operating cost. The issue with such a treatment is how to avoid so-called black holes. That is, R&D investment that appears promising and so is treated as capital, but which, in fact, cannot be used beneficially, must be recognised as such and moved between the two categories. This is an implementation rather than a policy issue.

Australia has a taxation treatment that allows more than 100% claims on R&D expenditure. While this creates incentives, it is a moot point whether the primary incentive is to create more R&D or more gaming. It is probably more important to get the implementation of our tax treatment for R&D expenditure right, thereby avoiding black holes, than to create artificial incentives as happens in Australia.

The alternative artificial incentive is the use of government grants which can be targeted, whereas tax treatments are a crude and untargeted tool, prone to attract gaming behaviour. However a grant-based system is unlikely to reach all worthwhile targets in the private sector, and, if indeed it did, the transaction cost would be considerable.

Overall, we consider that a well-implemented R&D tax treatment, augmented by a co-funding grant system in particular cases, is a practical approach for New Zealand.

7.3 Planning and other approvals

In a world where competitive advantage is the ownership of empowering IP, a business lives with the threat of having its IP superseded by a competitor. Time to market is therefore vitally important. Unnecessary delays caused by permission processes are a threat to any development project. Fortunately, the products of high technology companies do not require many regulatory approvals, but it is vital that where they are necessary, the regulator involved acts with reasonable speed.

The prime culprit of recent years is perhaps the RMA. The shortcomings and strengths of this piece of Legislation has been well documented by IPENZ and other commentators. Hopefully the recently announced review will go someway to trying to improve the RMA process so that business projects which have sound sustainable outcomes (social, environmental and economic) are not needlessly prevented from proceeding through the creation of undue uncertainty, increased costs and time to completion.

7.4 Compliance costs

In spite of promises to improve it, the compliance cost environment in New Zealand remains hostile – provisions are still being made in legislation for purposes of social equity which SMEs in particular find burdensome. A Business New Zealand-KPMG Compliance Cost Survey found that SMEs have a compliance burden six times higher than larger businesses, and that overall the compliance burden faced by New Zealand businesses is clearly a drag on growth (Business NZ, 2003).

In small cash-strapped businesses it is the managers whose time is taken up by compliance, reducing their availability to grow RDI&E activities.

Organisations involved in RDI&E need organisational flexibility. The codification of employment agreements has become so prescribed that a small company may decide that taking on a researcher is not worth the risk of high costs for disengagement if the organisation's needs change.

7.5 Infrastructure

The imperfections in national infrastructure that are impacting negatively on general economic productivity are increasingly well understood. People are not productive when stalled in the Auckland gridlock, and it is no surprise that productivity growth per capita is lower in Auckland. Certainty in pricing is also important for export industries; they need low risk in their at-home manufacturing activities so they can take on the greater risks in the international marketplace. However, in respect of the primary focus of this review – the public policy environment for fostering RDI&E – the impacts of infrastructure shortfalls are less than those in other areas discussed above. One area in which there may be an impact on RDI&E is the provision of world-class, high-capacity electronic communication to our R&D community. We must be able to move vast amounts of information internationally at low cost and without delay.

7.6 Availability of capital

The Government has moved to catalyse the venture capital market, a market that is small but developing in New Zealand. However, if New Zealand follows the overseas norm then about 90% of the development we need must come through expanding existing industries, usually funded through retained earnings.

The Treasury report highlighted that New Zealand has a low capital to labour ratio compared to Australia. Investment capital can move freely across New Zealand's borders, and there is New Zealand-sourced capital available. Perhaps the most vital question is why the holders of capital have chosen not to invest in New Zealand industry when there is no intrinsic reason why there cannot be good rates of return. The answer seems to lie in the perceived risk profile. New business ventures in New Zealand are far from their markets. As stated earlier, the skill base in New Zealand for making the business cases for new ventures or activities is not well developed.

Coincidentally, the Government's Technology for Business Growth programme is often under-subscribed with bids of sufficient quality – also an indicator that there is a problem in the private sector's skill base. The preparation of business cases for R&D grants and the development of a successful innovation into a capital works project requires similar business skills, which seem to be in short supply, as confirmed by the findings of Tullet et al. (2003).

8 Technology-push and Market-pull Models

Historically, public sector R&D investment agencies viewed their investments largely in terms of the technology-push model. The conceptual model has been of researchers developing IP (with government assistance) which is then transferred out to industry. For example, we talk nationally about the "science system" from which economic growth is going to come. This model is simplistic and misleading and defies what our few highly technological industries know – that linking of R&D effort to the market-place and market intelligence is absolutely vital. Yes, there will always be innovations at the fringe, so major that no market for them yet exists; but in relative terms, innovation at the margins - building on technology platforms, listening to the market and creating variants – is the more important means of steadily growing an existing industry or company.

Further, most empowering IP in use in industry has substantial technological and engineering development, even if the idea originated in a science lab and, in many instances, the IP starts with the engineers, technologists, or designers defining shape and form. Our perception must take in the whole of the RDI&E system, of which scientific research is only one part.

The amalgamation of Industry NZ and Tradenz to form NZ Trade and Enterprise has introduced market realism across its spectrum of activities, and market linkages are acknowledged in the Technology NZ

and Research for Industry components of FRST's activities. Our view is that despite these changes there may still be a problem. Technology-push companies are often weak in market research, and development of market strategies. Public policy analysts over recent years may not have sufficiently understood the commercial realities of what is needed to support market-led R&D in industry, and thus the policy environment is weak in its support of market-led innovation.

9. The Role of People Transfer in Technology Transfer

The balanced RDI&E system has both technology-push and market-pull mechanisms in place. Business growth arises in some cases from protected IP, but more often is based on confidential know-how or trade secrets. There needs to be long-term strategic partnerships between those doing the R&D, those operating in the market-place and those investing capital in new ventures or in-house developments.

In the New Zealand context, with the demonstrated low R&D performance of the private sector, these partnerships will often need to involve people from the public R&D sector interacting with the private sector. We need business-savvy people in the R&D sector, and R&D-savvy people in the private sector. Additionally, when a technology is transferred, the technical knowledge to support and further develop it must continue to be available.

These important aspects of technology transfer may have been undervalued in New Zealand in the past. In fact, we may have inadvertently created disincentives to these processes. For example, there is still major emphasis on researchers' track records in the way some public sector funding is distributed to CRIs and universities. This creates an environment where the retention rather than the transfer of researchers to industry is fostered.

One of the best long-term fixes for the low absorptive capacity highlighted by the Ministry of Economic Development is researcher transfer to industry. We must develop a new breed of people who start in the research environment then transfer to industry with their IP, and progress in that industry to senior management. People transfer to industry from the R&D sector then creates job opportunities and career pathways for science and engineering graduates. Graduates will learn that their progression to industry relies on developing both their technical and business knowledge, but that there are strong rewards for doing so.

10 Underpinning Human Resource Development

We are pleased to see that industry's need for technically skilled workers has now been recognised, and that New Zealand is seeking to reverse the trend of the last decade which saw this labour pool reduced. The rebuilding of apprenticeship schemes is vital. We also need engineering technicians and more professionals. In short, a balanced approach is called for.

Career paths for graduates in science, engineering and technology too often lead them overseas, in part for experience but also for better salaries to repay student loans. Their retention in, or return to, New Zealand requires both more jobs and better pay. The economics of supply and demand influence tertiary study choices. As a nation, we are both entrepreneurial and egalitarian, applying many checks and balances through our regulatory systems. This leads to high compliance costs, and also to more jobs in compliance. It is no wonder that so many bright people tend to choose safe careers in compliance, rather than risky careers in value creation. Positive support for people transfer as a technology transfer mechanism would assist in overcoming the negative perceptions towards careers in industry.

Another symptom of risk-averse attitudes is that skilled migrants brought to New Zealand have often experienced difficulty assimilating – there is eventual net benefit, but often the private sector is slow to employ them.

Attitudes are changed through education but we would argue, that without the right policy settings to back it up, education will not be enough. The market does not provide the best long-term signals to people making tertiary education decisions, and there is a national public sector responsibility to educate people of all ages about the needs of our companies in the future. Engineering and science graduates need to understand basic business principles and economics. More post-graduate students need to see working in the R&D sector as a career stage before private sector employment and not necessarily as a lifelong decision. School children need to understand about innovation and how to turn ideas into something practical in an industrial context. Attitudes are established at very young ages.

11 Alignment of Public Sector Investment to National Needs

11.1 High-level goals

Leaving aside research to inform policy development, the role of public sector investment in research is to:

- ensure that the research needed to implement national environmental policy is performed
- ensure that the research necessary to implement national social policy is performed
- maximise sustainable development by the private sector (which includes trying to obtain an optimal mix of innovation at the fringes, innovation at the margins, process innovation, and innovation to maintain market access).

In addition, there is probably a role for the public sector in maintaining sufficient research and development capacity (people and equipment) and capability (quality) against short-term fluctuations in demand. Improving industrial capacity and capability is an issue of long-term culture change, and even when private sector capability is improved, it is unlikely that industry will retain unused capacity. Where research associations exist, with major support from levy funding there can be some buffering against the market-place, but capacity and capability retention for more than short- and medium-term needs is again unlikely. Thus, it is generally recognised that we must look to the public sector to retain both sufficient capability and sufficient capacity against the foreseeable needs for research, in addition to its role of supplying enough graduates to move into industrial employment around RDI&E.

The primary research policy Ministry, MoRST, recognises four differently derived goals: economic, environmental, social and knowledge.

While the number of goals is right, we suggest that classifying our public sector by subject area rather than by the purpose of the research has led to an inappropriate association of purposes with funding mechanisms. For example, most research designed to implement government environmental policy should not be subject to sudden changes in direction. It therefore suits the development of key expertise with long-term funding. In contrast, public sector support for an industry's efforts to solve an environmental problem that is creating a market-access risk should be partial, short-term and withdrawn when the problem is resolved.

There is one cross-over between the environmental and economic areas – research related to sustainable development. As we indicated earlier, the goal is to simultaneously drive up both labour and resource productivity. Most of the resource productivity gain has to be made in the private sector, so it is logical to combine funding for research for private sector resource productivity gain with funding for sustainable development of the private sector.

11.2 Planning processes and their outcomes

The lead agency for government, MoRST, has conducted three reviews of spending patterns – STEP, SPiR and Foresight. The first, STEP, was quite limited and sought to break down expenditure by industry group. SPiR was rather similar. Both tended to push investment towards the traditional patterns that favoured ongoing improvement in well-established industries. As the NZIER found (Briggs et al. 2001), these industries had low potential to grow export income rapidly and it is not surprising that our export income did not increase as rapidly as that of other OECD countries during the early and mid-1990s when STEP and SPiR guided investment.

Foresight was much more ambitious, and had the huge advantage of seeking to be market-led. It asked industries to think about their future and sought to identify their research needs. Although seen by many as a failure, it highlighted long-standing issues: firstly, that companies competing in the market-place will not co-operate on research unless to address a common problem. Secondly, industry leaders did not always have the technological literacy to foresee how technology change would impact on their businesses; and thirdly, the public sector had no suitable way of following through on the results.

The ideal evolution from STEP and SPiR to Foresight would have been the development of a National Research Priority Statement aligned with national goals, divided according to the four categories we define above. Such a statement is urgently needed.

In the absence of research priority statements, for a number of years the main investing agency (FRST) operated a set of output classes that aligned more with existing industry groups than with the purposes of the research. As well as favouring what have been proven to be low export growth potential industries as identified by Briggs et al. (2001), the lack of alignment had serious implications which have flowed through

into decision making. Because there has been insufficient clarity, the research providers have been unable to align their human resources with the true national priorities, and shifts in direction taken by FRST have sometimes been too abrupt and not well-signalled in advance to assist smooth workforce planning. This leads to lobbying by affected groups, and ultimately is inefficient.

11.3 The balance of basic and applied research

Successive governments have recognised that, ideally, their role is to fund research that is far from the market, sometimes called basic research. Our public-sector investment in basic research is not far out of kilter by international standards. Our problem is that private-sector investment is so low that the public sector must take on the role of developing the private sector's capability in market-led research while at the same time doing the important research that the private sector will not.

The term "valley of death" has become popular and refers to the gap between research by the public sector and the activities of the private sector as described above. In a country of small and medium enterprises (SMEs), the bulk of empowering IP will be confidential know-how, as the enterprise cannot afford to protect and defend its IP publicly. Thus, there may be a greater need for government involvement in bridging the valley in a country of SMEs.

As stated earlier, internationally more than 90% of new IP is transferred to existing industry, and less than 10% or so goes to newly created ventures. This is further evidence that technology-push must be counter-balanced by strong support for market-pull mechanisms. Existing industries will seek to capture IP, reinforcing their traditional products and services, but their challenge is to also use some of their capital to invest in new areas, often with higher risk but potentially higher gains. The quality of the leadership in our existing industries, and the way that those industries are supported when they take on the risks associated with diversification are therefore vitally important.

On reflection, much was lost in the 1990s in New Zealand when perhaps too pure an ideology was applied to the definition of public good science, to ensuring that public sector investment did not displace private investment, to managing the problem of appropriability and to ensuring contestability. Rather than develop strong industry/research-provider links it was a decade of abeyance. The opportunity to develop joint venture, incubator, and venture capital and other mechanisms to bridge the valley of death were forgone. While we agree with others from the science fraternity that more investment in high-quality basic research will give benefits, we are strongly of the view that building the research receptiveness of industry and fostering means for crossing the valley of death has to be seen as an equally valid activity for government investment, at least in the short term.

11.4 The nature of a National Research Priority Statement

Whereas the outcomes of the STEP and SPiR processes were largely framed in terms of industry sectors into which to make inputs, a National Research Priority Statement must look different. It must be outcomes-focussed, and accompanied by clear measurement statements. We have had a decade of trying to pick winners, yet there is a growing realisation that many advances are serendipitous, happening at the fringe of programmed activities. Further, we are seeing increasing convergence between disciplines, and want to encourage inter-disciplinary approaches. This suggests that to be successful, a National Research Priority Statement must be low on prescription of how to achieve the outcome.

A starting point may be the three main goals (environmental, social, sustainable development), and then under each of these to create a set of objectives which describe the aims of the R&D investment. For each objective there can then be measurable outcome statements and dates by which we seek to achieve these. The outcomes statements in the environmental area might be reasonably specific (e.g what is the R&D outcome we want in terms of control of pests affecting our biodiversity), but for sustainable development they need to be generic rather than sector-based to avoid the issues highlighted by the NZIER (Briggs et al. 2001). We want existing industries to use their capital in areas of higher potential, which may be outside their traditional activities. Provided the industry sector that grows is consistent with our national values then it does not matter particularly which one it is.

Creation of a National Research Priority Statement requires a whole-of-government approach, and will not be an easy task – possibly why it has not been tackled previously. However, the old saying that 'if you do not know where you are trying to go, you will not get there' is unfortunately too often true. The benefit of having such a statement is that government agents like FRST can be sure that its investment is targeted accurately.

12 Operating Models for Universities, CRIs and Research Associations

12.1 The problem of disaggregation

It is pleasing that some steps have been taken by FRST to address the problem of disaggregation. A research provider bids a researcher onto a number of programmes (here the word programme is used loosely and not according to the definition applied by FRST). A number of bids are submitted to several government investment agencies by various deadline dates. Each agency may further disaggregate the bids and send them to assessment and recommending/decision groups. Decisions may be made at a very micro (disaggregated) level. When the research provider collates the recommendations/decisions they can find problems, for example, key platforms on which other programmes rely are sometimes not funded, making the programmes of the research provider as a whole inoperable, and specific researchers may be less than fully funded. Non-Specific Output Funding (NSOF) ameliorates this problem to some extent in CRIs. Universities have been better sheltered from the problem of disaggregation by their different modus operandi and their economies of scale.

It is pleasing that some steps have been taken by FRST seeking to address this problem.

12.2 Using the differing natures of universities and CRIs

As indicated earlier, universities and CRIs have quite different governance structures, and this difference is reflected at lower levels of the organisations. In spite of this difference, there has been a trend in allocating public sector R&D funds to allow increasingly equal competition between the two types of organisation. This raises the question as to whether the two organisation types are being optimally used.

If there is really no benefit in treating them differently, then taken to its logical extreme, and given that we need universities, we could close the CRIs and transfer their staff to relevant nearby universities. If indeed there is a benefit arising from their difference in structure then their treatments should not be the same. Wider recognition of, and support for, the difference between them may assist closer collaboration rather than competition between them.

An example of the difference is in the ability of the Universities and CRIs to store capability and capacity. Universities run a more diverse business, and many academic staff will spend only around 25% of their time on research, whereas CRIs employ mainly staff dedicated to research. Universities also have larger economies of scale. Until very recently, some research capacity was bulk-funded to Universities whereas NSOF was the primary means for the CRIs to store capacity and capability, even though it has been regarded by some as insufficient for this purpose. One might therefore conclude that Universities are possibly more efficient at storing capability and capacity than CRIs. This is not to say that this was intended, or is right or wrong, but just that it may be so.

12.3 Funding/rewarding capability and capacity

There are three main means currently in use that have as one of their effects to fund capacity and capability (although the aims of the schemes are wider) – the Performance-Based Research Fund (PBRF), the Marsden Fund, and NSOF. Both the PBRF and Marsden are intended to ensure that good research is performed; and thus in our view they have capacity and capability supporting outcomes, although they are not referred to as such. The Centres of Research Excellence (CoREs) are also capacity-reinforcing and the argument below could be extended to them.

12.3.1 Universities

Over the next decade, the PBRF will replace the old university bulk-funding of research. It has an important feature that we support – the measurement of both the capability of the university staff and the capacity by discipline area. It allows no university staff member to duck – it is a complete-system measure, which is good news.

However, we have some concerns with PBRF's quality measurement system in that it is heavily weighted towards the opinion of other

researchers (peer review, scholarship), rather than towards the fitness for purpose of the research. New Zealand urgently needs researchers who can solve industry's most difficult problems and create confidential know-how. The weightings applied in the PBRF system may not sufficiently recognise the validity of such research. We have received anecdotal information that suggests that some university researchers with heavy industry involvement intend to seek more scholarly output and forgo their industry linkages in the future. We need them to be incentivised to do both. We see this as a settling-down problem that needs addressing before the next evaluation.

One concern associated with the PBRF is that its funding action of rewarding performance may occasionally be at odds with the strategic needs for building nationally-critical capacity and capability. PBRF funding will be directed to areas where strength is found. Where capacity (quality) is low, money will be lost. Even though the PBRF is a bulk grant, those with high-earning scores will want the money spent in their areas, so it will be difficult for universities to allocate it differently from the way it was won.

The Marsden Fund is granted primarily on two grounds – track record and novelty of the programme of research. Universities received the bulk of the recently-allocated funds. From the viewpoint of building strategic capacity and capability, the fund operates like the PBRF – rewarding strength, with no strategic overview of the long-term impacts of shifts in patterns of investment. The start-up grants for new researchers are the only concession to building capability and capacity.

The competitive nature of both the Marsden Fund and PBRF does create incentives for improvement, for example by publication of the PBRF league table of university research quality scores by discipline area. However, in some areas that are seen to be nationally important but at risk of inadvertent capacity and capability loss, or making too slow recovery, direct intervention may be justified. Hence, there may need to be a strategic capability and capacity investment process operating alongside the PBRF and the Marsden Fund. The PBRF researcher quality scores will be one tool for identifying those areas regarded as strategically important in which there needs to be such strategic investment.

12.3.2 CRIs and other research providers

For the CRIs and other research providers, the capacity and capability means must be different. A measurement system like that of the PBRF for the CRIs could be proposed, but we suspect it would be more difficult to use because, even more than in the universities, the CRIs' measurement should be of fitness for purpose of their research. Therefore we are ambivalent on such a proposal.

Our view is that the primary means of storing capacity and capability in the CRIs should not be a funding mechanism, but rather CRI business plan alignment with national needs. The best means of ensuring this, and thus achieving strategic storage of capacity and capability, is to increase the discretionary decision-making function of CRI Chief Executives (devolution). At present, CRI Chief Executives are often decision-acceptors rather than decision-makers on matters related to their public-sector income. The means we propose for aligning business plans are outlined in the following sections. The need for stability and at the same time flexibility that is often talked about represents, at least in part, another statement of the same problem as storing capacity and capability, so the same policy means should achieve it.

12.4 Research to implement National Environmental Policy

Earlier in this review, we outlined the need for national research priority statements. In the presence of such statements, the role of the public sector investment agency would be to purchase high-quality, cost-effective research to achieve the outcomes. The research would be very much directed according to the national priority statement. One would expect the funded research provider to be in regular communication with the host Ministry or Department with whom the research priority statement being addressed is associated. In such circumstances the primary means of allocating research funds should be the negotiation of long-term contracts, subject to the right to renegotiate milestone outcomes should the research results suggest changes in direction. There also needs to be some opportunity for new entrants to demonstrate capability.

When forming long-term contracts the investment agency needs to be sure that the best possible team has been engaged, and that the programme is cost-effective (that is, of sufficiently high productivity). Measurement of quality by track record, and especially by publication rates, may not be appropriate; the best measure for such research is probably fitness for purpose.

We therefore suggest that the pool of investment should be broken

into two – the larger part should be negotiated with research providers on long-term contract, but each such contract would be subject to regular independent audit, and the renegotiation of milestones and participating personnel. We see no advantage in this pool being contestable.

The other part of the pool, which would be for small shorter-term programmes, should be contestable. It would allow new groups to demonstrate capability and novel approaches to be trialled; if successful they might be transferred to the longer-term contract pool.

The element that we consider needs further work is the transfer between the negotiated and contestable pools. If the investment agency considers that a negotiated contract is performing poorly, that contract could be transferred to the contestable pool. It might still be re-won by the initial provider, but to do so they would have to improve their performance. A well-performing project with short-term funding could transfer either way. We do not see that the transfers have to be equal in both directions at any particular time, but over a period of years should roughly balance. The existence of the transfer mechanism and the possibility of displacement would keep the providers with long-term contracts on their game. In our view, this is enough contestability, it would still allow research providers to control their own destiny to a degree, and thereby ensure internal stability. This suggestion is not so far from the way that environmental research investment is being driven by FRST already.

We consider that the long-term pool might well be dominated by the CRI sector, but the universities could also gain the longer term negotiated funding. We also want to stress that development of commercialisable IP should be an aim of this research pool only if it were an objective of the national research priority statement. Commercial income from IP should normally be a by-product, to be encouraged but not required in the contracts.

12.5 Research to implement National Social Policy

The public sector investment includes a pool of health research money, and a small pool of other social research money. The bulk of non-health social research in fact is carried out in the university sector and funded historically through contracts with departments and ministries or through university bulk-funding (now the PBRF). Health research funding has traditionally gone to the medical schools in universities, but is being spread more diversely with time.

We consider that there is a need to rethink how to align the national social research priorities better with the funding investment at a policy implementation level. This is a matter on which we make no specific suggestions as it lies outside the purpose of the review.

12.6 Research to implement National Economic Policy and the Growth and Innovation Framework

12.6.1 Funds and recent funding activities

The main funds invested by the public sector are the New Economy Research Fund (NERF), the Research for Industry Fund (RFI), the Technology New Zealand stable of funds (called TBG for convenience), the emergent venture capital funds, and the funding provided to industries through NZ Trade and Enterprise.

The roles of each of these entities can be related to the four motivations for research in industry we proposed earlier – the pursuit of innovation at the fringes; innovation at the margins; innovations in process; and innovations to retain market access.

NERF and the venture capital funds are clearly aimed at the first of these approaches. Their goal, expressed in the purest terms, is to create empowering IP so novel that there is not yet a market, and to commence the technology transfer of this IP (technology-push).

At present, RFI is used for a mix of the other three purposes. Ten years ago it was dominated by the third and fourth purposes, but of recent years FRST has sought to grow the second. The problem is that the fund should ideally conform to the market-pull model, at least in part, but our observation is that over the last decade it has operated too far from the market for several reasons:

- investments have tended to favour industry-wide approaches, yet companies who compete in the market-place will co-operate only on research to solve a common problem (in essence, to retain market access or address raw material oversupply), or is not mission-critical
- investment decisions up until quite recently tended to require letters of support from industry leaders which can be obtained without the research provider really engaging with the market-led issues of the industry sector (we acknowledge that real engagement, e.g. by co-funding or involvement of industrial personnel is now being sought)
- concerns about displacing of private-sector investment by public sector funds tended to lead to the selection for funding of research programmes further from the market
- investment decisions were significantly influenced by the track record of the researchers, and as a result research providers try to retain staff rather than let them transfer to industry and learn of the market.

The net result in our view has been too great a disconnection from the market-place. It is pleasing to note that FRST are seeking to address these matters and that positive progress was demonstrated in some recent funding decisions. There is also increasing acknowledgement of the importance of cross-sectoral research, recognising the increasing convergence of scientific disciplines.

The TBG cluster of funds tends to operate in the short-term R&D horizons of industry, and definitely has strong market-pull drivers.

In seeking to address the issues above, a useful starting point is to recognise the different purpose and roles of universities and CRIs. Whereas in other funding areas they can co-exist comfortably, in this area we consider that they might need to be treated quite differently.

12.6.2. CRIs and RAs

The model we propose for CRIs is a kind of performance-based investment model, but at an institutional rather than an individual researcher level. Each CRI would be provided with a set of individualised performance indicators (KPIs) selected as appropriate to the particular CRI from:

- alignment with relevant national research priority statements
- level of private sector co-funding achieved (through research consortia or other co-funding means)
- economic performance of its target industry sector or sectors (e.g. economic growth rate of the sector(s), labour productivity change in the sector(s), export sales growth, extent of diversification to new products or services, increased import substitution, efficiency improvements if the sector is involved with provision of national infrastructure.
- resource productivity performance of its target industry (reflecting the national goal of sustainable development)
- transfer of confidential know-how to industry
- transfer of researchers to industrial employment
- intellectual capital value created
- licence fees from protected IP

but not on publication rates or ownership of IP, to which a more flexible approach, fostering its use rather than its ownership, is needed. In return for its performance the CRI would be granted a lump sum of public sector investment, each year, and such amounts might be set on a rolling two- or three-year basis to assist business planning. There would be few rules about how it would be spent (beyond rules of propriety) other than that it be spent on CRI staff and the consumables they use. The CRI Chief Executive would know that to grow, or at least maintain, the funding pool in future they must grow the outcomes achieved according to their organisation's KPIs. Although we do not explicitly list it, the growing of research consortia with industry in various shapes and forms would be vital to achieving the performance measures. Ongoing flexibility to accommodate consortia within a sector, cross-sectoral consortia, and comsortia representing only small parts of a sector would be advantageous.

On the review dates, we would expect that each CRI would return a percentage of its funding into a central pool for re-distribution to those CRIs which performed best against their own KPIs. This approach overcomes the problem of disaggregation by collapsing down several

funds, and also creates stability and flexibility. It enables the CRI to make its own plan for capacity and capability retention because the pool of money over which it has discretionary decision-making power is sufficiently large. And more importantly, the CRI can really be successful only if its target industry is successful, and it will be forced to create strategic partnerships with that industry. The researchers will need to learn of the market issues, and help the companies resolve them. The problem of low absorptive capacity will be solved as the CRI transfers staff to the industry. In effect, there will be many consortia of varied types. The CRI Chief Executive would have a strong interest in maximising the co-funding achieved with the funds in hand, and would lever the co-funding ratio from case to case accordingly.

If a CRI Chief Executive thought an industry was being too shortsighted, they could use the available co-funding as a bait to change the thinking of its leaders. The distinction between RFI and TBG for CRIs might disappear – the Chief Executive could decide how to divide the funding pool between the two types of activity. When an industry was engaged and ready to co-invest, the CRI Chief Executive would make the funding decision, rather than having to prepare a funding application to a public-sector agency. This responsiveness would be welcomed by industry.

A well-performing CRI Chief Executive would be able to retain capacity and capability within the lump-sum RFI funding that we propose, by aligning their business plan to the short- and long-term needs of the industry sector. If the CRI was heavily involved in the research programme for implementing government environmental policy, this would also aid stability. Hence, there should be no need for specifically-tagged NSOF funding. The recent announcement to enlarge NSOF is a step in the direction we propose, provided the performance measures are outcomes-based.

We see no reason why a similar approach cannot, in principle, be applied to a research association although levy funds may need to be excluded from co-funding determination.

We believe that for the most part, the decision on the balance of funds between the various categories of research purpose should be made by those engaged in the sector – as represented by the relevant CRI or RA Chief Executive. The categories might be those that we propose, or others based on nearness to market such as those proposed by the Science Enterprises Group (technology mobilisation, tactical R&D for existing sectors, strategic R&D for existing sectors).

12.6.3 Universities

For universities, the devolution model may also be applicable on a smaller scale to specific research centres. However, it does not apply more widely. Instead, we believe there needs to be an industry co-funding pool to which universities can apply on a project by project basis, in a similar way to TBG. The co-funding ratio would be set by the investment agency depending on the research's proximity to market. In effect, this would maintain TBG for universities, but extend it further from the market by allowing the industry funding support to be a smaller proportion of the total bid.

12.6.4 Contestable funds and overall system contestability

We propose the continuation of NERF and venture capital support more or less as is. NERF is the fund for innovation at the fringes, seeking technology-push for new IP that has no apparent market at time of creation. As with other parts of the funding system, it is important that the funding decisions are made using a strong outcomes focus. There is no reason to suggest that either universities or CRIs are more likely to create such IP, so a contestable pool on a limited-length project basis is considered appropriate. An important consideration is that unsuccessful projects would need to be cut, and it will be easier to manage exit from such projects if the funding is short- or medium-term and contestable for renewal. In terms of overall system contestability, we suggest there is no need to distribute money according to output classes nor to guess which industry sector has the greatest potential to develop the best IP. FRST has signalled it is going to reduce its number of output classes, and create classes more in line with the research purpose than industry type. We would recommend collapsing the number of classes still further.

An important new contestability test would be required to decide the funding split for the sustainable development goal between the CRIs/RA sector and the tertiary education sector. This split should be reviewed regularly but infrequently according to a cost:benefit analysis of achievement, using the measurement statements in the National

Research Priority Statement as the yardstick. If the CRIs, even with the benefit of the devolution model, cannot be competitive against the universities or vice versa then so be it.

In terms of government agency, we consider that if the proposed approach is adopted there would need to be a careful review of the roles of FRST and New Zealand Trade & Enterprise to ensure that their interface and modus operandi were efficient and effective.

13. Transition

This review has suggested that substantial improvements can be made. We suggest that if these are to be acted on the approach required is not one of incremental change, seeking to move in the right direction. Rather, the redesigned system should be agreed, and then changes designed to achieve an orderly transition to a new system over as few years as possible.

14. Conclusions

Government must seek to create an environment in which the collective efforts of New Zealanders return New Zealand to a higher OECD ranking by growing our prosperity faster than the OECD average. Progress towards sustainable development will be made by ensuring we improve our resource efficiency (GDP per unit resource used) at least as fast as we improve our prosperity (GDP per capita).

The present low absorptive capacity (research receptiveness) of industry is probably the worst shortfall in our research, development, innovation and entrepreneurship system. Government might need to refocus some of its existing research investment to foster the development of market-pull R&D capability in industry. As industry develops greater capability, the Government might shift the balance of its investment in favour of spending on basic research in both science and engineering.

New Zealand has too small a pool of expertise to utilise innovation in existing and sunrise industries; the key people need knowledge of R&D, technology transfer and business processes; personnel transfer through the public-funded R&D sector is an important mechanism that is probably under-utilised in New Zealand.

Greater benefit might be derived from the structural difference of CRIs and universities. The contestable model on a project or programme basis is reasonably effective for funding of university research, but CRIs and research associations may be improved as delivery mechanisms by substantially increased devolution – lump-sum funding, application of outcomes-based performance criteria, and contestability of the level of lump-sum funding according to performance.

A National Research Priority Statement and associated outcomes-based measurement statements developed using a whole-of-government approach would help ensure that public sector R&D investment is aligned with national goals and relevant public policies.

Broader economic instruments such as company tax, R&D tax, planning regulation and the compliance environment, may require review to ensure they do not discourage capital investment and more generally foster rather than hinder the turning of research, development, innovation and entrepreneurship into real economic development.

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16. About IPENZ

IPENZ is the national professional body for the engineering profession. It has approximately 9000 members, drawn from a variety of engineering disciplines, and employed in a variety of sectors including central and local government agencies, consultancy, manufacturing industry, universities and research organisations. IPENZ is the Registration Authority under the Chartered Professional Engineers of New Zealand Act 2002. As well as assessing and quality-marking competent practitioners within the engineering professions, it supports the ongoing professional development of members and seeks to improve engineering practice standards. It seeks to provide leadership on national and community issues using the collective wisdom of the engineering professions. It is contracted to New Zealand Trade and Enterprise to deliver a programme called Futureintech – to encourage participation in tertiary education in engineering, technology and science.

Comments on this Review are welcome.
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