PUBLIC SUPPORT FOR SCIENCE AND INNOVATION

- A Draft Research Report from the Productivity Commission

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Summary

This submission makes the following points:

- *"Innovation" is so distinct from "R&D" and so important for economic and productivity outcomes that it needs more separate and deep consideration than in the draft report.*
- *It is more important to understand the innovation processes that are carried out at the individual company level than considering economy-wide statistical considerations.*
- *It is at the company level that the role and potential relationships between innovation and R&D (both private and public sector) are understood.*
- *It is important to understand the role of spillovers and leverages that come from effective clusters and infrastructure relevant to an integrated knowledge-based and technology rich economy.*
- *It is critical to distinguish between low-value-add, high volume manufacturing no longer relevant to Australia and that high-value, low volume manufacture which can be expanded in Australia, which is more responsive to relevant R&D, and which continues to form the major growth in both world trade and national economies.*
- *Changing, through evolution, the structure of the Australian economy cannot be simply dismissed as not of relevance to Australia's economic outcomes and productivity gains. It should be a core part of innovation policy within which there are broad areas where government support would satisfy the criteria for it that are given in the report.*
- *Reporting just on the status quo of Australian R&D and innovation activity perpetuates Australia's weaknesses and ignores the overseas examples of how similar economies have more effectively applied public sector funding to economic and productivity gains through R&D and innovation.*

*Given the above, the **economic impact of public support for science and innovation in Australia and, in particular, its impact on Australia's recent productivity performance** has been overly optimistic in the draft report.*

*Similarly, it is asserted that the analysis is both incomplete and shallow in covering **all key elements of the innovation system.***

*As a consequence, it is incomplete in identifying the full range of **impediments to the effective functioning of Australia's innovation system.***

*Without the understanding of innovation referred to above, the draft report is consequently deficient in addressing **programme design elements** that **influence the effectiveness and efficiency of Australia's innovation system** and **guide the allocation of funding between and within the different components of Australia's innovation system.***

*The consequence is that an opportunity has been missed to better **identify any scope for improvements and, to the extent possible, comment on any implications from changing the level and balance of current support.***

Introduction

The report uses a too-tight coupling between R&D (especially public sector R&D) and INNOVATION. There are two distinct issues – (a) support for public sector research and (b) support for the national innovation system of which public sector research is but a small part. It is especially small in Australia because very little of Australia's public sector research is directly relevant to the innovation processes of companies. In terms of spillovers, very little can be expected to occur. The input knowledge for successful innovation within a company is "useful" knowledge and technology that is more likely to be obtained from customers, market, internal knowledge, inwards licensing/purchasing/capture of technology, and the company's own directed R&D.

The terms of reference for the report are quite clearly focused on economic outcomes and national productivity. Economic outcomes are achieved within companies and it will be companies that make the major contribution to productivity. The report addresses Australia's internal economic achievement but of equal, if not greater, importance to the future economic situation for Australia is its performance in external trade (which is clearly suffering a sustained market failure) for which innovation in technology-based goods (more than services) is the most likely remedy. Restoring a positive balance to trade may go some way to addressing Australia's accelerating foreign debt. Discussion about Australia's economic growth cannot ignore, as has done the draft report, that the foreign debt growth of 3% of GDP last financial year was a significant element in that economic growth.

Therefore the current major impediment in Australia's innovation system and in government support for it is the lack of appreciation of this market failure and the wider range of ways that can help address this. It could be argued that the issue is of such importance that a simple re-juggling of current programmes/funds is insufficient and that a greater portion of outlays might be focused on programmes targeting the real underlying impediments to Australia's innovation system performance. There are international examples that can assist in illustrating how governments might more effectively focus funds in this area for national good.

To get to the heart of the issue requires a clearer understanding of both the design process and the innovation management issues that underpin a company's performance, as well as the cluster and infrastructure factors that can leverage overall regional and national economic performance through innovation.

Such understanding will not come about when the Commission does not even appreciate the distinguishing solution-generating characteristics of engineering (focused on synthesis and design) and lumps it together with the physical, biological and mathematical sciences in the Commission's definition of Science (page 1.5) as:

> *"Science is the methodical, replicable, accumulation of knowledge and perspective about the nature of 'things' (the natural world, social systems, the economy), based on conjectures that can be subjected to empirical tests."*

It is also debatable that the Commission's very broad definition of innovation, as "deliberative processes by firms, governments and others that add value to the economy or society by generating or recognising potentially beneficial knowledge and using such knowledge to improve products, services, processes or organisational forms" (page 1.7) has gained ascendancy and is more appropriate than the usual one within the context of the Terms of Reference.

A consequence of this lack of clarity is to make the wrong statement that the relevant institutions that pursue innovation include "... universities, government-funded science-

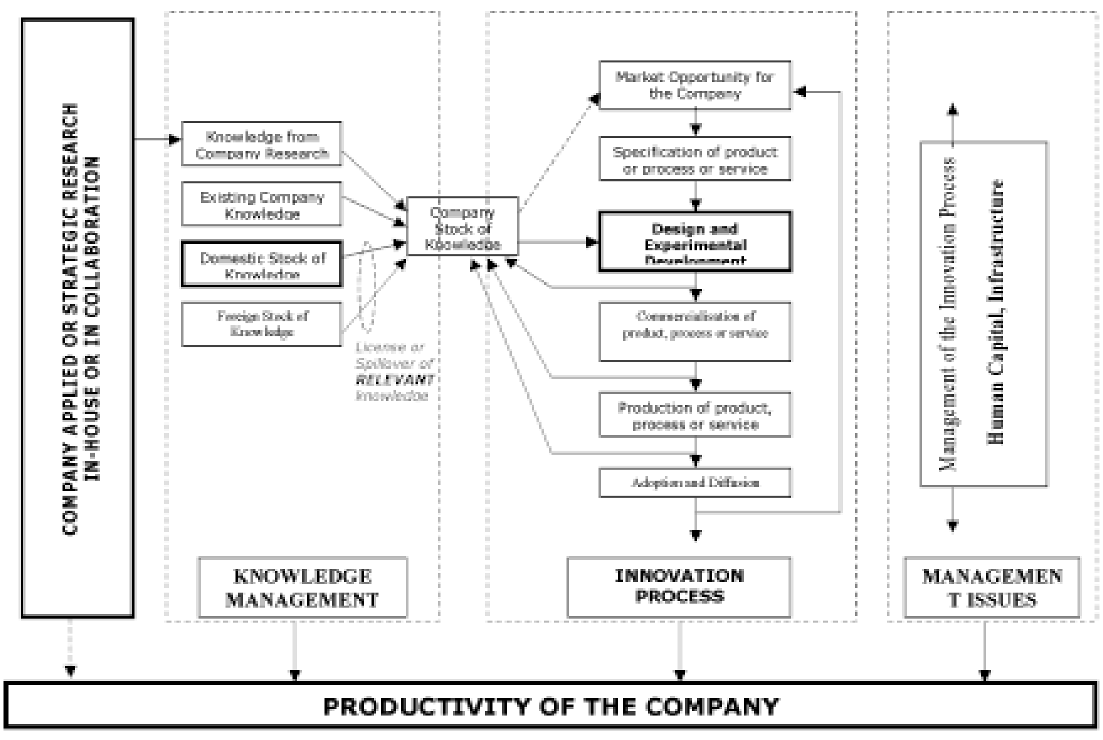
based organisations and communities" or that organise it are "DEST, the ARC and the NHMRC" (page1.17)

Finally, and most importantly, ***what is also needed is a robust rejection of the Commission's simple dismissal of both manufacturing and of an evolution of Australia's economic structure from that of the present.***

Effective innovation within companies

Successful companies are those that continue to provide globally cost-effective solutions to a customer's needs. Identifying those needs and assessing the capacity to provide a cost-effective solution are at the core. Good management that continually assesses and reduces the risk of achieving a successful outcome in the proposed product (or service) is one underpinning requirement. Managing the design flow and product/service realisation stages is the other. Hence companies require management and design skills particular to innovation management and these have little to do with research. ***It is a technological/engineering/management issue almost completely absent from higher education programmes in Australia.***

In better understanding how the innovation process works within companies, the definitions of innovation as used by the IR&D Board or by the following one from the EU's Eurostat are both more explicit and more relevant: "An innovation … is a new or significantly improved product (good or service) introduced to the market or the introduction within [the] enterprise of a new or significantly improved process. The innovation is based on the results of new technological developments, new combinations of existing technology or utilisation of other knowledge acquired by [the] enterprise".



Most importantly from this description, the company stock of knowledge which is built up and which underpins the company's capacity to continue to produce new and competitive products or services comes from a range of sources – a small subset of which is that licensed in from external knowledge and technology providers. Given

Australia's relatively small global scale, it is inevitable that most of this useful external knowledge is likely to come from overseas. The exception might almost only be when there is a good synergistic cooperation between the company and a local private or public R&D provider.

Government recognition of the criticality of the particular skills requirements and of the need for synergy between company needs in R&D and that carried out locally leads to a range of potential policies more effective in supporting innovation.

Cluster and infrastructure factors

Individual companies reliant on knowledge benefit enormously when they are in an environment in which relevant skills, resources, synergistic research and complementary companies are in abundance. The spillovers are multiplied and knowledge re-use is common. Such environments are commonly referred to as clusters.

The characteristics and benefits of clusters have been well covered in a range of studies of effective knowledge economies. The key element is one of interaction and Australia is yet to achieve the innovation-supporting environment well summarised as:

> *"The collective work can be achieved only through constant interaction. Engineers move from one firm to the next, samples and prototypes circulate, clubs of users are formed and disbanded, professors are engaged as consultants, and university researchers are recruited by industrial enterprises. A community is gradually formed, characterised by the richness of diversity and bound by sound common knowledge. Innovation networks are a mix of intersecting and interlinked organisations, human actors, machines, facilities, communication infrastructures, documents and materials."*

("Between Uniformity and Diversity", Michel Callon and Patrick Cohendet, 12th Convocation, CAETS, Edinburgh, May 1997.)

There are many practical policy programmes which can and have fostered such environments. These include the Centres of Expertise Programme of Tekes in Finland, referred to in more detail below.

The role of government is predominantly one of encouragement and stimulation supported by financial programs that address market failure through appropriate additionality.

Manufacturing appropriate for Australia

The word "manufacturing" covers a wide gamut from low value-add mass manufacturing to high value-add specialist and low-volume manufacture. It is the reality that Australian companies source low value-add or mass manufacturing overseas and, in particular, to China. No-one could make a cost-benefit case for such manufacture in Australia unless it is highly automated or has other factors such as transport inhibiting overseas sourcing (an example would be bricks and other building or civil infrastructure materials).

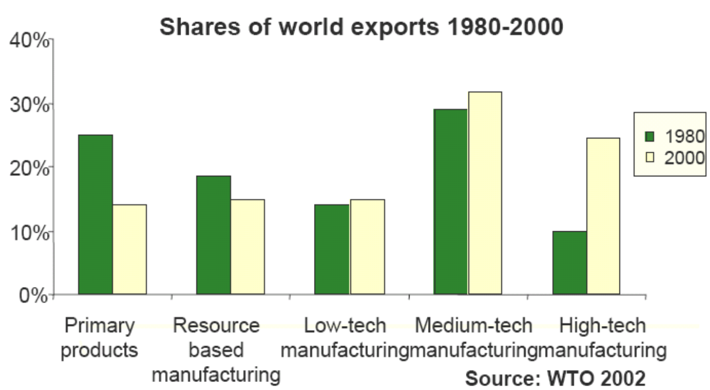
But it is already the reality that in many areas there exist Australian companies that are internationally competitive and successful high value-add manufacturers. There are just not enough of them and there is insufficient leverage from clusters of such interlinked companies. Examples range from wave-piercing catamarans and luxury launches to scientific instrumentation and medical devices.

In addition, manufacturing opportunities are growing in focal points of new technology integration such as telematics, complementing existing industries such as the automotive industry. As reported in the Electronics Industry Action Agenda:

"For example, it is estimated that 90 per cent of all future innovation in the automobile industry will be driven by electronics, with electronics representing up to 40 per cent of a vehicle's production cost by 2010. According to the Department of Defence, the value of electronics in defence related activities is even higher, with electronics representing up to 80 per cent of the production cost of a modern war ship and a submarine". (Electronics Industry Action Agenda, http://www.dcita.gov.au/Article/0,,0_1-2_11-3_475-4_107122,00.html)

(An alternative description of what is meant by high-value-add manufacture has been developed by Cambridge Investment Research in the UK. CIR uses the Trademark phrase 'High Value Manufacturing' or 'HVM' rather than the phrase 'high value-added manufacturing' as a more wholesome function of time-to-market, IP and reinvestments, among other factors such as design. CIR developed a working definition of HVM: "HVM is manufacturing where there is relatively high value created in the supply chain segment involved. In a corporate setting, HVM is usually characterised by higher-than- average expenditure on R&D as a proportion of sales, and/or is highly innovative with respect to product development, design, and/or is associated with above-average levels of intellectual property (IP). HVM often applies to newer markets, where design or manufacturing processes may be fast-moving, new, unfamiliar, or not well tried and tested; and where prototyping, demonstration and lower volume production are all still valuable. Selected business sectors where one realises this are: electronics and semiconductors; additive manufacturing; printing and displays; medical devices, sensors and biotechnology; aerospace; automotive and motorsport; new energy; materials & catalysts; and nanotechnology; and communications.")

Globally it is this high-value sector of manufacturing which is fastest growing and which thereby offers the greatest range of opportunities.



One other weakness of Australia's innovation system is its extremely poor value-adding to its basic commodities. Wood chip is exported rather than paper pulp let alone specialist papers and the printing/inks that create value from the basic product. Similarly, aluminium ingots are exported without Australia producing alloys and rolled products from them. One recognises the enormous improvements that technology and innovation have made to the processes within the minerals and primary sectors but it also highlights the limits to growth with current approaches and to the major market weakness in Australia to develop value-added products.

In this context, the draft report's negativity over any support for companies where mainly private returns are an outcome needs to be countered by the fact that innovation is considered an area where market failure exists. This was put usefully by the European Commission referring to market failure: " … the inability of a system of private markets *to provide certain goods either at all or at the most desirable or 'optimal level'. Market failure occurs, therefore, when private companies cannot or will not provide something because they cannot make a commercial return even where there is demand or need for this something. Under these conditions, the rationale for public provision of or public assistance to private firms in providing this is normally justified as it will lead to employment and wealth creation that would not otherwise have occurred". ("A Study of Business Support Services and Market Failure", European Commission, 2001.)*

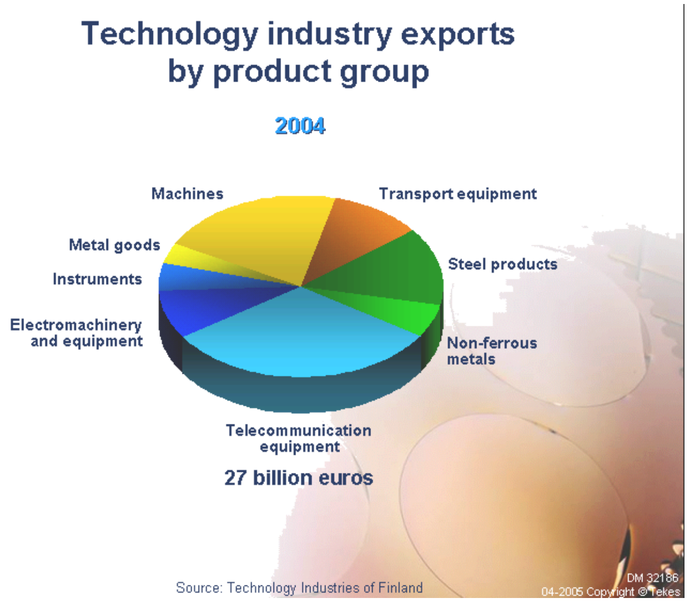
There are many ways that the high value manufacturing sector could be encouraged to expand in areas self-selected by the individual companies and entrepreneurs or guided by identification of cluster potential. The key aspects range from broad statements recognising the opportunity and importance, through the addressing of the professional skills gap in innovation management, design, marketing and productisation, to supporting the cluster/infrastructure issues that leverage activity.

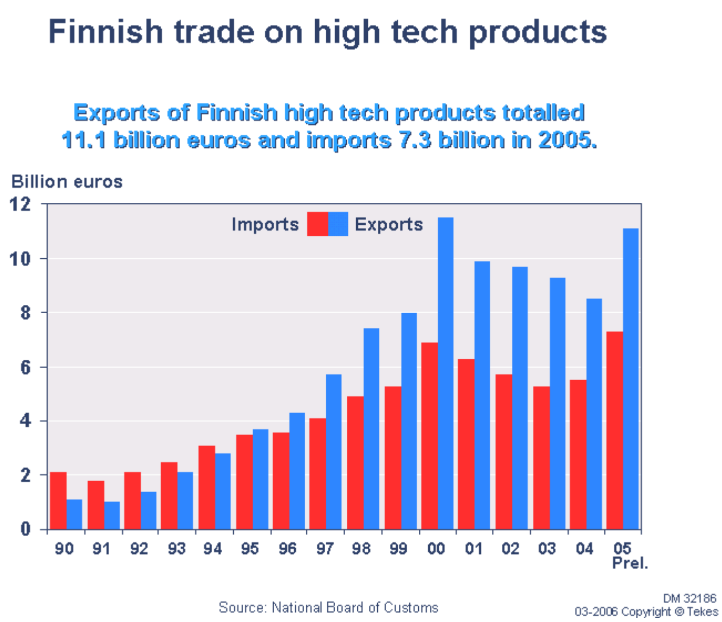
Evolving the structure of Australia's economy

The starting point is to ask if Australia would be better served if its economy structure evolved in particular directions better exploiting the evolving world trade opportunities and which built on a knowledge and technology-intensive Australia. Following from that is the question of whether government has a role in stimulating and/or supporting such change. The draft report dismisses the role of government in stimulating a change in the structure of the economy. That is a very risky and shortsighted view. Enormous benefits can evolve from an economy capturing the opportunities in the emerging new sectors of the ***world*** *economy. And significant evolutionary change in a country like Australia is possible within a reasonable timescale as evidenced by international exemplars. For instance, the structure of the Finnish economy evolved as per the following diagram with most significant change in the 1990s.*

In the area of technology goods, Finland also demonstrates a diverse capacity to add value through down-stream value adding to its more primary and low value products.

It is now a diverse economy in which 23% of its export goods are high-technology manufactures and the trade balance of high-technology manufactures is positive.





That is, high-value manufacture offers a diverse range of opportunities for Australia to generate wealth and, in particular, to create global opportunities for export revenue generation. It cannot be dismissed.

An overseas innovation system – Finland

If the goal of Australia's public support for R&D and innovation is to be more effective in producing positive economic and productivity outcomes then there is great scope to evolve the current situation. This would need to recognise the complementary goals of public-good and basic research, for which higher education and public sector research *bodies are the foci, and the innovation system's requirement for unashamed technological development (in a broad sense). It would also need to recognise the dichotomy within universities between the traditional science and humanities focus and the focii of the professional faculties that, by definition, are goal and outcomes oriented. Clarity over objectives and goals is essential in both the structure of any funding arrangements and the underlying infrastructure.*

Staying with the Finnish example, the separation of higher education research funding between the Academy of Finland, the universities themselves, and Tekes achieves this.

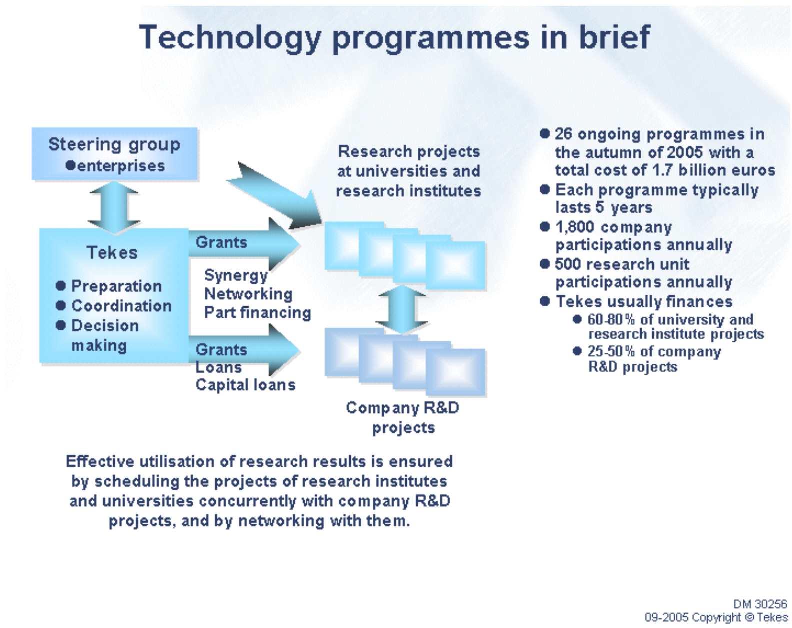
Tekes is the key government player in innovation support (within the Ministry of Trade and Industry!). The goal of the funding for the research projects of universities, research institutes and polytechnics is unashamedly to build "technological competence" through three main categories:

- *application oriented basic research*
- *challenging long-term or medium-term research*
- *applied research.*

Total Tekes R&D funding in 2004 was 409 million euros distributed across 242 projects. These covered:

- *R&D grants to companies 165 million euros*
- *Research funding for universities and research institutes 172 million euros*
- *R&D loans to companies 31 million euros*
- *Capital loans for R&D to companies 39 million euros*
- *Start-up loans to new technology companies 2.2 million euros*

Structuring of funding is through Technology Programmes, multiproject programmes initiated, steered and part-financed by Tekes with a focus on a key technology sector. They are implemented in cooperation by companies and research units in which companies can participate with their own projects or by joining common research projects. The projects and results are partially public – a critical issue to enhance spillover even beyond the large number of companies and research units involved in the programmes.



The straddling of projects across higher education research and the large number of companies leads to and fosters the synergies that are critical to cluster development.

Again, there are insights in Finland, Scotland and elsewhere as to how government action and support for clusters can be stimulated and achieve major wealth and productivity outcomes. It is not the intention to go into detail other than to quote the Finnish Prime Minster on 10 October 2006 where he addressed a Brussels Open Day:

> *"We have to find ways to best promote the process of bringing innovation into the market and turning them into competitive products at a global level. The formula for effective innovation policy is more than just promoting research and development projects. In Finland, the Centres of Expertise Programme represents the Government's view in how to improve regional competitiveness in line with national and European policies. This fixed-term programme was introduced in 1994 to create new jobs and to foster regional development in the selected fields of expertise. The Government has challenged regional actors to cooperate in joint strategies by using relatively small funding incentives and at the same time giving them a high-level status in the Finnish innovation strategy. From the very beginning the carrying force of the programme has been the active cooperation between universities, research and development institutions, companies and municipalities. Over 5000 companies take part each year in the preparation and implementation of projects. These projects have also contributed significantly to the diversification and renewal of the industrial structure within the regions. The total project volume for 1999-2005 is approximately 500 million euros, which has so far generated 12,000 high-skill jobs and over 1,000 new businesses. The result of the programme is a strong and active network of 22 centres of expertise with 45 fields of expertise."*
> *www.eu2006.fi/news_and_documents/speeches/vk041/en_GB/170848/*
> *(The homepages for the Finnish and similar Scottish programmes are at www.oske.net/in_english and http://www.scottish-enterprise.com/sedotcom_home/sig.htm)*

CRCs and commercialisation

Consequent upon the above discussion, several comments can be made in relation to CRCs and commercialisation in Australia.

It is noted that the draft report considers re-widening the objectives of CRCs beyond economic outcomes. This is considered a retrograde step if it dilutes the emphasis on obtaining an economic return from public expenditure on collaborative public sector/industry innovation-linked research. A reasonable expectation to place on all CRC-type bodies is clear identification of the need and/or opportunity being addressed and an articulation of both the opportunity and the practical pathway to its realisation.

Also, as the Eurostat definition indicates, economic outcomes have as much, if not more, to do with applying existing technologies in new combinations as it does the acquisition of radical or breakthrough technologies. Hence a CRC which is active in current technologies and the means to combine (that is, "design") them into applications is likely to be more successful than a purely research CRC.

The current CRC program is built around a science or technology "push" model of innovation. That is, it too often states to industry "this is what I have invented – apply it!" and claims it is industry's fault when there are no commercial returns. This approach is reflected in the constitution of committees and panels as well as in the traditional "academic" approach to what is meant by excellence.

What is missing is an industry or market "pull" or, even better, an "integrated" approach to the CRC role within the innovation processes of Australia. As has been indicated above, valuable comparisons and contrasts might be made with a number of international programs and funding processes of which Finland's TEKES (http://www.tekes.fi/eng/default.asp) has very strong lessons. Other models exist in Sweden's SOCware program run from the collaborative, membership-based company Acreo (http://www.acreo.se) and based at several universities illustrating that "design" is just as valid as "research" and that short and medium term relevance to industry is most important. A third example is IMEC in Belgium (http://www.imec.be/), an example picked up by the UK's House of Lords in a report proposing a national centre in microelectronics (Chips for Everything: Britain's opportunities in a key global market, House of Lords Select Committee on Science and Technology, Session 2002-03, 2nd Report, www.parliament.the-stationery-office.co.uk/pa/ld200203/ldselect/ldsctech/13/13.pdf).

With regard to commercialisation from public sector research, it is poorly understood in Australia that direct spin-out of a technology-based company incorporating public sector research IP can only ever be a very minor part of technology-based innovation activity. In the cluster around Cambridge in the UK, Gothenburg in Sweden and here at the ATP, such university-linked companies are less than 10% of the overall start-up activity.

The vast bulk of the growth of activity is from indirect start-ups where the key ingredient is the relevant higher education skills of the key founders utilizing their own skills and knowledge to integrate technology into a market-identified opportunity. Also identified as very important in the case of Cambridge is the handful of serial entrepreneurs who have done much in their own right and through stimulation to encourage new venture creation.

The conclusion is that providing relevant skills and attitudes amongst the graduates – especially first degree graduates – will develop the pool of those who will grow technology-based clusters. It is not often that the PhD or academic is the key driver of high-growth, technology-based businesses.

For both graduates and researchers to be "commercially oriented", it is critical that they are exposed to and understand the innovation process and the complete value-chain before commercial outcomes are reached. It goes beyond empathy to the patenting process.

Related to this is the increasingly understood fact that university ownership and exploitation of IP will not be a major revenue generator for universities. An interesting contrast is in Scandinavia where the researcher retains ownership. This has generated greater commitment to exploit and a good example exists at Chalmers University in Gothenburg where this has enabled many new companies and also strong involvement of Masters students developing innovation capabilities as they form the commercialising pathway for that IP.

However, within Australia, university structures and attitudes make it very difficult to establish a distinct focal point and the resources to sustain such innovation training activity. This is based on the author's own difficulties experienced when having developed and delivered programs in technology entrepreneurship to both undergraduate and postgraduate students. Of interest is that strong student interest exists in such programs.

Internationally, others have been much more strategic and supportive. In Scotland the Scottish Institute for Enterprise supports and co-ordinates entrepreneurship activities across 13 universities in Scotland. Within England, the Higher Education Innovation Fund (HEIF) exists as a separate source of funding, alongside research and learning/teaching. A total of £171 million has been awarded over 2004-05/2005-06. Resources can be used, not just for spin-outs, but for knowledge transfer, entrepreneurship training, seed venture funding and transferring knowledge into business and the community. ('Investing in innovation: A strategy for science, engineering and technology', DTI, DfES, HM Treasury, July 2002)

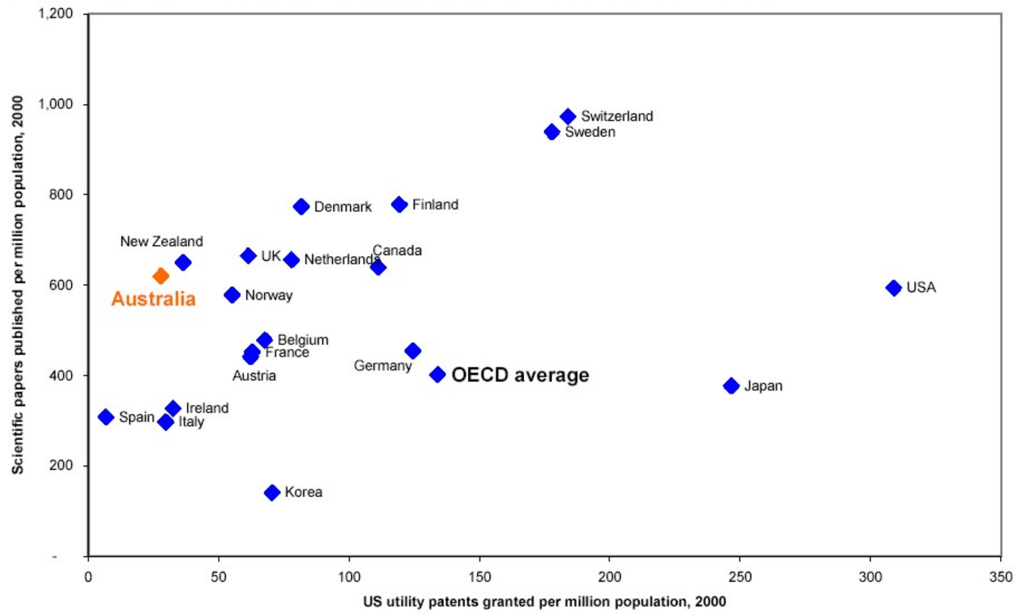
Specifically targeted funding such as in HEIF, with priorities on innovation development of the graduates and involvement of them in innovation activity, is perhaps the only way to ensure that resources are not dissipated within traditional university internal funding arrangements.

Mapping of Australian Science and Innovation

A number of the above issues were revealed in the report of 2004 but have received little attention since.

Market relevance of the knowledge being produced in Australia is abysmally low - enhanced by other weaknesses in research focus relative to market opportunity. A good indicator of the mismatch between research in Australia and market relevance is the following figure from the Mapping report (page 73):

Figure 2.20: A snapshot of Australia's performance in science and innovation



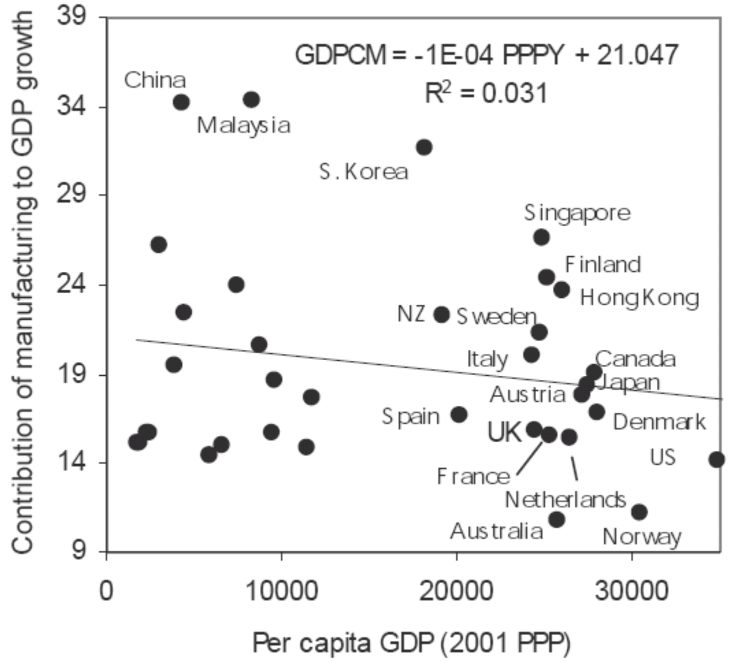
Source: OECD (2002g), p 317; and USPTO (2002), p A1–1.

Another relevant statement from that report is the footnote to a figure of Commonwealth support to business R&D (Figure 5.34, page 385): "Note: Data displayed on a logarithmic scale due to R&D support being an order of magnitude greater than commercialisation support".

Because they have not received the coverage they should, the following statements from that report are repeated:

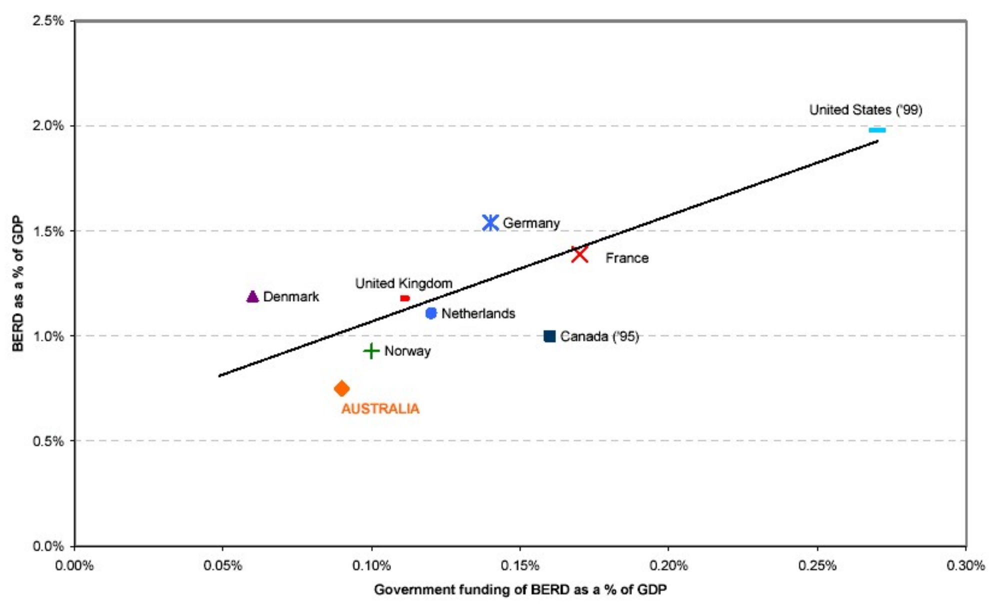
- *Australia's high-tech exports are less than a third of its imports and Australia 26th of OECD for high tech exports as proportion of GDP (page 12)*
- *Australia's manufacturing sector mostly companies with R&D intensity of less than 4% cf Germany and Sweden where more than half manufacturing sector is companies with R&D intensity greater than 5% (page 13)*
- *Government support for business R&D is low by international standards, being less than half that of leading OECD countries. Australia – with direct plus indirect support at about 0.09% of GDP – provides less support than all but one of the comparison countries, whereas the United States (with support totalling almost 0.30% GDP) is the most generous (page 300)*
- *Over the past 30 years there has been a rapid growth of world trade in manufactured products. Australia has not been a strong participant in this expansion, unlike such countries as Canada, Sweden, Finland and the Netherlands. Australia has built neither large Australian-based firms , nor areas of strong specialisation, in trade and technology-intensive industries. In 1913, the value of Australian exports was about the same as that of Canada and the Netherlands and five times that of Finland. By 1988, Canadian and Dutch exports were about four times greater than Australian exports, and Finland's exports were only slightly less (page 30)*

An illustration of the consequence of this for Australia is the following figure from the Commission's Trends in Australian Manufacturing 2003 report comparing 1975-76 with 2000-01 (page 26). It reveals Australia has foregone significant potential GDP growth by ignoring the world opportunities in appropriate manufacturing.



The Mapping report also reveals Australia as a low supporter of BERD. If public sector support for R&D had a greater emphasis on the wealth creating end related to innovation, then the stimulation of industry would lead to a more internationally comparable level of BERD.

Figure 5.45: Government support (direct and indirect) for BERD, 1997 or nearest year



Source: Derived from data in OECD, Main Science and Technology Indicators, 2002 and OECD, Science, Technology and Industry Outlook, 2002 and Science and Technology Budget Information, 3002–04.

This is not to suggest that particular sectors are to be necessarily overly prioritised. But is does mean that Australia could well benefit from an increased balance of support to *innovation in products and services within companies compared with support for unfocused public sector research.*

Relevance of public sector bodies to companies

Of importance is to have flexibility with which innovation companies can interact with the research sector and, especially, its publicly funded infrastructure. In the pre-competitive phase, the technical and commercial risks are still very high for companies. Encouraging effective innovation, especially within the SME-dominated industry of Australia, cannot take place if access to publicly-funded infrastructure is at full-cost recovery compared with the more generous academic access regimes that have existed in, for example, MNRF and university-based facilities.

But unfortunately, it is the case that the majority of current major research infrastructure was selected on public sector research needs and has little or no relevance to what Australian industry requires in their shorter-horizon research needs.

Even when there might be relevance, unless the potential of the resource to make near-term bottom-line benefit to industry is made clear, industry will not be interested. Communicating benefits of infrastructure and research results to industry is not something to be done by research scientists. The language must be that of the technologist and engineer in an economic context. Therefore, translating the benefit could well require specialist services.

Conclusions

With a requested focus on the potential of public investments in R&D and Innovation to create economic and productivity outcomes, the draft report falls short in its assessment of the relationship of Australia's performance relative to its potential for the same public outlay. The main causes are an unclear distinction between innovation and the role of R&D within it, an entirely Australian internal perspective, and lack of perspective of the range of program design elements that could make major contributions to a strong and sustainable, as well as export-oriented, Australian economy then able to support strong social, welfare and environmental programmes.

Brief CV – Professor Trevor Cole

Trevor Cole is now Professor Emeritus after 25 years as the Peter Nicol Russell Professor of Electrical Engineering at The University of Sydney. With a doctorate from the Cavendish Laboratory in Cambridge, he is a Fellow of the Australian Academy of Technological Sciences and Engineering and Honorary Fellow of Engineers Australia. Until recently he sat on the Federal Government's Industry Research and Development Board. For a number of years he was Executive Director of the Warren Centre for Advanced Engineering and Chairman of the Australian Microelectronics Network. He is currently a member of the implementation group for the electronics industry action agenda.

His major focus is the creation of wealth and jobs through the successful development and marketing of technology based goods and services.

During his career, amongst other things, he has spent a short time in a venture capital company, co-founded a speech technology company and he took a very significant role in initiating the Australian Technology Park. He chaired the R&D Board of Australia's Overseas Telecommunications Corporation and acted as CEO at the formation stage of the Australian Graduate School of Engineering Innovation. He played a major role in the National Innovation Summit in 2000. He also created and delivered a series of courses in technology commercialisation and entrepreneurship.