

Boosting the commercial returns from research

Submission by Phil McFadden

Introduction

As one would expect from Professor Chubb and his team, **SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS: AUSTRALIA'S FUTURE** is an excellent document in which it states "*Australia is now the only country in the OECD not to have a current national strategy that bears on science and/or technology and/or innovation*" and that "*The Chief Scientist here puts forward a strategic approach to STEM as a recommendation to government*".

Professor Chubb's document provides an excellent tactical response but it still needs a strategic framework in which to be applied most effectively.

An effective and appropriate strategy has to incorporate a clear policy position of the Australian Government, with regard to the integration and utilisation of science, articulated by the Prime Minister. In essence, it is necessary to state that

The policy of the Australian Government is to develop science and scientific research into an effective national capability and to integrate it into all aspects of government and Australian life to ensure maximum effect in improving the safety, security and well-being of Australians while contributing positively to the nation's sustainability and wealth.

The current document, "**BOOSTING THE COMMERCIAL RETURNS FROM RESEARCH**", edges towards making such a policy statement. If this were indeed the policy position of the Australian Government then I feel we would need to add some considerations to the Chief Scientist's paper and to the current document.

I am in agreement with the Chief Scientist's paper and with most of what is in the current document. Hence I restrict my comments to those instances where I am not convinced of the suggested approach and where I think additional consideration might be helpful.

Education

Education is, of course, a central component not only of ensuring that we have a workforce with the necessary skill base but also with appropriate attitudes as to how their skill base is to be used.

Recently there has been a lot of discussion regarding the joys of free education, including at tertiary level. There is little doubt that a well-educated populace is key to a thriving and balanced society with a healthy economy; appropriate education is a key investment for a nation. Equality

of opportunity, while not pretending to guarantee equality of outcome, is central to the health of a society. Thus the concept of free education is seductive.

Of course there is no such thing as "*free*" education, someone has to pay the bill. The question is whether providing everyone in the nation with unfettered access, paid for by the community at large, to all levels of education is in fact a good investment for the nation. Sadly, the evidence suggests not.

It would seem that here in Australia, access to free tertiary education did not draw in large numbers of students from low socio-economic-status backgrounds. This is of course a consequence of the interplay of a complex set of issues but the policy failed to achieve one of its major goals. There are notable exceptions but at the broad scale one major consequence of the policy was that those from low socio-economic-status backgrounds helped pay for the education yet did not avail themselves of it.

Furthermore, because of the absence of discipline in the process (an unwillingness to deal effectively with poor performance, with those seeking a style of education for which they were not suited or with those merely accumulating a range of qualifications but never contributing back to the society that was funding them), the costs blew out and so the investment became unsustainable.

The policy of choice in Australia then became HECS and HELP and this has enjoyed a level of success. Currently the income threshold to start repaying the debt is \$53,345. So this has created the rather odd situation where, in effect and as a generalization, the nation continues to provide free tertiary education to the very people who demonstrate that it was a poor choice for the nation to invest in them.

As is well-recognised, nature distributes intelligence and proactive character regardless of economic status, race, creed, sex, et cetera. Hence, surely the policy position for the nation should be to invest in the education of those (again regardless of economic status, race, creed, sex, et cetera) who have the aptitude (intelligence and character) to make effective use of their education and so represent an effective investment. This is unashamedly an elitist position but it is amazing how high is the percentage of people who, with the right incentives and opportunities, can achieve excellence and so drive a bigger, better, stronger elite. If Australia is to compete and win on the international scene, this is a necessity.

For me, two things stand out as important actions to achieve such an outcome.

First is the provision of scholarships to those who are showing clear promise. This provides a mechanism for the nation to invest in those who provide the evidence to suggest that they will be a good investment. The system should include a mechanism to terminate the investment should an individual's performance deteriorate; those individuals would of course be free to choose to make their own investment in their education. Thus there is a mechanism to target effective investment while providing the discipline to avoid an unsustainable blowout in costs.

Second, it is important to be proactive in getting to young, bright people, particularly from low socio-economic-status groups, early in their schooling to change their aspirations and trajectories. Many kids from low socio-economic-status groups do not know enough about a university education to understand the potential that it has to enrich their lives and their contribution to the nation and, furthermore, they do not believe (often quite incorrectly) that they could ever attain such heights. It is important to get to them young to change their perceptions so that they see a university education as both desirable and attainable and to have the confidence to strive for an appropriate scholarship.

The Core Responsibility of Universities

Despite the fact that Australian universities are now effectively business entities in their own right, they do receive substantial government funding. This should imply a core responsibility to provide education that matches the priority needs of the nation.

Yet in recent times we have seen individual universities making ad hoc decisions about closures or restructures of programs (particularly STEM and the linkages between STEM and business/entrepreneurship) that go to the strategic needs of the nation. It would seem that those decisions are sometimes made on the basis of the individual profitability of those programs to that particular university and do not necessarily take into account the national strategic impact of those programs nor whether strategically important programs are sufficiently catered for by other universities. Given the economic drivers for university businesses, this is almost inevitable without external intervention.

There needs to be a national approach taken to ensure that the university sector as a whole provides sufficient accessibility and encouragement for Australians to programs of national importance.

Industry-led or Industry-focused

In the **BOOSTING THE COMMERCIAL RETURNS FROM RESEARCH** document there is a concentration of thought on initiatives that are industry-led rather than initiatives to build genuine industry-science partnerships that are industry-focused. There is, to my mind, a genuine distinction.

In an industry-led structure, industry is relatively free to demand that researchers provide solutions to specifically identified problems. However, experience shows that this will not necessarily focus research on the underlying issue faced by industry but instead often on a subordinate issue that the industry thinks will solve the underlying problem. Until genuine trust is built, this is often because of the unwillingness of companies to expose the underlying issues for fear of losing commercial advantage. Overall this often leads to suboptimal "*solutions*" provided by the researchers and thence to dissatisfaction in the industry.

I proffer the UNCOVER initiative as an example of an industry-focused partnership between industry, government and academia and as a possible model for other partnerships. I append the strategic plan of that initiative. Critical to success, as indicated in that strategy, is open and clear

articulation from the industry about the scientific and technical (underlying) issues that genuinely impede their success followed by serious and hard-nosed discussion between industry- and research-leaders, as equal partners, to define and refine the important scientific questions, ensure that those questions are indeed amenable to resolution in a reasonable timeframe and then determine the best approach to resolving those questions. The goal is to make much more effective use for industry of the research funding that is already provided.

For such partnerships to work there has to be genuine trust across the community. This means that the administration of such partnerships either has to be funded by the whole community or not by the community at all. The former is unlikely before trust is built. Unfortunately government does not fund the administration of these type of initiatives and so it is currently hard to build them.

Genuine partnerships that are industry-focused will not only lead to just as much '*demand-pull*' for research but are likely to lead to far more effective solutions. Building the science and its applications in a dynamic partnership with industry so that the industry can remain interactive in the prosecution of these questions and the effective deployment of the new knowledge is probably the most effective way of creating research that will readily translate into commercial outcomes.

Science in the 21st century, Applied Science, and the ARC

Reductionist science has served us well in the past century. However, to bring genuine value to society, science in the 21st century is going to have to become substantially more effective in dealing with complex systems (such as mineral exploration under cover or providing the knowledge for effective management of systems such as the Murray Darling Basin or the Great Barrier Reef). I make a pointed distinction here between complicated systems (where enough reductionist science can usually provide a complete explanation) and complex systems (where it cannot).

This is not to say that we should walk away from reductionist science - far from it. Basic curiosity-driven research in electricity led to the electric light and no amount of targeted R&D on candles would have achieved such an outcome. But we need to get better at system science and we need to put in place funding systems and innovation mechanisms that will facilitate this.

Currently the structure and ethos of the ARC is better-suited to facilitating the prosecution of high-quality reductionist science than to facilitating the multi- and inter-disciplinary research needed to deal with complex systems. This needs to evolve.

Many will argue that if we are to improve the commercial returns from research then we should shift the weight of our research to what many people call "*Applied Science*". This would be unfortunate because on the one hand this appellation is sometimes used as an excuse for lower quality and on the other hand it is often inferred that if it is applied science then somehow it is of an inferior status and/or quality.

There is no such thing as "*applied science*"; instead there is "science" and there are "*applications of science*".

In, for example, the UNCOVER initiative it is the aspiration that the science undertaken will have application and that those applications will be a significant component of the knowledge used to make decisions regarding investment of tens or even hundreds of millions of dollars. Hence the science undertaken and delivered has to be extremely robust and of the highest possible quality. Amongst other things, this imposes two demands upon the researchers. First that the problems addressed will actually make a real difference when solved and second that the effort goes into problems for which it is reasonably likely that significant advances can be made in a realistic timeframe, whilst welcoming and embracing the inevitable serendipitous advances. This should be the case for all research undertaken with industry/commercial applications in mind.

This does not make the science inferior in any way. Indeed, quite the contrary and this will need to be recognised and embraced by funding agencies if we are to improve the performance of our science in the industry/commercial world.

It should be possible for an industry/government/academic community (such as, for example, UNCOVER), working in an area of priority for the nation, to come together as a partnership and distil the scientific questions that need to be addressed in order to remove major impediments for the industry and then to inform ARC that "*Solution of these problems deserves priority in terms of research funding*". This would then define priority areas for investigation without specifying individual researchers to undertake the necessary work. Knowing that such an area is a priority for funding, it is highly likely that a greater number of researchers would apply for funding to work on those questions and the ARC could allocate research funding strictly on the basis of quality through its usual, but preferably improved for system science, competitive processes.

At all levels, quality of the science is critical. Funding poor-quality science on the basis of inappropriate proxies and then delivering that science to industry will, in the long term, prove disastrous. Industry both needs and deserves the science to be top quality and robust so that they can invest reliably on the basis of that science.

On this point it is worth noting that the *number* of patents held by a researcher is not necessarily a good proxy for the quality of their research. If extant patents are to be used as a partial determinant of the allocation of research funds then a carefully nuanced approach is required.

At the executive level, the ARC has a Chief Executive Officer and five professor-level Executive Directors (EDs). Each of the EDs has responsibility for a disciplinary grouping such as "*Physics, Chemistry and Earth Sciences*". Each of these disciplinary groupings spans an enormous range of individual disciplines and, despite the support these EDs receive from the ARC College of Experts, it is unrealistic to expect them to understand and anticipate the nuances across the whole of their grouping. If we wish the ARC to be instrumental in boosting the commercial returns from research, it might be worth considering an increase in the number of EDs.

Translation of research into commercial outcomes

Using the minerals exploration industry as an example, there is a wealth of industry-relevant high-quality research that has already been undertaken (that is, research for which we have already paid) but is not being utilised by the industry.

The problem is that the industry community and the research community have different cultures. The researcher will say "*The knowledge is there in our papers, just find it and use it*" while the minerals explorer will say "*I don't have either the tools or the time to find that knowledge and even if I did it is not packaged in a way that is useful to me.*"

UNCOVER is hoping to create projects that will trawl through the appropriate academic literature, find the relevant knowledge and package it in a manner that is useful to the industry practitioners. The cost of such projects will be small compared with the investment that has already been made in creating the knowledge that is not used.

Naturally it is far more efficient and effective to build the research in collaboration with the industry and then to keep industry actively engaged in the prosecution of the research and the deployment of the resulting knowledge.

NCRIS

As acknowledged in the current document, world-class infrastructure is known to drive national research excellence and high-quality research is a driver of innovation. Appropriate industry engagement can also be an effective driver of research excellence.

Prior to the National Collaborative Research Infrastructure Strategy (NCRIS), Australia did not have an efficient model for providing national research infrastructure that was effective at underpinning and driving high-quality research and innovation.

Key elements of NCRIS that have contributed to its success include the following:

- Driving the program on the basis of a set of principles targeted at outcomes;
- Development of facilities that each created a national *capability* rather than having facilities that catered to individual scientific disciplines;
- Strategic decisions by a well-informed, high-level, active and engaged committee regarding the capabilities that the nation needed to be developed rather than a competitive process that would favour those with a well-oiled application mechanism;
- A decision to invest larger amounts of money into a smaller number of facilities to ensure that the facilities created were actually viable;
- A flexible approach to co-investment;
- Broadly-based collaboration;
- Development of KPIs specific to each of the facilities so as to drive the right behaviours rather than having a generic set of KPIs that would inappropriately distort the behaviours.
- Access (in order genuinely to constitute infrastructure, the facilities had to be able to facilitate innovative high-quality research projects from a wide range of researchers, regardless of their seniority and reputation and regardless of whether they were from academia, PFRA or industry/business); and, critically

- The inclusion of funding for top-level people (both technicians and researchers) to provide wise and expert advice and support to clients of facilities.

Since its inception the NCRIS program, through its facilities, has improved the performance of Australian research in seminal ways, including:

- A much greater utilisation of equipment purchased, so money that was previously wasted on under-utilised equipment has been freed up;
- Because of the inclusion of highly-skilled people as part of the infrastructure, a substantial improvement in the effectiveness of the equipment in driving high-quality research and innovation;
- The availability of high-quality, nationally significant data streams;
- A far more coherent and advanced approach to the use of information technology and information management;
- The development of several major innovations within the infrastructure facilities themselves; and
- Accessibility of the infrastructure and expert advice to researchers in industry and business who would not previously have been able to access the necessary equipment that was almost invisible to those outside the academic framework.

NCRIS is based on a national-level collaboration and runs on an ethos of providing service to the research community at large. It is important to recognise that the community NCRIS serves is much broader than just the university research community. By contrast, the NHMRC and the ARC dominantly serve the university sector and operate on the basis of competition to drive the quality of individual research projects. Hence it is sensible and wise to keep separate the operations of NCRIS and of these two funding agencies but the nation would be better served with a closer alignment of their strategic intents, particularly if we wish these programs to be more effective in boosting the commercial outcomes of research.

After termination of the original NCRIS funding, subsequent funding of the NCRIS facilities through the EIF was critical to survival of the program. But EIF does not acknowledge the provision of expert people as an appropriate component of effective infrastructure, which it clearly is for scientific research. The program, and consequently its ability to drive high-quality research and innovation, has suffered greatly because of the reduced emphasis on providing expert support as part of the infrastructure. This must change.

Stable, predictable funding over the long term is critical for the development of national infrastructure for scientific research. Within the NCRIS program many (well over 1000) technicians and researchers have been trained, at great expense to Australia, to provide a high level of technical support and scientific advice to researchers accessing the facilities; this has had an enormous positive impact on the quality of Australian research. But the current ongoing lack of certainty and predictability about funding for this program and/or its successor is rapidly destroying this. In every facility these highly-trained experts are looking at overseas opportunities that offer much greater security for their careers and families. Hence, once again, Australia is finding itself in the situation where it expends a large amount of effort and money to train expertise for our competitors. This needs to stop.

If Australia genuinely wishes to develop science and scientific research into an effective national *capability* to the benefit of the nation, including in particular the effective commercialisation of

research outcomes, it must learn to fund the science, and specifically the infrastructure that underpins that science, in a *strategic way*.

The major point is that for the typical expenditure the Australian Government and Australian State Governments put into research infrastructure over the long term, a much better outcome could be achieved for that money if it were provided in a strategic way so that the science research community could plan appropriately and could provide some reasonable career certainty to the expert people who underpin the infrastructure and therefore the research and innovation.

The Australian economy is neither sufficiently large nor sufficiently buoyant that we can afford to continue to waste money by poor and inefficient means of funding delivery. This needs to be fixed.

Phil McFadden

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UNCOVER Strategy

A vision for Exploration Geoscience in the covered areas of Australia

An initiative of the Australian Academy of Science

working with:

the Australian mining and exploration industry;

government geoscience research agencies;

geoscience surveys;

and the Australian academic geoscience research community.

PATRON

The Honourable Martin Ferguson AM

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Goal

To focus Australia's relevant geoscience effort on providing the knowledge base and technology that will substantially increase the success rate of mineral exploration in Australia, particularly in the greenfield regolith and sedimentary basins that cover about three-quarters of the continent.

By reducing the risk of exploration in Australia this new knowledge and technology will, over time, naturally draw in a greater share of the international exploration budget flow to Australia, which, together with the improved knowledge base and technology, will then lead to a significant increase in the rate of mineral discoveries and thereby maintain and grow the contribution of the minerals industry to the national good.

This will inevitably contribute to defining the government's approach and to maximising the effectiveness of the public investment in geoscience while helping to define the means towards a multigenerational economic legacy for the nation by unlocking the as-yet-undiscovered mineral reserves across most of Australia.

Strategy

To provide an effective forum for a national-level conversation to ensure that government, funding agencies, policy developers, relevant government geoscience research agencies, surveys, relevant technology developers and the relevant geoscience research community at large are all clearly aware of the geoscience knowledge needs of the minerals exploration industry

- so that the geoscience research, survey work and technology development can all be focused on the important questions and can be integrated to leverage the different contributions to maximum effect
- and so that the industry can remain interactive in the prosecution of these questions and the effective deployment of the new knowledge.

Process

Through discussion and consultation, identify which of the current research and survey programs meet the priorities and help define innovative new programs that will create critical knowledge.

Discussions and consultations must be genuine two-way collaborations with a transparent chain leading to programs, defined in a national context, that are formally endorsed by UNCOVER.

- Open and clear articulation from the industry about the scientific and technical issues that genuinely impede their success.
- Serious discussion with the researchers and surveys so as to define and refine the important scientific questions, resolution of which will provide the new knowledge necessary.
- Hard-nosed discussion as to whether those questions are indeed amenable to resolution in a reasonable timeframe.

- Identification of the capability needed to address the questions and who is best placed to be involved. Frequently this might involve broad-scale collaborations involving a range of industry and academic researchers together with the surveys. On other occasions it might involve a specific, small, targeted team. It might require a new program or a better focus of resources into an existing program. We should look first to our own capability in Australia but be willing to draw on international skill when necessary.
- Provide formal UNCOVER endorsement for these programs and raise the public profile of the importance of the work. Advise government, government agencies, funding bodies such as the ARC, and universities that these scientific questions are of strategic national importance and that resources should be focused to resolve them.
- Facilitate coordination of these initiatives so that they are complementary in nature.