Te Ara Paerangi Future Pathways submission from Dr. Matthew G. Cowan

I am an active research scientist with an academic position at the University of Canterbury. I have 15 years' experience in academic and applied research covering Chemistry and Chemical Engineering. My international experience includes 5 years in the USA working on academic/industrial projects and 6 months at the Centre national de la recherche scientifique in France working on industrial projects (similar to the New Zealand Crown Research Institutes). I therefore provide a multi-disciplinary and globally informed perspective for this submission.

The University of Canterbury, MacDiarmid Institute, and Kiwinet Emerging Innovator submissions have all benefited from my involvement. Having seen the drafts of those submissions, I have been inspired to provide this personal submission, which is free of institutional biases and jockeying for funding. This personal submission is to provide a strategic overview that enables the government to achieve its stated goals for the research sector.

My personal bias is strongly towards science and engineering research that assists existing industry or builds new industry. I do not comment on areas beyond my experience or expertise.

The majority of this submission focuses on a **two-speed system** where CRIs and Universities are funded differently to provide the long-term impact and short-term responsiveness desired by the government.

Two-speed system

Universities	Crown Research Institutes
Role: Responsive research	Role: Address strategic issues
Funding: Short-term competitive grants 3 year cycle scaled by political cycle	Funding: Long-term stable base funding Insulated from political cycle
Wide talent pool of specialties	Skill-sets relevant to strategic projects
Short-term response to Māori needs	Long-term authentic relationships with Māori
Accountable for short-term impact	Accepted as high-risk with disperse impacts

Common threads

PBRF system to counter stagnation
Transfer of IP to individuals and companies for rapid value creation

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The whitepaper begins with the quote, “Researchers naturally seek to address the most important and pressing opportunities and problems that are facing people and the planet.”

In my experience, this is incorrect. Researchers have many motivations, the strongest I have seen evidenced is a desire for personal promotion within whichever system they exist. Other motivations include personal recognition/fame and maintaining the freedom to spend time on their area of interest/expertise. Any redesign of the system should consider that scientists and engineers are human and will respond to reward/punishment incentives.

This is the source of ineffective resource allocation within the RSI system.

Using universities as an example, promotion is tied strongly to the ability to win grant funding. This is distinct from the production of research, either as academic articles or successful engagement with industry. Therefore, many academics focus their efforts on story-telling to win grants – regardless of their intention to provide outcomes the grant was designed for.

Some illustrative quotes from academia showing the attitude to securing funding:

Advice on writing grants:

“If you feel dirty enough to take a shower after writing it, your grant application is probably good.”

“Academia is words for money.”

Systematic, institutional (not University of Canterbury) call to manipulate the Marsden funding process:

“The PCB panel, probably the panel that most of us apply to, awarded only 8 grants last year, which is dire. This low number simply reflects the fact that only 78 proposals were submitted to the panel at the EOI stage. I recall, not that long ago, that over 100 proposals were submitted regularly to this panel. So, what can we do to increase the numbers of applications funded? Remember, 10% of a big number is a bigger number than 10% of a smaller number! So, I encourage as many of you as possible to submit to the fund, who knows, you might be successful, but if not, by simply applying you will ensure more money is allocated to the panel and more grants are funded.”

1.1 Solving the government’s struggles: A two-speed system

The whitepaper outlines multiple struggles in section 1.1.

To solve these struggles, the government should split the research ecosystem into two distinct sectors with focuses on long-term strategic projects and short-term responsiveness.

Crown Research Institutes (CRIs) should host long-term strategic research programs that are determined by government priorities and long-term intentions. These should be funded with long time horizons (5+ years) that allow consistent movement through failure points.

CRIs make the ideal hosts for long-term research projects as they can be tightly directed by the government and act as centres of research infrastructure with the guaranteed resources to obtain high-end equipment and maintain it over time.

In contrast, Universities should host short-term responsive projects (<3 years). Universities make excellent hosts for responsive projects because they hold a large talent pool of diverse research expertise. When this expertise is not required for specific projects, the academic’s workload can move to teaching. This enables the universities to remain financially sustainable over time without the requirement of a base-grant or inefficient non-competitive allocation of funding.

With relation to government aims, the two-speed system allows:

- Increased effectiveness of resource allocation
    - CRI funding is directed toward long-term research projects and priorities determined by the government.
    - CRIs provide relatively stable employment with researchers aligned to 5+ year projects, meaning they can focus on these projects without external pressures.
    - Universities compete for competitive funding for short-term projects that support long-term CRI initiatives, or are responsive to arising problems.
    - University academics are able to increase their teaching workload when their expertise is not currently in demand. This allows job stability and a large pool of talent retention.
- lack of transparency over purpose and accountability
    - Well defined long-term (CRI) and short-term (university) projects provide clear purpose and the differentiation forces collaboration between the CRI and university sectors.
    - The long-term outcomes from government investments are easier to identify as impact from the CRIs. The defined purpose and focus also provide clear accountability.
- unnecessary complexity
    - Universities driven by short-term research will need to create clear entry points for industrial/commercial projects.
- inability to shift priorities over time
    - Rapid responsiveness from a pool of idle talent in the universities.
    - Short-term grants mean large amounts of capital are not tied up in irrelevant or failing projects.
    - There is a commitment to the long time horizon projects at CRIs; this protects long-term goals and benefits being compromised by short-term priority shifts.
- persistent uncertainty over the value of investments
    - This is actually particularly easy within short-term projects. I have worked on multiple commercial/industry projects through both consulting and research funding. Success and failure of projects is easy to determine, and often the quantified benefit to the end-user.
    - For example: development of a chemical waste recycling project that allowed the company to save $100,000 in annual chemical imports and $100,000 in annual chemical waste exports. Because it is a real impact, it is easy to quantify.
    - The New Zealand Product Accelerator keeps records on end-user engagement, the cost of projects, success rates, and project value created.
    - Because of the dispersive impact of funding, I suggest that the government enforces similar accounting for other research institutes. (Rather than organizations awarding the funding).
- unbalanced investment portfolios
    - The two-speed system allows governments to choose their investment balance of long-term and short-term priorities. Limiting short-term projects to 3 years will allow the government to rebalance every 3 years to match the election cycle.

1.2 Designing Research Priorities

The whitepaper outlines clear desires for how research priorities would function.

All goals can be achieved through the two-speed system due to government influence over the CRIs and ability to define priorities and hold leadership accountable for progress. The longevity and infrastructure of these centres will allow for authentic and established engagement with Māori that gives active effect to Te Tiriti which is extremely difficult to establish for short-term and responsive research projects given the decision making timeframes and emphasis on trust and established relationships.

1.3 Setting National Research Priorities

Research priorities should be set at the political level and verified by experts to ensure the aims are feasible and do not break any fundamental laws of nature.

Feasibility evaluations should be rigorous and carried out by multiple experts. These experts should be carefully selected and vetted for honesty, domain-specific deep expertise, and desire to see tangible outcomes.

I emphasize the above due to interactions such as:

Response to explaining the fundamental energy costs of direct air capture of CO_2 to a Venture Capital Fund:

“You don’t understand, Matt. The numbers don’t matter, so much money is going into direct air capture that we need to be part of it.”

Academic feedback on writing a popular article explaining the fundamental limitations of direct air capture:

“I don’t disagree with what you’re saying or the sentiment, I just think you’d need to give the reader a little more hope! Indeed, if we are going to continue to attract funding we don’t want to shoot ourselves in the foot.”

3. Research Priorities

Transparency to the current ecosystem

In my current role, funding that comes with some proportion of time, reflected in Full-Time Equivalent (FTE), is not allocated within the workload model. I have not talked with a colleague where that is the case. In general, funding provides two roles: 1) subsidizes the wider institution and department; 2) provides student and some financial resources for the project.

3.1 *Ensuring research organisations can adapt to changing priorities*

The two-speed system achieves this by the control governments can have over CRIs and the ability to enforce accountability in CRI leadership.

3.1.2 *Reducing problems of unproductive competition*

The two-speed system achieves this by forcing CRIs to collaborate with Universities to solve scientific/engineering/social problems that emerge by using universities and their talent pools as more agile research organizations that can adapt to changing priorities.

The differentiation of roles removes unproductive competition and forces productive collaboration.

3.1.3 *Ensuring research organisations can adapt to changing priorities*

The two-speed system achieves this by using universities and their talent pools as more agile research organizations that can adapt to changing priorities.

3.3 How we fund our research organizations

3.3.2 *Design choices for a new funding model*

Base grants will provide stability at the cost of stagnation. In a two-speed system, base grants should therefore be provided to CRIs but not Universities.

To counter the risk of stagnation at both types of institutes, any base grant should cover infrastructure, but not people. The PBRF system should be continued, with additional emphasis on real impacts alongside publications, and used to replace ineffective staff.

4. Institutions

4.1 What problem or opportunity are we trying to address

In a two-speed system, defining the role of CRIs to focus on long-term challenges resolves many of the problems raised by placing them outside the scope of CRIs (e.g. inability to adapt), and provides clarity and focus of the CRI role.

The government must accept that guaranteed blanket funding of any organization, such as a CRI, will resolve the problem of financial resilience but will cause ineffective and inefficient resource use. Ultimately, the government will need to set scientific priorities that have long-term payoffs significant enough justify the inefficiency of guaranteed continual funding.

4.2 Design principles and choices that formed our CRIs need to be refreshed

4.2.1 *Company model of operation for CRIs*

The company model does not fit with an organization focused on providing long-term, often intangible or dispersed research benefits.

4.2.2 *Unproductive competition and barriers to collaboration across all research organisations*

In a two-speed system, defining the role of CRIs to focus on long-term challenges and Universities to focus on short-term responsiveness will enforce collaboration rather than unproductive competition.

CRIs will need to collaborate with Universities to solve short-term problems that arise, and Universities will be motivated to form healthy collaborations to access the guaranteed resources.

4.2.3 *Transactional stakeholder relationships*

Governmental engagement with Māori when setting the long-term funding for CRIs would guarantee Māori involvement at a deeper level than the need to box-tick for funding applications.

University involvement with industry and commercial end users is currently financially driven. Academic incentives are towards sponsorship of students, which is a long-term commitment, and I have observed can lead to over-promising of capability or results.

Because no workload time is allocated to consulting work, only certain types of academics are willing to take on short-term industrial/commercial projects.

The response time of commercial end users and academics is therefore a massive mismatch in perspective, exacerbated by miscommunication and misunderstanding of the value offered by either party.

4.2.4 *Inability to respond to system priorities and lack of adaptability*

Delineating the research responsibilities between CRIs and Universities will ensure that at least one type of organization is dedicated and motivated by the need to bring in funding to provide short-term responsive research.

This is in stark contrast to the conclusion stated in the Future Pathways document. “this makes a further case for lowering the boundaries between different types of research organisation.”

The opposite is true, differentiation of organizations is the key. Each having its own dedicated function (long-term or short-term) rather than producing an ineffective smear of organizations that are ‘jack of all trades, master of none’.

4.2.5 *Lack of coordination for large property and capital investments*

Optimization of system-wide infrastructure is a noble goal. From experience, I do not believe this is possible within the communication limitations and cultures of research organizations. In nearly all situations, there are not enough resources to provide specialist equipment users and high-capital cost

equipment is often not maintained or damaged by inexperienced users. This leads to protectionism of equipment, or its rapid deterioration.

4.4 *Key design choices for the future state*

4.4.1 *Organisational form, governance and structure*

KEY QUESTION 9: How do we design collaborative, adaptive and agile research institutions that will serve our current and future needs?

This is only possible by differentiation of the roles and responsibilities of the research organizations. The two-speed system outlined throughout this document is one way to achieve that differentiation.

The two-speed system will ensure there is distinct responsibility for long-term and short-term results, enforce collaboration between institutions, and retain agility through the university talent pool.

The idea of fewer, larger research institutions seems like the wrong direction. From experience in the U.S. National Labs system, corporate regulations and safety procedures associated with operating in large organizations result in low utilization rates of equipment, lab space, and employee time.

Additionally, the large corporate environment gives rise to metrics focused behaviour. With focuses on number of publications/patents/presentations, which are easy to measure and vital for individual career success, rather than outcomes or material benefits for stakeholders.

4.6 Better impact delivery – knowledge exchange and research impact

KEY QUESTION 13: How do we better support knowledge exchange and impact generation? What should be the role of research institutions in transferring knowledge to operational environments and technologies?

Commercialization pathways

It is important to note that organizations do not commercialize anything. Individuals do. Due to the low success rates in commercialization, there is little incentive for scientists or engineers to risk their stable-highly paid positions to take the risk of commercialization.

This has been evident from the Kiwinet Emerging Innovator and XF90 initiatives which achieve capability development in scientists and engineers.

Government funded research should adopt the same philosophy as privately funded research. In privately funded research, the university usually agrees that intellectual property will reside with the funder. In contrast, government funded research makes the university the intellectual property holder. This is in spite of the situation that the government often pays significantly more for research because it covers general overheads in addition to project costs.

The government should assert its right to the intellectual property (IP) and have the default position that the inventor/scientist is transferred the rights of the IP. This provides the inventor, who is often passionate, energetic, and dedicated to the idea, with the position of power that can be used to negotiate terms that will incentivise them to carry the research into the real-world *via* the commercialization pathway.

Note that this does not exclude the university from benefits. Universities are particularly adept at licensing technology, and can exchange their established processes for financial shares of the IP. Additionally, universities giving rise to successful start-ups benefit from reputational bonuses, organizational culture improvements, rental of space, and ongoing research and development funding.