

Submission to the review of the national innovation system

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Executive summary

This submission contains two parts. The first reflects general observations about innovation debate in Australia over the past decade or so, while the second draws on some findings from a recent book I edited on high-technology innovation in Australia.

With respect to general observations, I argue:

- Innovation is not equivalent to the commercialization of high-technology inventions
- Academic institutions (Universities, CSIRO, research institutes) should be understood as knowledge platforms for the economy, not as sources of inventions that are thrown “over the wall” to the business community. Knowledge should be transferred to the general community through teaching activities, consulting, contract research and invention. Of these, invention may well be the least important for the national innovation system.
- Innovation is as much a social process as a technical process. Successful innovation requires people from a wide range of skills and disciplines, not just science and engineering.
- The extensive focus of governments on the role of the academic sector in innovation appears to be a product of their contact with, and power over, the academic sector, rather than an assessment of the strengths and weaknesses of the innovation system per se.

With respect to the book, I argue:

- Australian high-technology ventures appear to face excess risk when compared to overseas counterparts. These risks arise from poor physical or cultural proximity to key markets, deficits in managerial skills, lack of skills in innovation governance, and poor access to capital. They manifest themselves as an excessive technological orientation and poor management of risk, among other things.
- There is a place for teaching people the “nuts and bolts” of innovation management.
- A major lever for change appears to be in improved innovation governance.

A declaration of interest and affiliation is presented as an appendix.

Elements of this submission

This submission is broken into two parts. In the first part, I present some assumptions which I bring to the debate, which appear to be contrary to those in most discussions of innovation in Australia. In the second part I bring some specific findings a forthcoming book I have edited.

Some assumptions about innovation

Innovation is not the same as science-driven high-technology commercialization

Although this assumption is laid out in the review's call for submissions, the counter assumption is pervasive, and leads to a number of subsidiary assumptions which are, in my opinion, well entrenched and need to be addressed if the review is to be successful in addressing its terms of reference.

Academic institutions need to be seen as knowledge platforms for the economy, not invention shops which throw knowledge "over the wall".

A portion of participants in the innovation debate appear to believe that all important invention occurs in the academic sector (i.e. Universities, CSIRO, CRC's etc.) and that once something is invented, it is fully baked, so it can be thrown "over the wall" to the market, where full commercialization will be trivially easy and breathtakingly rapid. Notwithstanding, we would like to encourage invention in the commercial sector.

Many single people are surprised to learn that marriage does not end at the wedding ceremony; but rather begins there. Similarly, high-technology innovation begins with the licensing out of an innovative piece of technology, or the spinning out of a company. When it leaves the university or CSIRO laboratory, only a small portion of the necessary knowledge for commercialization has been created. For example, Ausmelt – a world leading manufacturer of non-ferrous smelters -- was spun out of the CSIRO in the early 1980's. Only now, 25 years later, can the technology be considered mature. Consequently, a given high-technology venture needs constant nourishment from the academic sector. For its first product, a given company it will need to constantly augment its intellectual property, as it works through the problems associated with taking its product or service to market. It will then need intellectual property for its second and subsequent products. Even if that intellectual property is be generated predominantly internally, help from the university sector will still be needed.

The academic sector transfers intellectual property into the commercial sector by four mechanisms:

1. It embodies it in students.
2. It consults.
3. It performs contract research

4. It outsources intellectual property (spins out companies, licenses technology, etc.)

The reason I lay out these four mechanisms is that government policy has overwhelmingly focused on #4.

Training students is overwhelmingly the most important mechanism. For this mechanism to be effective, you need students who are inspired and excited by the prospect of doing new and interesting things. That, in turn, requires a learning environment that is conducive to attracting inspiring faculty – faculty who can show them uses for their training beyond either a university career or a corporate job where they won't use most of the things they learn.

Training students as if the only use for a higher degree is a career in academia effectively limits the extent to which sophisticated knowledge can be transferred by mechanism #1. By way of contrast, I had a post-doctoral fellowship at the Swiss Federal Institute for Environmental Science and Technology (www.eawag.ch). It is broadly equivalent to a division of the CSIRO, a U.S. national laboratory, or one of the medical research institutes (e.g. WEHI, Ludwig, Florey, Baker). Of the 400 staff members at the Eawag, about 150 are staff researchers, 100 are PhD students, and 40 are post-Docs (the rest are administrators). The expectation is that 80% of PhD students and post-docs will leave academia once they leave the Institute, not because they aren't good enough to get an academic job, but because a Ph.D is seen as valuable outside academia. Note that this implies a completely different way of thinking about Higher Degree education from the current model in Australia (and such a model may not be culturally appropriate for Australia).

Anecdotally, a focus on spinning out new ventures rather than supporting existing ones has crowded out #2 and #3. These are seen as, at best, second-tier forms of revenue generation, rather than as critical functions of the university. I have even heard multiple stories of ventures that were spun out in an earlier period finding themselves in competition with the Universities and the CSIRO, because the institutions were rewarded on the basis of their patenting performance, rather than being seen as a broad source of intellectual capital for the community. One of the findings of my book (see below) is that Australian high-technology start-ups are starved for resources. This exacerbates that problem.

If the academic institutions are to provide the knowledge platform for innovation in Australia, then we need to construct that role very broadly.

Innovation is as much a social as a technical process.

Invention is a technical process. However, *innovation* -- taking an idea, developing and embodying it in a product or service, and then taking that product or service to market, is fundamentally a social process. One of the fundamental characteristics of innovation is emergence – the idea that you don't know where you are going to end up when you start the innovation journey. Without emergence, it is just engineering. To manage emergence, people need to be able to cope with high levels of ambiguity, and to engage in complex sense-making activities. Furthermore, because innovation is highly ambiguous, its execution tends to be highly political. Without clear

measures of success along the way, social skills are fundamental to bringing a project forward and to fruition.

I emphasise social nature of innovation and the importance of emergence because they are antithetical to the assumptions of two of the core disciplines from which innovators are supposed to come, namely engineering and accounting/commerce. Both of these disciplines teach that the world is fundamentally deterministic and that problems can be solved by carefully analyzing them and then controlling things on the basis of that analysis. Certainly, these skills are fundamentally important for part of the innovation process. However, if we simply control things on the basis of our prior analyses, there is no possibility for finding something new.

Innovative organizations require employees who not only have high levels of analytical ability, and an ability to understand the organisation's technical problems, but also have the ability to analyse highly ambiguous poorly defined problems, and an ability to "read" complex social situations. Our Arts faculties are much better at training graduates with those skills than our Law, Engineering, Medicine, or Commerce faculties. Consequently, it would be a mistake to underplay the importance of these schools to the overall project.

Academics are more competent than government bureaucrats appear to believe, while people in business are the converse.

In my dealings with the Victorian and Federal Government over the years, in relation to innovation policy, I've been struck by two assumptions. The first is that people in the academic sector have limited competence and capability. The second, and more surprising, is that people in the business community are really smart and competent. Therefore, problems with innovation in Australia can be solved by putting more pressure on the academic sector. I presume that this arises because government departments have more contact with and power over the universities and CSIRO, and less contact with people in business, and not because they have made a careful assessment.

My assessment, as someone who teaches MBA students at one of the two best programs in Australia, is the opposite. Australian business culture – and most business education – appears to create managers who are focused on transactions rather than on building businesses, and on control, rather than on emergence.

Findings from my forthcoming book

The book examines the histories of eleven high technology projects or companies in Australia.¹ All eleven cases had the potential to be world-beaters – six of the founders won the Clunes-Ross Medal, and three other may well at some time in the future. The projects were all relatively long-lived. Most had survived since the early 1980's. Consequently, on average, they were *much* more successful than the average Australian high-technology venture. Notwithstanding, only three or four of them could really be considered as achieving anything near their commercial potential. The book, which is scheduled for release in June 2007, elaborates some of the points I make here, and adds a few more.

Central findings of the study

The analysis breaks up neatly into two domains, namely issues within the control of senior management, and issues beyond that. In terms of issues within management control, the poorer performing companies tended to be much more focused on their technology than on the markets they were attempting to serve. This pervaded the organisation, its culture, its leadership, and its behaviour in the market. In the worst cases, the managers of the companies didn't really understand how their product created value for customers, and didn't realise they didn't understand. At some level, this wasn't surprising, given that this issue has been documented well. However, given that these ventures had been selected on the basis of being moderately successful, it was surprising how pervasive this problem was. Two other interesting problems endogenous to the firms were very poor management of the risks they faced, and poor control over intellectual property. The poor management of risk generally meant that the several of the firms faced levels of risk that were significantly higher than was necessary for the businesses they were in. The poor control over intellectual property was not a trivial problem like failing to patent when they should have. Rather, despite their best efforts, the firms often found themselves with someone else effectively controlling the intellectual property they had created.

Beyond management control, we found three things of particular interest. First, firm-level governance was tremendously important. The poor-performing firms had directors who appeared to not understand why the ventures were performing badly, often because they appeared to adopt a governance model designed for corporations with stable revenue in a stable market, rather than for a venture facing enormous ambiguity in its technology and markets. In the firms and projects with appropriate governance, none of the internal issues described above were important. Second, external agents had a significant impact on the risk the ventures faced. Pivotal were financiers and research institutions. Some financiers absorbed a huge amount of risk from the ventures, and in so doing, provided extra resources for growth, or at least shielded management from its mistakes. Other financiers focused on a timely and profitable exit, and in so doing, moved risk into the venture. Similarly, by setting themselves up in competition with one venture, the CSIRO made it harder for it to survive, while by cooperating with others, the CSIRO, Universities, and TAFE

¹ Ausmelt, Compumedics, Computershare, GBC Scientific, Extended Wear Contact Lens Project (Ciba-Vision, CSIRO, Vision CRC), Falcon Project (BHP Billiton), International Catamaran, Kinacia, Micronisers, Proteome Systems, Vesda Smoke Detectors (Vision Systems)).

sectors, were fundamental for venture success. Finally, and not so surprisingly, initial market size mattered tremendously. The start-ups that could launch their product initially into just the Australian market could focus resources on their products and operations, and build cash flow and operational competence before needing to develop any significant marketing competence. Those that essentially had to launch into overseas markets, however, had to build marketing competences beyond those of their international competitors from the beginning, because they had poor understanding of their customer, from whom they were physically and/or culturally distant. The need to launch globally was particularly problematic in ventures that lacked sufficient capital to staff a global launch.

Policy suggestions

The research in the book suggests three broad areas for policy interventions to improve the success rate of innovation attempts in Australia: training the managers of individual ventures; governance; management of risk. While these recommendations are derived from a very narrow sample of cases, I suspect that the issues are pervasive to innovation in Australia, and so the solutions will be universally useful.

Training managers

Given that many of the issues faced by the organisations present themselves as management problems, one would hope that there is a possibility of training managers to manage innovation better. A plethora of courses is available around the themes of entrepreneurship and commercialisation. These are offered by all the business schools and organisations like the Australian Institute for Commercialisation. In addition, the more sophisticated programs have courses in subjects like innovation strategy and intellectual property management. This research suggests, however, that there is also a need for courses on the nuts and bolts of how to manage innovation, which teach students, practitioners, potential board members, and people peripherally involved in innovative enterprises (such as bankers) how innovation management differs from general management, and how to do it effectively.

Governance

To blame the founder of a high-technology venture for its failure is, in my opinion, highly misguided. There are at least three reasons for this. First, the founders of high-technology ventures are most likely founding a company for the first time. That is, they have no experience in starting or running a business. And, unlike other enterprises, if they are coming from a scientific or technical background, they probably have no experience in business whatsoever. Second, in as far as they have the necessary skills, they have very little way of knowing which portion of their skills are useful, and which portion, if used, will harm the business. At the same time, they have developed tremendous technical competence in their profession, which will push them towards the behaviours that have worked in the past, whenever they are unsure. Finally, the founding entrepreneur will eventually face a fundamental conflict. Founders who found companies are passionate about their technology. While this is vital for creating a business, it creates a fundamental tension as soon as the ongoing development of the technology conflicts with the business needs. Such a conflict is virtually inevitable, and so the founder-leader is placed firmly on the horns of a dilemma.

These three reasons suggest that the key group to hold to account is the governance group, by which I mean the company directors in the case of the start-ups or senior managers in the case of the within-company projects. This raises the obvious question of why the governors of these enterprises performed so poorly, and whether an intervention can do something about it. The core issue, as I see it, is that directors are not trained to manage innovative enterprises. My aim here is not to criticise traditional governance models and recent work to improve them. Rather, it appears that innovative enterprises have different governance needs from a conventional business, and so they need to be governed differently. Directors with broad commercial experience are often unhelpful on the boards of start-ups because they are trained that governance is about avoiding “downside” risks. Innovative ventures are dealing with highly ambiguous activities, which can make the conventional tools of control, management, and governance useless, or even destructive. Furthermore, the overwhelming risks high-technology companies face are not financial risks or malfeasance in the traditional sense. Rather, the risks are that the organization will squander “upside” opportunities. That is, paltry resources will not be used as effectively as possible because losing (or winning but unnecessary) strategies are being pursued for too long, or the venture will trip over a known hurdle, or good opportunities will be foregone in the hope of unrealistic better ones, or the organisation will collapse as the product succeeds. These imply an additional dimension to governance which involves actively managing the risk of failure, and creates additional requirements for a board. Finally, in the cases in the book, the size of the governance group approximated the size of the project team. Given that the project team is often woefully short of key resources – skills, competencies, experience, relevant network relationships etc. – a key role of the governance group should be to compensate for this. That is, the governors should bring experience, skills, and contacts to the organisation and potentially be actively involved in its operations (while separating the governance role from the operational role). In that respect, it is noteworthy that at least six of the case organisations had no one in a governance role with relevant prior hands-on experience as innovators at the time when innovation attempts were failing.

Potentially, we can take this up a level. In particular, the ASX contains a large number of companies with very low levels of capitalization, essentially because they have no products in the market. These companies are concentrated in high technology (and mining). A common maxim is not to invest in something you don’t understand. The question I raise is whether a sufficient proportion of people understand these companies to create a cadre of investors who can effectively replicate the governance function in the market – i.e. create a stock price that represents approximately the risk-adjusted value of the underlying asset, and thus weeds out poor management. I suspect not. Only a vanishingly small number of Australians would understand the technology of these companies, let alone the commercial risks they face. There are few analysts in the sector. I interviewed the manager of the Small Capitalization fund for a major Australian investment bank, and he said that he bought shares on the basis of the persuasiveness of the management presentation – because he couldn’t actually understand the technology. I suspect he might be typical. This suggests, among other things, that poor directors could conceivably hide their lack of ability by listing investee companies on the ASX as early as possible.

Before making specific recommendations here, there is a need for further research into the problem. However, I suspect that it is a fundamental issue.

Risk management

A broad conclusion of the book is that the ventures faced extraordinary risk. By this, I don't mean that because the firms were innovating, rather than operating in stable markets, they faced a higher risk of failure. Rather, it would appear that they faced risks beyond those they would face if they were operating in a country with a well developed innovative sector which was geographically and culturally close to its markets. Examples of these risks include:

- Very thin capital markets mean that ventures are often under-capitalized, and that any errors or misjudgements will cripple the company because there are no alternative sources of capital.
- Competition with Universities and CSIRO mean they have poor access to knowledge resources at a reasonable price.
- Physical and cultural distance from markets mean that markets are more difficult to address.
- Lack of experience and training of managers and board members mean that highly skilled employees are hard to source and retain.

One consequence of these increased risks is that even well-managed new ventures may well take longer to get off the ground in Australia than overseas. However, the preferred means of funding appear to be venture capital, which – being based on the U.S. software industry -- has closed funds of 7-10 years duration, and public capital markets, which are sensitive to performance on a quarterly basis. Neither of these would seem to be ideal.

Successful policy for high-technology commercialization needs to somehow reduce the constraints on these ventures. The Australian government's approach to encouraging venture capital has been through schemes like the Early Stage Venture Capital Limited Partnership scheme. These schemes essentially subsidise the returns to investors in venture funds, without addressing the impediments that increase the risk above the global average and justify the need for subsidised returns. Rather, these schemes assume there is simply a shortage of high-risk capital in the Australian market, and that by doubling the nominal returns, more capital will be attracted. However, the binding constraint doesn't seem to be a shortage of capital – Australia has an enormous pool of compulsory superannuation funds -- but an aversion to investing because of the enhanced risks described above.

I make two suggestions which may help to manage this problem.

- Government programs aimed at facilitating innovation should be extremely clear about which risks they are attempting to alleviate, and how they are attempting to do so. For instance, if the aim is to reduce technical risk – to subsidise the refinement of products and services – then it is important to not

add additional risk at the same time. For example, use a grant scheme rather than requiring fund recipients to create an unnecessary corporate vehicle.

- The Commonwealth Future Fund and superannuation funds have incentives which are highly aligned with high risk Australian ventures. They are interested in investments with a very long time horizon, which will generate large spillovers into the rest of the economy, as well as high returns. It may be possible to combine these pools of capital with an appointed panel of highly skilled investment managers to at least reduce the financial risk for these ventures.

Appendix: Declaration of interest and affiliation

Among other things, I bring the following to this submission:

- PhD from the MIT Sloan School of Management, where I interacted with, and took classes from key innovation scholars (e.g. Eric von Hippel, Peter Senge, Tom Kochan).
- Post-doctoral fellowship at the Swiss Federal Institute for Environmental Science and Technology (EAWAG), where, among other things, I studied issues associated with creating a market for electric vehicles.
- Six years teaching Innovation Strategy at the Melbourne Business School.
- Four years teaching Innovation Management at the Melbourne Business School.
- Principal designer of the Melbourne Business School post graduate program in Innovation Management.
- Faculty coordinator of the Melbourne University Entrepreneurs' Challenge.
- Recently completed a book examining the life histories of eleven high-technology innovation projects and/or start-ups in Australia.

My principal area of expertise is in the organizational and managerial processes associated with innovation, particularly with technically difficult and complex innovations.