



Global Integration

**Australian Academy of Technology Sciences and
Engineering**

August 2006

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Australian Academy of Technological Sciences and Engineering

Submission on the

Background Paper:

GLOBAL INTEGRATION

By

Department of Industry Tourism and Resources

August 2006

1. Australian Academy of Technological Sciences and Engineering

The Australian Academy of Technological Sciences and Engineering (ATSE) has some 700 elected Fellows, consisting of the leading applied scientists and engineers in the country. The Academy is one of four established learned Academies in Australia (the others being Science, Social Sciences and Humanities). The mission of ATSE is to promote the application of scientific and engineering knowledge to the future benefit of Australia.

2. Background

Australia has enjoyed recent economic prosperity. By global standards, Australia is an affluent, but relatively small market. However, accelerating global integration is changing forever the volume and composition of international trade. To achieve international competitiveness, many Australian organisations must produce for the global market to achieve the necessary economies of scale and scope. Focussing on the domestic market not only limits growth opportunities, it can handicap competitiveness.¹ In addition, Australia is facing a major intergenerational change that will place significant pressure on Australian society to maintain its economic prosperity. Against this background of global change, intergenerational change and the knowledge economy, Australia must find ways to generate competitive advantage to increase output in order to sustain society. Clearly, one major focus for Australia must be to be a major innovating society to increase wealth for the benefit of society.

3. Overview of Submission

The Academy strongly supports the Government's intention to release an industry policy statement and is very pleased to make a submission on the Background Paper, Global Integration.

The Academy believes the main focus of future policy needs to be on knowledge based industries. Traditional service, manufacturing, agricultural and resource industries will continue to meet customer demands and improve their efficiencies but their growth will normally at best match the rate of growth of population or world demand. Real growth will require new industries or new products and services from existing industries, which is why the Academy's submission² is focused on two themes of the agenda, namely:

- Innovation³, and

- Investment.

Under each of these themes, the Academy has addressed a number of "possible issues for consultation" as identified in the Background Paper. Given below, under each of the relevant consultation issues, are the Academy's:

- key action items (dot points), and the associated
- recommendations (**in bold text**)

that are made in the Academy's submission; details are given in Section 5.

Innovation

Background Paper Issue: Building the Capacity of Firms to Innovate
ATSE Action Item and Recommendation:

- Ensure that industry is the major driver for innovation:

Provide increased support and incentives to industry to undertake innovation.

Background Paper Issue: Collaboration
ATSE Action Item and Recommendations:

- Encourage more collaboration between organisations and Publicly Funded research Institutions (PFRIs)⁴:

Develop new policies and provide increased funding for R&D linkage projects between organisations and PFRIs undertaking innovation. This includes funding projects in range between the ARC Linkage and the CRC programs. Further, the CRC program should be reviewed to ensure its long-term sustainability.

Develop policies and fund programs that enable organisations to both access relevant human capital skills from, and collaborate with, PFRIs.

Background Paper Issue: Improve Technology Diffusion
ATSE Action Items and Recommendations:

- Increase the capability to use knowledge generated elsewhere

Provide substantially increased funding to support 'outreach' programs, including the establishment of "Innovation Clusters".

- Stimulate the transition from the science base to the business sector

Governments should support improvements in institutional frameworks and capabilities that will facilitate the transfer of knowledge from PFRIs to the business sector and to provide access to funding support for early-stage innovation by PFRIs.

Investment

Background Paper Issue: Investment Facilitation
ATSE Action Items and Recommendations:

- Introduce flexibility in the innovation pipeline

Review existing government programs that support business innovation and implement greater flexibility in the allocation of such funds.

Review the various programs that support public funding of science and innovation and to facilitate the elimination of gaps and conflicts in the innovation system in Australia. In the case of the proposed RQF model, Impact must have at least the same weighting as Quality.

- Increase the national investment in the skills required to prosper in a knowledge economy

Provide significantly increased number of graduates in science, engineering and technology. Accordingly, much greater resources need to be provided for the teaching and curricula development of science and technology subjects in primary and secondary schools and the promotion of career opportunities.

- Need for investment in knowledge in Australia

Implement policies to strategically focus (increased) funding for R&D in PFRIs and encourage further investment in business expenditure on R&D (BERD) in Australia in order to stimulate growth of the knowledge-based industries.

Details of the Academy's submission are given in Section 5.

4. The Global Knowledge Economy - A Central Focus for Innovation

"There is one certainty: the long-term trend towards a knowledge-based economy continues, driven by the growing globalisation of knowledge".⁵

"In a knowledge economy the production, distribution and use of knowledge is the main driver of growth, wealth creation and employment across all industries".⁶

Available statistics support these claims:

- **Investment in knowledge exceeds investment in capital goods:** investment in knowledge (R&D, education and software) is 9 per cent of GDP in OECD countries, compared with 7 per cent for machinery and equipment.

- **Investment in knowledge generation is growing at 5 per cent per year** in the OECD nations.
- **Knowledge workers now constitute the largest category of employment:** professional and technical workers constitute over 35 per cent of employment in Australia.
- **Intellectual property is a major generator of economic activity:** the number of patents doubled in the past decade, to 450,000 pa, and many knowledge intensive companies generate greater profits from trade in intellectual property than in sales of goods and services.
- **The ICT sector now is responsible for 10 per cent of global business value added.**

Three rules of the global knowledge economy have been proposed:

- i. What determines economic performance is not so much knowledge creation as the knowledge distribution power of a country, company or culture;⁷
- ii. What counts is knowledge of how to develop new knowledge, how to locate and acquire knowledge generated elsewhere, how to recognise connections between different pieces of knowledge, how to embody knowledge in goods and services – these are the challenge for the modern manager and policy-maker;⁸ and
- iii. Knowledge is being transformed from an intellectual pursuit to a commodity in the global capitalist system. This leads to inevitable pressures for increased efficiency, productivity, outcomes and ownership, of knowledge.⁹

These observations provide the basis for the Academy's submission.

Globalisation of R&D/ Knowledge Production

Until 2000, the extent of globalisation of R&D was relatively modest. Most multi-national corporations conducted the majority of their R&D close to corporate headquarters. The exceptions were where local markets had sufficiently specific conditions to require local R&D capability; for example, the US IT companies setting up R&D in Europe, or where the goal was to gain access to particular world-leading expertise (for example, Sony at Stanford).

However, with the dramatic growth in advanced R&D capability in emerging countries with a markedly lower wage structures, notably China and India, there is a significant move by many companies to outsource R&D. In the 10 years from 1993, China's expenditure on R&D has grown from 25 billion Yuan to 130 billion Yuan. Investment in R&D by the multi-national companies operating in China has now reached 10 per cent of turnover (ACIIC China database).

There are a number of direct implications for government policy. For example:

- how to maintain, let alone increase, the attractiveness of Australia as a location to invest in R&D;
- future employment of the local R&D labour force; and
- how to access the offshore R&D capabilities to promote Australian innovation.

5. Key Issues

5. 1 Innovation

5.1.1 Building the Capacity of Firms to Innovate

- **Ensure that industry is the major driver for innovation**

Only 35 per cent of businesses in Australia are involved in innovation and expenditure on innovation is highly concentrated in a small number of businesses¹⁰. Clearly, existing organisations are a major source of innovation in Australia.

Publicly-funded research, in support of industry collaboration, has provided an incentive for industry to increase its share of its funds to innovation and R&D. This, in part, has resulted in a sustained increase in BERD over the last decade after a dramatic decrease when the 150 per cent tax concession was lowered to 125 per cent. The position has improved since then because of the incentive for companies to match funds in many government linkage programs, through the introduction of 175 per cent premium tax concession and so on. The tax concession and the rebate programs are a form of public support for research as it is a tax foregone. Further initiatives to encourage industry to engage in R&D would be to raise the threshold for the tax rebate system from the present \$1million research expenditure/ \$5 million turnover threshold to say \$2 million / \$10 million and to provide additional funding for collaborative research grants.

A business environment that is conducive to innovation depends on a wide range of policies that run the gambit of macro economic fundamentals (such as stable prices to competition policies) and to micro economic science and technology matters (such as incentives to private R&D and public procurement) and regulatory policies.¹¹

Accordingly, one major strategy to increase the level of innovation in Australia is to increase support and incentives provided to industry to undertake innovation.

5.1.2 Collaboration

- **Encourage more collaboration between organisations and PFRIs**

Of the total expenditure on innovation and R&D in Australia in 2003, 31 per cent was on R&D (26 per cent was internal R&D and 5 per cent was acquired R&D)¹². Furthermore, only 8 per cent of organisations had cooperation arrangements for their innovation activities, and of these about one-third had these arrangements with universities. Conversely, a fifth of those organisations in the top quintile, by innovation expenditure had collaborative arrangements for innovation with the 'science base'. Clearly, as more organisations become actively engaged in the innovation process they will naturally engage with the PFRIs, particularly if these institutions are prepared to actively market the services they can provide.

This low percentage of acquired R&D is consistent with the results from the UK study where only about 3 per cent of organisations had collaborative arrangements for innovation with the PFRIs¹³. These observations are occurring at a time when there is a trend towards 'open innovation' as organisations (particularly those organisations that are actively engaged in

innovation) increase their collaboration and the use of external sources of innovation to enhance their internal capabilities and address uncertain economic conditions.¹⁴

Results from the UK study indicate that less than 2 per cent of organisations in Britain regarded the 'science base' as being of 'high importance' when sourcing information for their innovation activities. Further, as organisations increase their own commitments to innovation, there is a greater percentage of these organisations engaging with the 'science base' to support their innovation activities. Accordingly, the relatively small proportion of organisations that are actively involved in innovation will make greater use of the PFRIs. Conversely, the various linkage grant programs funded by various agencies in Australia are over subscribed with quality applications. Hence, the challenge is to get more organisations engaged with PFRIs as a way to support increased levels of innovation by organisations.

It is necessary, in view of the unmet demand, to increase the quantum of funding that is available for the various programs that support linkage with industry, such as the ARC Linkage Grant Program and the Co-operative Research Centre Program (both of which are excellent programs). It is noted that there is a significant gap between the size of grants for ARC Linkage and the CRC program. Also, it is very difficult to aggregate adequate funds to justify a CRC application. Accordingly, ATSE recommends that consideration be given to introducing a new program to fund those projects that fall between the Linkage and CRC programs. In addition, increased support and incentives for PFRIs to align their activities with the innovation system could be provided by substantially increased funding for relevant programs; in the case of universities, this could be via the Institutional Grant Scheme, IGS. The IGS should be based, in part, on the quantum and quality of research supporting innovation in addition to the quantum and quality of academic research being undertaken. Increased funding for universities under such schemes as the IGS can be achieved by increased budget allocations and or by use of a small percentage of the Commonwealth operating grant to universities.

Accordingly, there is a need to further develop policies and provide increased funding for R&D linkage projects between organisations and PFRIs undertaking innovation. This includes funding projects in range between the ARC Linkage and the CRC programs. The CRC program should be reviewed to ensure its long-term sustainability.

A very effective mechanism for organisations to collaborate with PFRIs and to become engaged with the innovation process is via access to human capital. Programs which might be considered include funding both recent graduates and advanced undergraduates for placement in those businesses that have a history of a low level of innovation but which have identified the need for them to become actively involved in the innovation process. It is appropriate that there be complementary funding provided by organisations and that participating universities actively support and are engaged with these new initiatives. Such programs will lead to greater collaboration between these organisations and the PFRIs and thereby further enhance the innovation system.

Accordingly, there is a need to develop policies and fund programs that enable organisations to both access relevant human capital skills from, and collaborate with, PFRIs.

5.1.3 Improve Technology Diffusion

- **Increase the capability to use knowledge generated elsewhere**
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A frequently quoted statistic is that Australia generates only 2 per cent of the world's knowledge, so must seek the remaining 98 per cent overseas. Many countries, particularly in Europe, are making major investments to strengthen their access to international knowledge, through a variety of programs, such as: enabling students to move between universities in many countries during their degree studies (the Barcelona Agreement), supporting students to study abroad for a semester or year, international exchange programs, funding for researchers to participate in international research programs and funding for the interchange of personnel between PFRIs and industry. The same level of investment for similar programs does not exist in Australia.

There are significant opportunities to establish "Innovation Clusters" in Australia that focus on particular industry sectors and technologies. The purpose of these clusters is to link, via innovation / technology brokers, the knowledge base with appropriate organisations and PFRIs. It is important that PFRIs form part of the linkage to help interpret the sources of information and to translate it to specific organisations. This process will also help to develop collaborations between PFRIs and organisations that will be of long-term benefit to the process of innovation in organisations. There has been only limited support for such 'outreach' programs in Australia.

Accordingly, there is a need to provide substantially increased funding to support 'outreach' programs, including the establishment of "Innovation Clusters".

In recognition that there are multiple pathways for the adoption of research by industry, there has been recent debate about the prospect of Australia introducing a "third stream" or knowledge transfer" funding program to support such pathways. While the Academy is prepared to support such a concept, it is on the basis that such support is not at the expense of the introduction of "Innovation Clusters", and that any program funding is biased heavily towards those cases where industry/ end-user is clearly the driver of such pathways and where significant impact (or prospective impact) can be demonstrated.

- Stimulate the transition from the science base to the business sector

Spin-offs and licence fees from publicly funded research can make a useful contribution to innovation, especially in the information technology and, increasingly, in the biotechnology/medical technologies sectors.¹⁵ Their indirect contribution to cultural change in PFRIs is even larger. There are numerous examples¹⁶ of the need to improve the institutional frameworks (such as incubators and management of PFRIs and intellectual property) and to provide incentive structures (such as regulations governing researcher's mobility and the benefits from entrepreneurship) to ensure that there is more effective engagement between PFRIs and commercial organisations. Public seed capital to help early finance early-stage research (particularly at proof-of concept stage) when uncertainty is high and the projects too small for private venture capital has also proved useful, especially in countries where informal investors (such as business angels) cannot contribute much to filling the gap. There is also a case for public support and incentives to existing SMEs, especially in mature industries, to help them forge stronger links with the science sector.¹⁷

Accordingly, governments should support improvements in institutional frameworks and capabilities that will facilitate the transfer of knowledge from PFRIs to the business sector and to provide access to funding support for early-stage innovation by PFRIs.

5.2 Investment

5.2.1 Investment Facilitation

- **Introduce flexibility in the innovation pipeline**

While Australia performs well in basic research, there is currently a void in the middle of the innovation pipeline. At the commercialisation end, good products and processes will be picked up by existing industry; for example, intellectual property in the ICT¹⁸ and biotechnology areas is being further developed by the large companies.

While there are a number of very useful Government programs to facilitate the innovation process post invention, there are a number of restrictions place on the allocation of these assistance funds. There are examples¹⁹ where organisations have found it difficult to access funds locally (because of the conditions attached to the grants) and they have been forced to go overseas to source funds to support the development phase.

Accordingly, there is a need to review existing government programs that support business innovation and implement greater flexibility in the allocation of such funds.

An outcome of such a process will be the need to accept a higher level of risk in the allocation of funds. This increased risk must be considered from a portfolio perspective, recognising that while some projects may be assessed at a higher risk, they may have the potential to deliver significant returns.

There are a various examples of gaps and conflicts in the innovation system. One example of a conflict in the innovation system is provided by the Australian Government's intention to implement a Research Quality Framework (RQF) and link it to the distribution of research block funding to universities. The Academy has doubts about the value of such an approach but if it is to be implemented, is adamant that the system must consider Impact separate from, and equal to (for the purposes of funding distribution), measures of academic Quality. This Academy is most concerned that the importance of Impact has been substantially downgraded in the RQF Preferred Model; this issue still remains unresolved²⁰ and must be clarified. The Academy would prefer that the framework be retitled to "Research Quality and Impact Framework". Should there be a down grading of Impact, the research community in universities will rapidly adjust focus to give greater emphasis to Quality and less emphasis on Impact. This will produce major negative trends on the level of engagement by the research community with external stakeholders and the innovation system will suffer accordingly. [In addition, the teaching of engineering will suffer as academic staff (in engineering departments) focus more on academic outcomes; this will be reflected in hiring policies and staff will have less propensity to engage with industry and the quality of teaching to prepare students for professional life will decline]. As a result, the Australian community will receive less value for its investment in research, which is the direct opposite of what RQF is designed to achieve. The RQF model runs counter to other government policies and initiatives which are designed to encourage engagement between the research community and industry. Furthermore, if the RQF is introduced, it is essential that it be accompanied by a simultaneous increase in the block grant funding and that funding is provided to compensate for the additional administration costs that will be incurred. If this is not done then it can reasonably be argued that the large transactional/ administration costs that will be incurred with the RQF model will have the net effect of reducing the productivity, quality and impact of the national research system.

Innovation and R&D policy and funding programs are the responsibility of several departments such as Education & Science, Industry, Agriculture, Health, Environment, Communications and so on. It is important to maintain the spread and not to place these programs under a single umbrella as specific expertise is needed to respond to the requirements to the various industry sectors. Nevertheless, given this diversity of agencies, there are multiple opportunities for conflicts and gaps to be created in supporting the innovation system. In particular programs funded through agencies other than DITR may not always have an adequate focus on achieving commercial outcomes for the research investment. Many believe for instance that responsibility for CSIRO could be returned to the industry and resources area.

Accordingly, there is a need to review the various programs that support public funding of science and innovation and to facilitate the elimination of gaps and conflicts in the innovation system in Australia. In the case of the proposed RQF model, Impact must have at least the same weighting as Quality.

- **Increase the national investment in the skills required to prosper in a knowledge economy**

The researcher workforce in OECD countries continues to expand, driven mainly by investments in R&D and innovation in the business sector. Between 1991 and 2000, the number of researchers in OECD countries increased by 42 per cent. Although business is driving the overall demand for researchers, demand for researchers in the public sector, especially in universities, continues to expand. Large R&D-performing companies have downsized corporate laboratories and as a consequence have increased outsourcing. A growing share of business R&D spending and employment is found in small and medium size companies, in high technology start-ups and spin-offs and universities. The demand for tertiary-level graduates and science, engineering and technology (SET) personnel in particular, is expected to continue to grow in many OECD countries. On an international comparison, the number of Australian engineering graduates per million population lags most other OECD countries. Further, the aging of academic and research staff in PFRI is expected to further increase the demand for young researchers. In the UK study (Attachment 3), lack of skilled staff was identified as an important factor inhibiting innovation.

The supply of human resources in SET depends strongly, but not solely, on new entrants into higher education. However, not all countries are making equal progress in generating a sufficient supply of SET graduates despite the general up skilling of the population. Science and engineering graduates represent just over one fifth of all graduates in OECD countries.²¹

“Australia’s productivity gains over the past two decades are well known. Less well recognised till now is the price that we have paid as a result of reduced funding of skills formation...the next wave of productivity gains will need to be founded on a new skills formation strategy.”²²

There are major concerns that an inadequate number of people with science, engineering and technology skills is likely to provide a brake on growth in Australia as opportunities in their own countries reduce the availability of skilled immigrants and enrolments in education in these areas remains static. A Science, Engineering and Technology (SET) Skills Audit by DEST (December 2005) pointed to a range of initiatives required to expand the participation in enabling studies in schools, the need to upgrade SET skills in teachers, the need to lift enrolments in all tertiary studies, the need to attract and retain skilled migrants and encouraging Australians overseas to return. The conclusions of this Audit are of concern and need to be

followed up with policies to address the issues identified. In addition, it has been found that potential science and engineering students are poorly informed as to the employment opportunities that such qualifications can lead to and that this is proving to be a severe disincentive for students to enrol in science and engineering courses.

Hence, to support increased levels of innovation it is essential that there are a significantly increased number of graduates in science, engineering and technology. Accordingly, much greater resources need to be provided for the teaching and curricula development of science and technology subjects in primary and secondary schools and the promotion of career opportunities.

One of the most important challenges facing countries is the waning interest in science amongst young people. However, no single policy measure can address the underlying causes which are many and varied. Indeed, government, universities and business as well as individuals and society, must play a role in shaping values and perceptions of science and technology.²³

- Need for investment in knowledge in Australia

Australian investment in R&D, one key generator of knowledge, is approximately half that of the OECD average. This outcome is largely due to a relatively low business investment in R&D. However, it must be recognised that business has been funding an increasing share in recent years. Further, as noted in the Productivity Commission's Issue Paper (April 2006), Australia's total investment in knowledge (R&D, software and education) is similar (but somewhat below) the OECD average.

A recent Business Council of Australia report²⁴ argued that criticism of Australian industry for its relatively low investment in R&D, compared to other OECD countries, was inappropriate, essentially for two reasons: the R&D was comparable on a sectoral basis (given that Australian industry happens to be concentrated in low R&D sectors), and there is significant investment in other, non-R&D types of innovation. These findings may be correct, but they tend to reflect a view that the current industry mix constrains Australia to the current levels of R&D intensity without searching for strategies to improve performance and thereby meet Australia's future needs for economic and social development in a global economy.

Two broad determinants of national investment in R&D have been established: intrinsic factors which address the propensity to invest, and structural factors, which reflect the above argument that different industry sectors require different levels of R&D investment to remain competitive. The ICT and pharmaceutical sectors are the highest investors in R&D (typically 10 per cent of turnover) and they barely exist in Australia.

The Academy considers the evidence is clear with regard to both factors in Australia. Intrinsically determined investment in R&D is progressively falling further behind that of OECD nations, and significantly behind, in absolute terms, that of emerging economies such as China and India.

With regard to the structural issue, it is misleading to argue that we have a level of R&D appropriate to our industry structure. While there is a commodity boom we prosper, though at the cost of a dramatically rising deficit in our balance of trade, as we are forced to import the necessary goods from countries that do operate in the knowledge-intensive sectors. When the cycle turns, our present industry structure may find us desperately uncompetitive. In these

circumstances Australia's prosperity relative to the rest of the world will decline.

An examination of the relative economic performance of the US and the EU has revealed that 22 per cent of the US companies which were in the top 1000 (by market capitalisation) in 2000 had been created after 1980, compared with only 5 per cent in Europe.²⁵ Some 70 per cent of these new US companies were in the IT sector. Examination of the companies in the Industrial R&D Scoreboard²⁶ would indicate the Australian situation is far closer to (probably worse than) that of Europe than to the US.

The important conclusion is that countries that do not adequately support a substantial level of formation of new technology-based organisations in emerging high-growth industries, will not gain a foothold in these industries, and their subsequent industry structure will be progressively skewed towards low knowledge-intensity.²⁷ A particular opportunity for Australia is the strong commitment of public funds to medical research, in which Australia has a well-deserved outstanding international reputation yet much more needs to be done to explore the possibility and means of generating a significant industrial capability based on this research capability.

To avoid this decline means adopting measures to encourage the formation of a strong Australian capability in the next generation of emerging knowledge-based industries. In embryonic form some of these industries already exist but rarely are they financially robust enough to afford the type of research outlays to allow them to grow rapidly and become world competitive. This is where publicly funded support for research becomes extremely valuable to help these new companies or existing companies to diversify into new areas.

Other countries have policies and programs to nurture infant industries and attract foreign investment in key technology areas. They all rely significantly on public investment. Appropriate mechanisms could be developed in Australia, particularly in supporting the development of new technology. Furthermore, because we don't have industrial strength in the knowledge-intensive areas, (for example, DaimlerChrysler invests millions of dollars a year in a substantial in-house Strategic Futures Group) we tend not to have the capacity to identify important areas of potential growth via the private sector. Our industrial structure requires that we provide this knowledge-intensive capacity.

Accordingly, the provision of this capacity rests crucially on the strength of public sector institutions and the breadth and depth of their relationship with industry. Despite the additional funding for research through the 'Backing Australia's Ability' program, the capability of Australian universities to play their central role in knowledge creation and distribution is being eroded by the failure to maintain adequate growth in their basic funding. Further, the evidence available suggests that a number of major public sector research organisations are somewhat in disarray about their roles and purpose, with a consequent decline in staff morale. It would appear that there has been a significant decline in public esteem in a number of these organisations, and they are less able to play a crucial role in transmitting appropriate knowledge throughout the Australian economy.

Accordingly, there is a need to implement policies that strategically focus (increased) funding for R&D in PFRIs and encourage further investment in business expenditure on R&D (BERD) in Australia in order to stimulate growth of the knowledge-based industries.

Definitions

Innovation

A definition that is widely accepted and is supported by the Academy for innovation, is as

follows: "the introduction of any new or significantly improved goods, services, operational and/or organisational processes". There are definitions that are much broader relating to other business processes but for this submission only those that are linked with science, technological science and engineering (for brevity referred to subsequently as "science") are considered.

Publicly Funded Research Institutions

Publicly Funded Research Institutions (PFRIs) include universities, CSIRO, AIMS, ANSTO, DSTO, Geoscience Australia, Bureau of Meteorology, medical research institutions and so on. State government-funded organisations are also important, particularly in agriculture areas.

Footnotes

1. Industry Statement, Global Integration – Background Paper, Department of Industry Tourism and Resources, July 2006
2. This submission is based, in part, on two earlier submissions by the Academy. Namely the Academy's submission to the Productivity Commission research study on Public Support for Science and Innovation in Australia, June 2006 and the House of Representatives Standing Committee on Economics, Finance and Public Administration, Inquiry into Australia's Manufactured Export and Importing Base, Now and Beyond the Resources Boom, July 2006.
3. See Definitions at end of this document
4. See Definitions at end of this document
5. OECD, Science, Technology and Industry: Scoreboard 2005, Organisation for Economic Cooperation and Development September 2005
6. OECD, Science and Innovation Policy: Key Challenges and Opportunities, Organisation for Economic Cooperation and Development, Paris 2004
7. Ibid
8. Ibid
9. Professor Ron Johnston FTSE, <http://www.aciic.org.au>, 2004
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11. OECD Science and Innovation Policy, Key Challenges and Opportunities, Organisation for Economic Cooperation and Development, Paris 2004
12. Trewin, D and Paterson, M, Patterns of Innovation in Australian Businesses 2003, Australian Bureau of Statistics, Canberra 2006
13. Tether, B S & Swann, G M P, Sourcing Science – The Use by Industry of the Science Base for Innovation; Evidence from the UK's Innovation Survey, Version 1.2, 8 August 2003
14. OECD, Science, Technology and Industry Outlook, Organisation for Economic Cooperation and Development, 2004
15. The Economic Impact of the Commercialisation of Publicly Funded R&D in Australia, A report prepared on behalf of the Australian Institute for Commercialisation by the Allen Consulting Group, September 2003
16. Floyd, J M, Converting an Idea into a Worldwide Business Commercialising Smelting Technology, Metallurgical Transactions B, Vol. 36B, October 2005, pp557-575
17. OECD Science and Innovation Policy, Key Challenges and Opportunities, Organisation for Economic Cooperation and Development, Paris 2004
18. One such example is Radiata Communications Pty Ltd. Radiata was a publicly funded research spin-out that was the result of strong collaboration between CSIRO and Macquarie University. Radiata was the first company in the world to publicly demonstrate high transmission rates via wireless local area networks. Radiata was subsequently

acquired by Cisco Systems. (This example is included in reference 14).

19. Axon Instruments Pty Ltd. In 1985 Axon (an Australian company) submitted a small business innovation research (SBIR) grant to the US government to develop new technology, called an integrating patch clamp. The SBIR grant did not require any matching funding, nor were there any payback obligations or equity expectations.
20. Expert Advisory Group, Final Advice on the Preferred Model, DEST, Commonwealth of Australia, 2005
21. OECD Science and Innovation Policy, Key Challenges and Opportunities, Organisation for Economic Cooperation and Development, Paris 2004
22. Senate Enquiry, Employment Workplace Relations and Education References Committee, Bridging the Skills Divide, Commonwealth of Australia, November 2003
23. OECD Science and Innovation Policy, Key Challenges and Opportunities, Organisation for Economic Cooperation and Development, Paris 2004
24. Business Council of Australia, New Concepts in Innovation – The Keys to a Growing Australia, March 2006
25. EC Working Document, 2006
26. Van Dyke, N, R&D and Intellectual Property Scoreboard 2005, Intellectual Property Research Institute of Australia, University of Melbourne, 2006
27. Marceau, J et. al., The High Road or the Low Road?, Australian Business Foundation Limited, August 1997