



# HOW NOT TO INNOVATE: THE CASE OF AUSTRALIA'S BIONIC EYE

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*July 2019*

## Executive summary

### Questions of commercial viability

While Australia's bionic eye initiative had a clear goal — to build and commercialise a bionic eye — the initiative was launched without solid evidence that it could be successfully commercialised.

### Weak collaboration

In keeping with former Prime Minister Kevin Rudd's goal of building an Australian bionic eye, lead applicants for Australian Research Council support were Australian research and industry entities. Given the head-start international organisations held, this focus on Australian entities was a lost opportunity to build on results. There was, as well, poor collaboration between the research and industry partners.

### Structural barriers

One of the significant structural barriers to successful innovation is Australia's three-year political cycle. Incoming governments tend to 'knock over' projects, policies and budgets established by the previous administration. Governments also begin campaigning for the next election, generally within 18 months in office. Funding and policies are often chopped-and-changed.

Additional structural barriers include geographical distance between partners, making productive interaction difficult; a comparatively small population and, thus, a smaller talent pool; and the 'valley of death' where many early-stage results wither for lack of investment.

### Cultural barriers

Cultural barriers to innovation occur both within and between the political, research and industry arms of the system. The scientists, politicians, administrators, advisors, business executives and consultants peopling the system do not share the same values, goals and measures of success. They are often reluctant to talk to people outside their sector, and generally do not know how to do so.

## Recommendations

**Recommendation 1:** Establish Innovation and Science Australia as an independent and permanent agency responsible for developing and overseeing a national strategy for science and innovation in Australia and link the research and innovation activities of the political, academic and industry sectors.

**Recommendation 2:** Increase the Commonwealth budget for science and innovation to a minimum of 3 per cent of GDP.

**Recommendation 3:** Explore the adoption of a single and simplified approach to intellectual property across the university and publicly-funded research sectors.

**Recommendation 4:** Develop a flexible regulatory system for late-stage biotechnology developments.

**Recommendation 5:** Evaluate the performance of large, publicly-funded research projects such as the ARC's bionic eye initiative.

## Introduction

It's often said that when it comes to science and innovation, Australia punches above its weight. Yes, the nation's fundamental research is well-regarded internationally, but when it comes to commercialising its applied science, the nation plays well below par. Decades of government reviews and interventions have done little to boost Australia's ability to take its ideas to market.

Part of the difficulty is that, thanks to Australia's three-year political cycle, many federal policy and funding changes are short-term and scatter gun. This is where the Australian Research Council's Research in Bionic Vision Science and Technology initiative — the so-called bionic eye initiative — offers a productive way to explore the barriers to successful innovation in Australia. It is a lesson in how not to innovate.

Announced in 2008 at the end of former Prime Minister Kevin Rudd's 2020 Summit as a national goal, the initiative was, at nearly \$60 million over five years, an unusually well-funded project that sought to bring together the research and industry sectors. But this support was not enough to develop and commercialise an Australian bionic eye. In contrast, the first practical device entered the international market in 2011.<sup>1</sup>

A systemic analysis of the official and unofficial history of the initiative sheds light on the structures and processes that hinder successful innovation in Australia. The findings form the basis for a suite of interconnected, system-wide recommendations with the potential to attract bipartisan political support

and boost the effectiveness of Australia's innovation system as a whole.

The quality of Australia's research rates well on international rankings, but its ability to commercialise applied research is weak. Speaking on the nation's research and development (R&D) capability,<sup>2</sup> Bill Ferris, former chair of Innovation and Science Australia's board said, "Australia has internationally competitive 'R' and bugger-all 'D'".<sup>3</sup>

Ferris is not alone in making his claim. Previous analysis from the United States Studies Centre highlights the dilemma,<sup>4</sup> and a suite of internationally-respected metrics makes the case. In 2018, for instance, the Global Innovation Index (GII) ranked Australia 20th of 126 countries in terms of research performance. But on the measure of how much output 'bang' a country gets for its input 'buck' (its innovation efficiency), the nation ranked 76th. In contrast, New Zealand, with a population smaller than that of Sydney, ranked 59th in innovation efficiency.<sup>5</sup> Australia was dead last on the most recent (2017) OECD Science, Technology and Industry (STI) Scoreboard on a measure of high-growth enterprises.<sup>6</sup>

What can be done to maximise its intellectual activity, commitment and investment? The story of Australia's effort to create and commercialise a bionic eye — an implanted prosthesis for restoring functional vision in those with partial or total blindness — goes far to reveal some fundamental barriers to successful scientific innovation in Australia.<sup>7</sup>

The bionic eye initiative was established and funded by the federal government, which announced it as national priority and a showcase for Australian research and innovation. Building on the reputation of Australia for developing groundbreaking medical devices, following the success of the Cochlear implant, the development and commercialisation of bionic eye technology would have added significantly to Australia's innovation landscape. Ultimately, however, it is a telling example of how *not* to innovate, revealing barriers to successful innovation, from conception to conclusion.

Tellingly, the initiative was not a smooth tale in which exciting new science was developed in the lab and sent on the road to successful commercialisation. Instead, it was an enterprise weakened by poor research-industry relations. But the more important barrier to success was a weakly integrated science and innovation system, one subject to the vagaries of Australia's political cycle.

The bionic eye case is a particularly good example of a troubled R&D initiative and its lessons hold true more broadly. As an example of how not to innovate, a study of the bionic eye example leads to a suite of recommendations aimed at boosting the nation's ability to take applied science to market.

These recommendations focus on the lack of continuity in Australia's ad hoc innovation system, its funding shortfall, poor collaboration and hurdles in the process of translating advanced biotechnology into commercial products.

## The case of the bionic eye

When new governments come to office, they want to look productive and, above all, different from the previous administration. So, in April 2008 newly-elected Prime Minister Kevin Rudd held the Australia 2020 Summit. It was attended by 1,000 prominent Australians from diverse fields and triggered wide public engagement and much media fanfare. The task was to "shape a vision for the nation's future" and to discuss ways to meet "future challenges", wrote Rudd in his introduction to the government's response to the summit recommendations.<sup>8</sup>

The weekend event — co-chaired by Rudd and then-Melbourne University Vice-Chancellor Glyn Davis — generated hundreds of ideas, nine of which were

picked up as new initiatives by the Rudd Government. One of the nine was "research in bionic vision science and technology to support the development of the bionic eye in Australia". It was, said Rudd, "a huge public good that we should be engaged in".<sup>9</sup>

At the time of Rudd's announcement an international race to get a bionic eye product to market was already well underway. Research to build a bionic eye to help compensate for deficiencies in the vision pathway had begun in the United States in the 1960s and was well established there and in Europe in the 1990s.<sup>10</sup>

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In Australia, a Sydney group was investigating the concept. Led by ophthalmologist Minas Coroneo, who was affiliated with Prince of Wales Hospital and Sydney Eye Hospital, the group claimed to have developed a basic prototype for less than \$100,000 that they were going to trial with a single volunteer when key components for the system arrived from Sydney-based Cochlear Ltd. Cochlear is the manufacturer of the so-called 'bionic ear', a system for restoring hearing by stimulating nerves in the inner ear.<sup>11</sup> Coroneo's group was excited about Rudd's announcement, believing it meant the possibility of obtaining the funding they needed to conduct a more advanced trial.<sup>12</sup>

The prospect of government funding stimulated immediate and widespread interest. Researchers and organisations began jockeying for political attention, both behind-the-scenes and publicly through releases to the media which kept the story going in Australia and overseas, where potential collaborators were based.

Twelve months later, in April 2009, Commonwealth funding of \$50.7 million over four years for "the development of the bionic eye in Australia" was announced.<sup>13</sup> The funding would be provided through the Australian Research Council (ARC), the Commonwealth entity that administers the National

Competitive Grants Program. The ARC established a Special Research Initiative in Bionic Vision Science and Technology. "The funding will help Australia stay at the forefront of research and commercialisation," the announcement for the initiative stated, spruiking the competitiveness of the nation's overall research capability.<sup>14</sup>

Nationwide, however, researchers pursued possible scientific and industry collaborators to enhance their applications for funding. Soon, international players joined in, seeking Australian partners to help advance their own projects.<sup>15</sup>

Ultimately, seven applications were submitted to the ARC.<sup>16,17</sup> Among them was one from a University of Melbourne consortium; one driven by Coroneo (then affiliated with University of New South Wales (UNSW)), and fellow ophthalmologist Vivek Chowdhury at the University of Sydney; and another Melbourne collaboration based at Monash. The University of Queensland (UQ) entered a joint bid with the US bionic eye firm Second Sight and its collaborators at the University of Southern California's Doheny Retina Institute.<sup>18</sup>

Three proposals were shortlisted. Two were approved for funding: the University of Melbourne-led consortium (later named Bionic Vision Australia or BVA and, in 2016, Bionic Vision Technologies Pty Ltd) received \$42 million over four years; and the Monash University-led Monash Vision Group (MVG) was awarded \$8 million, also for the period 2010-2013.<sup>19</sup>

The initial ARC funding was extended for a year in July 2013. BVA received a further \$8 million and MVG, \$1.9 million.<sup>20</sup> Work continues today on MVG's prototype and two of BVA's four prototypes.<sup>21</sup> Both groups have worked with volunteers in the laboratory. But to date, only a single prototype, one of BVA's, has gone to clinical trial, announced in November 2018.<sup>22</sup>

From 2009 to 2014, the Australian government spent nearly \$60 million to develop the bionic eye. Although research was supported, students trained and prototypes advanced, Australia was beaten to commercialisation by the US-based Second Sight, whose joint funding bid with UQ was unsuccessful in obtaining ARC funding. In 2011, Second Sight received approval to market its Argus II Retinal Prosthesis System in the European Union and gained market

approval from the US Food and Drug Administration in 2013.<sup>23</sup> Additionally, Germany's Retina Implant AG and French firm Pixium obtained European market approval in 2013 and 2016, respectively.<sup>24</sup>

Second Sight reported net sales of US\$1 million in the first quarter of 2018 and had obtained US\$10 million in private investment in May of that year.<sup>25</sup> Its next-generation OrionTM Cortical Visual Prosthesis System was implanted in a human subject in the first quarter of 2018 with no reported serious adverse effects.<sup>26</sup>

Despite the Australian bionic eye initiative's comparatively poor track record — as with virtually all funding projects — there was no formal, independent review of either the success of the bionic eye initiative or the process of developing and supporting it. On its website, the ARC concludes: "The *commercialisation* of BVA's bionic eye implant is an impressive example of the translation of publicly funded research to deliver significant social and economic benefits to Australia."<sup>27</sup> Again, BVA's prosthesis has not been commercialised.

## What happened to Australia's efforts?

Go back to the 2020 Summit in 2008. A series of national goals were identified by participants, along with the recommendation to build and commercialise a bionic eye by 2020. Others included a deployable civilian emergency response capacity, an indigenous cultural education and knowledge centre, and mature age mentoring schemes.<sup>28</sup>

Such national goals serve to focus public, governmental, research and industry attention.<sup>29</sup> But announcing a laudable goal does not make it happen. As the original 'moonshot' demonstrates, odds of success soar when bolstered by a coherent and adequately funded implementation strategy that inspires observers and unites participants.

"We choose to go to the moon," US President John F. Kennedy told a crowd in Houston, Texas in September 1962. The Apollo program (1963-1972) organised the nation's talent and energy and made the goal happen under the auspices of the federally-funded National Aeronautics and Space Administration. The result is history.

### Questions of commercial viability

While the bionic eye initiative had a clear goal, the initiative was launched without solid evidence it could be successfully commercialised according to my participant interviews.<sup>30,31</sup>

Early in 2009, the ARC Special Research Initiatives (SRI) scheme was adopted by then science minister Kim Carr as the mechanism for reviewing applications and managing the distribution of funds for the bionic eye initiative. As such, the project had been authorised by the minister and would be funded by the government, not requiring further evaluation of the commercial viability. Similarly, the government would provide four years of funding, so there was no additional consideration of the time needed to build a commercial-ready prototype or of the level of overseas competition.

Given uncertainty over potential market demand, the head-start by overseas teams, and the limited time and funding available under the SRI scheme, it is unsurprising that an Australian bionic eye is not on the market — and may never be.

### Weak collaboration

In keeping with Rudd's goal of building an Australian bionic eye, lead applicants for ARC support were Australian research and industry entities. All chief investigators or partner investigators on winning applications represented Australian organisations. Similarly, all original collaborating and partner organisations were Australian. Given the head-start international organisations had developed, this focus on Australian entities was a lost opportunity to build on hard-won results to the benefit of all participants.

There was, as well, poor collaboration between the research and industry partners. Private sector participants put their name to applications with little enthusiasm, primarily offering in-kind support. Industry's general reluctance to collaborate with academe derives in part from sectoral differences, one being dissimilar measures of success. In a nutshell, academic performance is assessed largely using publications and grants as the metric, while industry rewards efforts to boost corporate profits and patents.<sup>32</sup>

Compounding this was the private sector's risk-averse approach to investment in research and development (R&D). Australian business expenditure on R&D as a percentage of GDP was just 1.0 per cent, around half that of the United States and Germany and less than a third that of Israel and South Korea.<sup>33</sup>

### Why did such challenges occur?

The obstacles discussed previously did not occur in a vacuum. They were shaped within Australia's overarching system for science and innovation, one cobbled together over the years in response to current events and political imperatives of the times. Moreover, without modification similar obstacles will continue to hamper Australia's ability to commercialise research. It is important, then, to identify the factors within the system which hindered progress of the bionic eye initiative in order to build strategies for reducing their future impact.

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Not all Australia's innovation barriers are unique. Many are faced by other nations, albeit dealt with more successfully due to integrated initiatives and policies devised to reduce their impact. Such interventions offer insight to Australian politicians and policymakers, as well as industry and research leaders. Some have been incorporated into the recommendations offered in this briefing.

### An overview

Twenty-nine participants in the ARC's Research in Bionic Vision Science and Technology initiative were interviewed in the development of this research, including those mentioned previously.

Participants came from a range of positions across the innovation system. They include politicians and policymakers; university and funding body representatives; consultants and industry partners; and scientists and clinicians. All were involved with Australia's bionic vision initiative at critical stages.

### **Structural barriers**

According to nearly all participants, the most significant structural barrier to successful innovation is Australia's three-year political cycle.<sup>34</sup> They observed that incoming governments tend to 'knock over' projects, policies and budgets established by the previous administration. This is in contrast to some democratic nations — for example, Germany, Sweden, Finland and the United States — which have built-in or built-up measures that promote continuity across their science and innovation systems. New Australian governments also seldom enter office with a deep understanding of the nature and dynamics of science and innovation.

Complicating this ever-changing environment, governments generally begin working towards the next election after about 18 months in office. As they seek to appeal to voters and maintain the support of critical constituents, short-term thinking prevails regarding policy, programs and the amount of funding allotted to them.<sup>35</sup>

The resulting chops-and-changes hinder the ability of the Commonwealth to establish and maintain long-term national strategies and priorities. The uncertainty also makes long-term planning difficult for the private sector, not to mention federally-funded research agencies, funding bodies and universities.

Day-to-day governance becomes difficult, particularly for research and industry managers forced to handle frequent changes in budgets, policies, programs and regulations. Changes to funding volumes and priorities are especially disruptive. Many projects are inadequately funded and/or cannot be completed within the two to four-year funding envelopes preferred by politicians.

Australia suffers from another structural barrier: historian and economist Geoffrey Blainey's tyranny of distance. Participants in research and innovation projects often are geographically distant. While the internet has profoundly altered human

communications, face-to-face communications are vital to building trust, enhancing relationships, and sharing ideas.<sup>36</sup>

This was a particular problem for the BVA consortium's Sydney and Melbourne researchers. They shared the consortium's funding, but pursued different projects in different locations. Over time, tensions developed, leading to a major rift involving researchers and BVA's board of directors and its Scientific Advisory Committee.

Australia's small talent pool is leaking, as early and mid-career (EMC) scientists often move overseas for better job prospects or leave active research entirely.<sup>37</sup> Recruitment of overseas talent seldom compensates for the loss, participants said, pointing to increasingly restrictive visa requirements and comparatively few attractive positions. They added that at the senior level, too, there are significant gaps in management and translation expertise within the innovation system. Projects and company boards often struggle to fill positions with suitably qualified people.

Finally, there is the 'valley of death'. A 2009 Australian government policy document characterises it neatly: "The passage from experimental development to commercialisation is so treacherous that high-tech start-ups call it the valley of death."<sup>38</sup> Australian prototypes often die there, lacking sufficient funding and expertise to finalise the largely government-funded prototypes and to manage the regulatory and intellectual property (IP) hurdles to translation. Like vultures, overseas entities hover, frequently snatching promising IP and even researchers.

### **Cultural barriers**

Nestled within the political, research and industrial arms of Australia's science and innovation system are people: scientists, politicians, administrators, advisors, business executives, consultants. Qualitative analysis of the bionic eye initiative revealed a host of interpersonal, political, attitudinal and organisational factors which — when combined with the previously mentioned structural barriers — affected the initiative's progress towards a prototype, ready for commercialisation. These cultural barriers to innovation occur both within and between arms of the system.

**Academic culture:** The picture emerging from participants is of a working environment coloured by interpersonal clashes and incompatibilities. Participants reported that many researchers, or they themselves, hesitate to collaborate in order to build and control a professional and publication profile in a specific research area. Why? Funding and publications are key criteria for career advancement. It's little wonder then that personality clashes are cited as a barrier to innovative research, along with reluctance to investigate risky but potentially productive areas of research.

With an unofficial mantra of 'meet the metrics', researchers also reported limited interest in collaborating closely with industry, adding that there's a tendency for researchers to look at business people with thinly-disguised disdain.

**Industry culture:** Conversely, interviewees noted that industry experts can be equally unwilling to collaborate with academic researchers, despite shared interests. They will put their name to joint applications for federal grants, which go to the researchers, but do so without enthusiasm and little commitment beyond the minimum in-kind support. To quote an industry interviewee: "We don't want to stand here and throw rocks at them... but we're not an active participant."

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### The 2017 OECD STI Scoreboard places Australia last out of 28 nations on the measure of business and research collaboration behind countries like Greece, Estonia and Chile.

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This aversion to collaboration by both the academic and industry sectors is reflected in international statistics. The 2017 OECD STI Scoreboard places Australia last out of 28 nations on the measure of business and research collaboration behind countries like Greece, Estonia and Chile.<sup>39</sup> The phenomenon derives in large part from the vast cultural differences between the sectors. These include different measures of success — publications and grants versus patents and profits — as well as different values, understandings, mutual expectations and patterns of behaviour. The differences

are heightened by the fact that few academics have industry experience and vice versa.

**Political culture:** Although people in the political sector are generally comfortable interacting with those in industry, numerous stumbling blocks impede efforts by researchers and university administrators to interact with politicians and their advisors. Interviewees suggested a key hurdle is the failure by many academics to recognise that the political class seldom has a grasp of the scientific process, its complexity and timelines. Further, politicians and their advisors must deal daily with the realities of governing and retaining office.

## What can be done?

Clearly, Australia has a problem. The nation's system for commercialising its applied science is bedevilled by structural and cultural barriers. There is no simple solution, but all is not lost. By looking at these barriers broadly, not individually, it is possible to identify changes which, if taken together, may enhance performance.

To that end, a mix of policy actions are offered, building on a review of relevant literature, from academic analyses to government and stakeholder reports, as well as the rich data drawn from participant interviews.<sup>40</sup> These recommendations match the four main challenges arising from participant interview themes. They are:

- A lack of continuity in Commonwealth policy, programs and structures. Challenges are triggered by frequent changes in governments.
- Inadequate and inefficiently managed funding for research and development. Academic and industry stakeholders struggle to plan, budget for and manage their activities.
- Poor levels of collaboration within and between the university and industry sectors. Challenges arise from the differing academic and industry cultures, as well as barriers to productive collaboration, primarily within academe.
- A difficult environment for research translation. In Australia, it is difficult to manage the legal and regulatory complexity of taking a new product or process across the 'valley of death' to market.

## Continuity

**Recommendation 1:** Establish an independent and permanent agency responsible for developing and overseeing a national strategy for science and innovation in Australia. This agency would link the research and innovation activities of the political, academic and industry sectors.

Numerous international reports, reviews and academic papers point to models proven successful globally. Relevant examples include experiences from Finland, Sweden, Germany and Israel.<sup>41</sup>

As part of its 2015 National Innovation and Science Agenda, the Turnbull government announced the formation of Innovation and Science Australia (ISA), responsible for researching, planning and advising the government on science, research and innovation matters. With legislative backing ISA could serve as the seed for the recommended agency and seek to meet the following objectives:

- Reduce disruptive changes to science and innovation policies, priorities and administrative structures triggered by the political cycle.
- Enhance the quality and continuity of long-term planning and evidence-based policy formation within government.
- Stabilise planning processes at the academic and industry levels to facilitate effective administration and program formation.
- Provide an intellectual and policy framework for building the integrated programs and critical infrastructure needed to implement the funding, collaboration and translation recommendations.

## Funding

**Recommendation 2:** Increase the Commonwealth budget for science and innovation to a minimum of 3 per cent of GDP.

At first glance, Australia's financial commitment to science and innovation looks generous. Out of 126 nations ranked in the 2018 GII, Australia ranks 19th in gross expenditure on R&D by percentage of GDP.<sup>42</sup> But compared to Israel (4.3 per cent) and South Korea (4.2 per cent) Australia's commitment of 1.9 per cent GDP pales. Other innovative nations — Japan, Switzerland and Sweden — spend more than

3 per cent of GDP on R&D. In addition to these five countries, Australia spends less of its GDP on R&D than 13 others including Germany, Finland, Belgium and the United States.

Policy experts have considered the issue. They conclude that Australian science and innovation must be supported more generously if the nation wants to maximise its R&D effort and be globally competitive. While it may seem an arbitrary figure, many recommend that the Commonwealth invest at least 3 per cent of GDP in R&D.<sup>43</sup>

The increased funding would support the following objectives:

- Provision of funding for policies and programs developed under the national strategy for science and innovation in Australia discussed in Recommendation 1.
- Increased and consistent support to the national science funding bodies, the ARC and the National Health and Medical Research Council, enabling them to:
  - Fund more high-quality applications and fund project extensions where appropriate, as not all worthwhile projects can be completed within the standard 3-4-year grant period.
  - Increase and retain Australia's scientific talent pool by providing more opportunities for EMC researchers who rely heavily on post-doctorate grants to build a career, and by encouraging the return of senior Australian-trained scientists by offering well-funded research programs.
- Establishment of a government-funded, pre-commercial procurement program to drive private sector investment in R&D. Such programs encourage small to medium-sized enterprises to conduct market-oriented R&D by supporting development of products and services not commercially available but required by governments. One of the longest running is the Small Business Innovation Research (SBIR) program, launched in the 1970s in the United States.<sup>44</sup>

## Collaboration

As in the case of the bionic eye initiative, collaboration is often poor between the academic and industry sectors, as well as between researchers themselves.



Opportunities are then lost to broaden the questions asked, to widen networks, and to spread expertise and resources critical to taking prototypes to market.

In terms of intra-researcher collaboration, participants in my research note that individual universities are extending metrics used to assess researcher performance to include measures of engagement and impact. These efforts fit neatly with an ARC project to reshape measures aimed at evaluating the performance of Australian universities regarding their non-academic impact and their industry and 'end-user' engagement. The 2018-2019 Engagement and Impact Assessment National Report is the first such report released and provides a set of outcomes that will be crucial in building innovation frameworks going forward.<sup>45</sup>

These efforts are to be commended, however, they cannot stand alone.

### Translation environment

'Translation' is the final stage in the complex, iterative, intensely human process of innovation. It is the stage during which product or process prototypes are refined then diffused and integrated into the wider society. This is how a nation maximises the benefits of its research capacity.<sup>46</sup>

**Recommendation 3:** The Commonwealth should explore the adoption of a single and simplified approach to intellectual property (IP) across the university and publicly-funded research sectors.

Adoption would reduce what the Australian Industry Group (AIG) describes as "a confusing mass of idiosyncratic contracts and internal procedures that can be expensive and time consuming for business to navigate". As the AIG also argues, universities often encourage researchers to claim so much of the real or potential IP that firms see no value in partnering with the sector. Disagreement over IP can, as evidenced by the bionic eye case study, "nip collaboration in the bud".<sup>47</sup>

One approach is the Easy Access IP model. It uses a simplified one-page contract to provide companies and individuals with free access to research findings for three years in return for significant financial investment. Brought to the UNSW in 2011 by its UK founder, Kevin Cullen, the model has been adopted by 26 global research organisations and seven Australian universities.<sup>48</sup>

**Recommendation 4:** Develop a flexible regulatory system for late-stage biotechnology developments.

Rigid regulatory regimes can hinder biotechnology translation by increasing compliance costs and delays.<sup>49</sup> Introduction of a flexible regime which permits universities and/or businesses to test or trial prototypes more efficiently and cheaply, while providing community safeguards, would help boost commercialisation of new products and processes.

As noted in the CSIRO's review of future opportunities for medical and pharmaceutical advances, a model exists which could be adapted.<sup>50</sup> The Commonwealth could commission Health Safety Environment Australia to oversee adoption of this recommendation.<sup>51</sup>

**Recommendation 5:** Evaluate the performance of large, publicly-funded research projects such as the ARC's bionic eye initiative.

Australia's science funding bodies, the ARC and the NHMRC, require grant recipients to provide performance reviews. This is appropriate. What does not occur is independent evaluation of the performance of large, publicly-funded projects such as the bionic eye initiative. This is a lost opportunity to identify strengths and weaknesses in the operation of the nation's science and innovation system.

The bionic eye initiative is a case in point. If it had been formally evaluated by independent experts, significant barriers to innovation would have been identified from establishment of the project and development of the funding applications to the research process itself.

## Endnotes

1. See <http://retinalprosthesis.com/assets/pdfs/20110906-second-sight-release-ee.pdf>
2. The OECD define Research and Development (R&D) as covering three activities: basic research, applied research, and experimental development. <https://stats.oecd.org/glossary/detail.asp?ID=3111>
3. Quoted in Hartcher, Peter. "Technological breakthrough needs a follow-up," *The Sydney Morning Herald*, 15 March 2014. Accessed online: <https://www.smh.com.au/politics/federal/technological-breakthroughs-need-followup-20140314-34s0s.html>
4. McFarland, Claire., Mondschein, Jared, & Meers, Zoe. *Failure to Launch: Australia, the United States and the threat of inefficient innovation*. United States Studies Centre at the University of Sydney. Last modified November 13, 2017. <https://www.ussc.edu.au/analysis/australia-the-united-states-and-the-threat-of-inefficient-innovation-failure-to-launch>.
5. See <https://www.globalinnovationindex.org/gii-2018-report#>
6. See <http://www.oecd.org/sti/oecd-science-technology-and-industry-scoreboard-20725345.htm> The definition of high-growth enterprises recommended is as follows: All enterprises with average annualised growth greater than 20% per annum, over a three-year period should be considered as high-growth enterprises. Growth can be measured by the number of employees or by turnover.
7. The story of the bionic eye initiative is the case study of my 2017 PhD dissertation *Australia's Quest for the Bionic Eye: Barriers to Innovation*. The work was conducted at Macquarie University.
8. Government of Australia. (2009b). *Responding to the Australia 2020 Summit*. Canberra: Commonwealth of Australia. [http://www.tda.edu.au/resources/20020\\_Summit\\_paper.pdf](http://www.tda.edu.au/resources/20020_Summit_paper.pdf).
9. Davis, Mark. 2020 vision: Rudd summit to map future. *The Sydney Morning Herald*. Last modified February 4, 2008. <http://www.smh.com.au/news/national/2020-vision-rudd-summit-to-map-future/2008/02/03/1201973740462.html>.
10. Rizzo, Joseph F. & Wyatt, John. "Prospects for a Visual Prosthesis", *The Neuroscientist* 3, no. 4 (1997): 252-262.
11. Rudd's announcement disrupted the trial which never went ahead.
12. Dayton, Leigh. Bionic eye team sees far into the future. *The Australian*. Last modified July 5, 2008. <http://www.retinaaustralia.com.au/documents/bioniceyeteamseesfarintofuture.pdf>.
13. See <https://www.couriermail.com.au/news/national/just-nine-2020-ideas-get-the-go-ahead/news-story/3948575673e4ccf8d988e13c6642bb9?sv=51127428fb3f4fa9d9816c6bde25e990>
14. See <http://archive.industry.gov.au/ministerarchive2011/carr/MediaReleases/Pages/2020GIVESRESEARCHBOOSTFORBIONICEYE.html>
15. For details of the project application requirements see <https://www.legislation.gov.au/Details/F2009L02869>
16. See ARC document "Call for Proposals for the Research in Bionic Vision Science & Technology Initiative". See [http://www.arc.gov.au/sites/default/files/filedepot/Public/NCGP/SRIs/PDF/SRI\\_BE\\_call\\_proposals.pdf](http://www.arc.gov.au/sites/default/files/filedepot/Public/NCGP/SRIs/PDF/SRI_BE_call_proposals.pdf).
17. The ARC declined to identify unsuccessful bidders citing confidentiality.
18. Coroneo & Chowdhury, Queensland, and Second Site considered forming a consortium, but it did not progress due to commercial conflict between the US and Australian commercial participants (e-mail correspondence between the proponents; participant interviews).
19. The Selection Advisory Committee comprised: Dr Mike Hirshorn, Director, Four Hats Capital Pty Ltd (Chair); Professor Philip Luthert, Institute of Ophthalmology, Director & Head of Division of Pathology, University College London; Professor Mike Calford, Deputy Vice Chancellor (Research), The University of Newcastle; and Mr David Money, a retired biomedical engineer (Correspondence from Dr Liz Jazwinska ARC to Professor Minas Coroneo provided to author).
20. See <http://www.arc.gov.au/news-media/media-releases/10-million-continue-bionic-vision-research>

21. See <https://www.monash.edu/bioniceye/about-us>
22. See <http://bionicvis.com/our-products/bvt-technology-pipeline/>
23. <http://investors.secondsight.com/news-releases/news-release-details/second-sight-medical-products-receives-fda-approval-argus-ii>
24. <https://www.blindness.org/foundation-news/alpha-ims-becomes-second-bionic-retina-approved-europe> and [http://www.pixium-vision.com/file\\_bdd/dynamic\\_content/file\\_pdf\\_pdf\\_en/1469398551\\_Pixium\\_Vision\\_CEmarkIRISII-ENG-FINAL-FINAL-CLEAN.pdf](http://www.pixium-vision.com/file_bdd/dynamic_content/file_pdf_pdf_en/1469398551_Pixium_Vision_CEmarkIRISII-ENG-FINAL-FINAL-CLEAN.pdf), Retina Implant AG's fundamental research was conducted by a consortium of academic groups and research institutions, enabled by German research funds in the mid-1990s. Following on from the initial funding, in 2003 business angels provided support for the development of prototypes, clinical trials and certification. In 2004, Retina Implant was incorporated as a not-publicly listed, stock-holding company. <https://www.retina-implant.de/en/company/who-we-are/>.
25. Second Sight Reports First Quarter 2018 Financial Results <http://investors.secondsight.com/news-releases/news-release-details/second-sight-reports-first-quarter-2018-financial-results>.
26. See, <https://www.healio.com/ophthalmology/retina-vitreous/news/online/%7B5f579b23-77e7-479c-9979-6b7198a0e81f%7D/first-patient-receives-orion-cortical-visual-prosthesis>
27. <https://www.arc.gov.au/news-publications/publications/making-difference-outcomes-arc-supported-research-2016-17/bionic-eye-implant-restoring-sense-vision>
28. The others were: a Prime Minister's Asia-Australia cultural scholarship, a dedicated ABC children's channel, a business-school roundtable, a carbon challenge initiative and a vocational education broadband network. See [http://pandora.nla.gov.au/pan/81461/20110310-0438/www.australia2020.gov.au/docs/government\\_response/2020\\_summit\\_response\\_full.pdf](http://pandora.nla.gov.au/pan/81461/20110310-0438/www.australia2020.gov.au/docs/government_response/2020_summit_response_full.pdf).
29. For example, Innovation and Science Australia's Australia 2030: Prosperity through Innovation sets out National Missions for Australia. <https://www.industry.gov.au/data-and-publications/australia-2030-prosperity-through-innovation>
30. The participants in my case study represented relevant groups involved with the bionic eye initiative: politicians and their advisors, researchers, consultants, and representatives from funding bodies, academe, and industry.
31. Unless statements such as this one are referenced, the information comes from my research participants.
32. In her 2005 article, *Antipodean audits: Neoliberalism, Illiberal governments and Australian universities*, *Anthropology in Action*, 12(1), 31-47, Margaret Jolly notes that since the 1980s the performance of academics is assessed by audit-oriented measures. Publication and grant success are easily calculated.
33. Australia's expenditure on research and development compared with peers, 2015 <http://www.oecd.org/sti/msti.htm>
34. Although the Australian Constitution the House of Representatives — the dominant policy-making chamber—may sit no more than three years, parties, even prime ministers, may change more frequently. Between December 2007 and the present there have been 7 prime ministers.
35. Compared to other developed nations, the bulk of Australia's R&D funding comes from the federal government with limited contributions from the private sector. See for example, <http://uis.unesco.org/apps/visualisations/research-and-development-spending/> and <https://www.austrade.gov.au/News/Economic-analysis/core-arguments-and-facts-of-the-2017-benchmark-report-innovation>
36. Björn Asheim and colleagues discuss the importance of face-to-face communication in science in their paper *Face-to-face and buzz, and knowledge bases: Sociospatial implications for learning, innovation, and innovation policy*. *Environment and Planning C: Government and Policy*, 25(5), pp. 655-670.
37. The EMC brain drain is known informally as the 'postdocapypse'. Statistics are cited by the 2016 workforce survey by the Australian Society for Medical Research (ASMR), <https://asmr.org.au/wp-content/uploads/library/Workforce16.pdf>, and the Australian Council of Learned Academics' 2016 research training system report <https://acola.org.au/wp/PDF/SAF13/SAF13%20RTS%20report.pdf>.

38. Government of Australia. (2009). *Powering ideas: An innovation agenda for the 21st Century*. Canberra: Commonwealth of Australia.
39. See [https://www.oecd-ilibrary.org/docserver/sti\\_scoreboard-2017-20-en.pdf?expires=1556622725&id=id&accname=guest&checksum=DC7D5F255C06316EB05006CE2C780331](https://www.oecd-ilibrary.org/docserver/sti_scoreboard-2017-20-en.pdf?expires=1556622725&id=id&accname=guest&checksum=DC7D5F255C06316EB05006CE2C780331)
40. Further details of the recommendations that follow, along with details of others not included here, are covered in my PhD.
41. See <https://apo.org.au/sites/default/files/resource-files/2015/11/apo-nid59036-1172906.pdf>; [https://www.go8.edu.au/files/docs/go8backgrounder29\\_finland-1.pdf](https://www.go8.edu.au/files/docs/go8backgrounder29_finland-1.pdf)
42. See [https://www.globalinnovationindex.org/userfiles/file/reportpdf/gii\\_2018-report-new.pdf](https://www.globalinnovationindex.org/userfiles/file/reportpdf/gii_2018-report-new.pdf)
43. See [https://www.aph.gov.au/Parliamentary\\_Business/Committees/Senate/Economics/Insolvency\\_construction/Report](https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Insolvency_construction/Report); <https://www.smh.com.au/opinion/australia-being-left-behind-in-the-innovation-stakes-20151011-gk68ro.html>
44. See Scott-Kemmis, Don. "What Australia can learn from SBIR," *InnovationAus*, 11 March 2019: <https://www.innovationaus.com/2019/03/What-Australia-can-learn-from-SBIR>
45. See <https://www.arc.gov.au/engagement-and-impact-assessment/engagement-and-impact-assessment-2018-outcomes>
46. See Beard, et al., 2009, A valley of death in the innovation sequence: An economic investigation. *Research Evaluation*, 18(5), 343-356. Doi: 10:3152/095820209x481057
47. See AIG (2016), Joining forces: Innovation success through partnerships. [http://cdn.aigroup.com.au/Reports/2016/JoiningForces\\_Innovation\\_success\\_through\\_partnerships\\_Sept\\_2016.pdf](http://cdn.aigroup.com.au/Reports/2016/JoiningForces_Innovation_success_through_partnerships_Sept_2016.pdf)
48. See [https://www.knowledgeexchange.unsw.edu.au/sites/default/files/documents/guidelines/Easy%20Access%20IP%20for%20Business\\_Final2.pdf](https://www.knowledgeexchange.unsw.edu.au/sites/default/files/documents/guidelines/Easy%20Access%20IP%20for%20Business_Final2.pdf)
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50. CSIRO (2017). *The medical technologies & pharmaceuticals (MTP) roadmap — Unlocking future growth opportunities for Australia*. <https://www.csiro.au/en/Do-business/Futures/Reports/Medical-Technologies-and-Pharmaceuticals-Roadmap>
51. See <http://www.hseaustralia.com.au/>

## About the author



### Dr Leigh Dayton

Building on her career as a multi-award-winning science writer and broadcaster, Leigh Dayton completed a PhD at Macquarie University in 2018. Her topic was Australia's quest for the bionic eye and the barriers to innovation. The Innovation and Entrepreneurship Program at the United States Studies Centre commissioned Leigh to turn her research into this report, which contributes to the ongoing discussion about innovation in Australia.

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### Acknowledgements

I want to thank the United States Studies Centre for recognising formally the importance of science and innovation with the establishment of the Innovation and Entrepreneurship Program. The program provides an invaluable opportunity to discuss rigorously the realities, positive and negative, embedded in the nation's research and development system. Specifically, I owe a large 'thank you' to Claire McFarland and Jared Mondschein for breaking with tradition and commissioning this piece, based on my PhD.

Regarding the PhD, I must note the excellent support I received from my Macquarie University supervisors: Wendy Rogers, Katrina Hutchison and Lisa Wynn. I also owe a debt of thanks to Roy Green at the University of Technology Sydney; Lars Coen, formally of Lund University and now Melbourne University; and the University of Queensland's Mark Dodgson. They helped turn my doctoral draft into a real-world PhD. Thank you all.

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Cover photo: Getty Images

#### **This publication may be cited as:**

Leigh Dayton, "How not to innovate: The case of Australia's bionic eye"  
United States Studies Centre at the University of Sydney, July 2019.

Briefs published by the United States Studies Centre are anonymously peer-reviewed by both internal and external experts.



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