PRIME MINISTER'S SCIENCE, ENGINEERING AND INNOVATION COUNCIL

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COMMERCIALISATION OF PUBLIC SECTOR RESEARCH

An independent working group, supported by the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) Secretariat prepared this paper.

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EXECUTIVE SUMMARY

Australia invests millions of dollars in innovation and research each year. The results enhance virtually every aspect of our lives either directly, such as better health and education, or indirectly, like the broader economic benefits of exciting new business opportunities.

This report focuses on commercialisation of research—the process of transforming ideas, knowledge and inventions into greater wealth for individuals, businesses and/or society at large.

The report concentrates on the need to improve Australia's ability to turn great concepts into commercial success stories, so we all benefit from the returns on our research investment.

The Prime Minister's Science, Engineering and Innovation Council (PMSEIC) was asked to explore commercialisation of 'public sector research', and recommend how we can strengthen this important part of the innovation process. (See Appendix 1 for Terms of Reference and membership details.)

Commercialisation of public sector research is on the rise in Australia. However, the working group believes there may be many missed opportunities that could deliver significant economic returns. How significant?

If we can grow 200-250 more Australian research-based companies like five of those shown in this report over the next 5 years, the prize would be around $20 billion added to our annual export earnings. Australia would be well on the way to reducing the national debt and the cost of servicing it.

Getting the prize will take effort and cost, though with ample reward. We need to generate about 10 times the number of licenses and spin-off companies that currently grow from the research of our universities and government research agencies.

They can't do it on their own. Their business partners are at least half of the equation: commercialisation specialists, those familiar with markets, with the world of private sector finance, venture capitalists, other investors and both small and large firms willing and able to innovate.

Together they will need to learn new skills, develop new tools and approaches to working together for mutual benefit. They will need to make better use of existing resources as well as attract new investment funds.

And taxpayers must signal strongly to governments that more public investment in people and activities devoted to this prize pays a golden dividend.

It worked for our Olympic performance, even more must it work for commercialisation so that our children enjoy the skilled jobs of tomorrow.

To improve performance, we should ensure that research projects with commercial potential have every opportunity to move through the commercialisation process. This involves bringing together the exciting work already underway in our research laboratories, with what industry needs and what the world market will embrace.

Government, industry and the research community must build on current initiatives and commit to improving business-research links and developing stronger commercialisation skills-base.

The public must become aware of and get behind our researchers, innovators and entrepreneurs and support a culture that welcomes risk taking, learns from failures, and celebrates success.

The PMSEIC working group determined that real effort is needed to improve Australia's performance in the early stages of the commercialisation process, particularly the 'pre-seed' or concept stage. The provision of incentives for collaboration between clusters of research organisations under the Government's new Competitive Pre-Seed Fund for Universities and Public Sector Research Agencies would assist in this area.

The report makes recommendations on four key issues:

- Information Exchange—facilitate information linking intellectual property (IP) to market opportunity, and help industry and researchers find a 'common language', for example, through a regular 'trade fair of ideas';
- Confidence to Commercialise—give researchers and their business partners the skills to commercialise, by raising researchers' awareness of commercial reality, educating industry about the potential returns from investing at the pre-seed stage, and providing both with the tools to better manage the risks. For example, encourage exchange programs and 'commercialisation sabbaticals', and establish a national forum of commercialisation units;
- Incentives for Success—provide appropriate incentives to encourage researchers to consider the commercialisation potential of their work and remove obstacles such as the taxation treatment of share options, media and political beat up for perceived failure; and
- International Development—establish profitable international developments to optimise the benefits of global collaboration, and showcase Australia's innovation potential to the world, while increasing local awareness and appreciation of research, innovation and commercialisation.

Australia should aim for world's best practice in commercialisation. To do this we need to get serious about tracking our performance against the 'best of the best'. We need to stretch upward, and set high targets for increasing the current number of licenses generated and spin-off companies created.

We can achieve this vision if governments, researchers, industry and investors work together to create and sustain a compelling future for Australian innovation and commercialisation.

SUMMARY OF RECOMMENDATIONS

Monitoring Commercial Outcomes

Recommendation 1

The working group supports the survey of university and medical research commercialisation and recommends the survey should be annual or biennial with consideration also given to analysing this data in conjunction with innovation and research and development (R & D) data collected in other surveys by Australian Bureau of Statistics and the Department of Industry, Science and Resources.

Consider including Commonwealth research agencies in the survey (as is the case with the Commonwealth Scientific and Industrial Research Organisation, CSIRO), or extending and adapting their existing data collection procedures to more easily track Australia's performance on licensing and spin-off companies.

Information Exchange

Recommendation 2

Improve access to information, linking IP to market opportunity through support for initiatives such as:

- Trade fair of ideas—to be developed from analogous models or integrated into existing industry-technology trade fairs. This initiative should be cross-sectional and designed to engage the interest of investors.
- Australian Research Council (ARC) study on research access mechanisms—to assess whether information held by government funding agencies, such as the ARC, is of value to technology investors and, if so, examine the best way to provide investors with quick and easy access to the information.

Confidence to commercialise

Recommendation 3

Improve commercialisation skills through:

- Commercialisation sabbaticals—promote greater mobility between industry and researchers through exchange programs for senior staff (for example, extending existing ARC linkage and CSIRO leadership and training programs).
- Commercialisation Forum—establish a forum for sharing information and experience in commercialisation, and for bringing together the staff of commercialisation and business units of publicly funded research organisations to: a) identify best practice, and b) sponsor activities to develop the skills of the staff.
- Short courses in basic business skills or commercial awareness—to supplement undergraduate science, engineering and technology courses. Similarly, the working group believes that business courses should include science awareness as a topic, to heighten our students' ability to understand and manage the technical risks associated with commercialising research.

Incentives for Success

Recommendation 4

Improve incentives and reduce disincentives:

- Offer a greater range of incentives—to ensure that researchers can gain clear financial and non-financial benefits in pursuing commercialisation. There should be few, if any, restrictions on the opportunities for researchers to directly and personally benefit from the commercialisation of their work, through a share of royalties or equity in the venture or other means. Non-financial incentives are important as well. These include greater professional recognition of commercialisation activities in tandem with traditional academic indicators (such as publishing), offering 'commercialisation sabbaticals' with industry, and enhanced mobility out of and back into research.
- Reduce tax disincentives—the Government should remove the current disincentive created by the immediate taxation liability that is incurred when share options are granted to researchers in spin-off and start-up companies.

Recommendation 5

The working group supports the initiative in *Backing Australia's Ability* to provide the Competitive Pre-Seed Fund for Universities and Public Sector Research Agencies.

It is important that the Competitive Pre-Seed Fund for Universities and Public Sector Research Agencies maintain a determined and ongoing commitment to investment in research commercialisation at its earliest stages and, at the same time, attract industry funds. The working group recommends that the pre-seed fund should provide incentives to augment collaboration between clusters of research organisations and their commercialisation entities, in order to establish critical masses of projects under professional management and the pooling of commercialisation skills.

International Development

Recommendation 6

To facilitate international development for commercialisation; Australian governments could provide more support and direction to their export agencies such as Austrade, in collaboration with industry associations, private sector financiers and service providers, to:

- strengthen, coordinate and maintain over the long term, existing programs to position Australia as supplier of innovative solutions and facilitate the entry of our new high-tech firms to international markets; and
- extend the services provided to new Australian businesses offshore through business centres (physical and information infrastructure), and networks, which provide a platform and supportive environment for accelerated learning about operating in international markets by Australian management teams.

Creating a Compelling Future

Recommendation 7

Role models—remaking our image at home and abroad as innovators

A national and ongoing campaign for entrepreneurial heroes should be instituted to boost local and overseas recognition of Australian researchers and entrepreneurs working together, taking calculated risks to develop their ideas for the market.

This could build on and strengthen existing programs at all levels of government, such as the entrepreneurial heroes element of the Commonwealth Government's Promoting Young Entrepreneurs initiative.

CHAPTER 1: ADVANCING WITH COMMERCIALISATION

The Commonwealth Government's Innovation Statement, *Backing Australia's Ability,* provides a comprehensive and integrated package of initiatives worth an additional Government investment of $2.9 billion over five years.

This major commitment paves a way forward for those in the research, development and innovation fields, focussing attention on and devoting resources to building research capacity, with better links to commercialising our research. Enhancing the way we manage our intellectual property (IP) and promoting awareness of innovation, amongst others, are also matters for ongoing attention.

Although Australia can be proud of its progress as a nation, *Backing Australia's Ability* made it clear that we need to more actively innovate and commercialise to make the most of the opportunities ahead. The statement addresses some early stage innovation funding gaps in the public and private sectors.

Public sector researchers in Australia, and the institutions they work for, are more actively reaching beyond the laboratory and looking towards the needs of industry as well as of society. Their links with business are steadily increasing[1]. The working group welcomes this trend, which is already producing positive results.

At the same time, the group acknowledges the strong view held by some in the research community that many public sector researchers wish to concentrate on their research, rather than try to also become entrepreneurs. Neither should a 'culture of commercialisation' become the dominant feature of all research agencies.

But should we not at least consider all public research for its commercial potential? The working group believes that all researchers could benefit, as well as their colleagues and the nation as a whole. This may be done while also ensuring, where appropriate, open and low cost access to research outcomes for the public good.

And, where commercialisation is desirable researchers should be encouraged to embrace best practice, and engage with end users to maximise economic and social returns. The gap between researchers and industry, which has been a barrier to success (for many other countries overseas also), is closing.

Limited data suggests that the commercialisation performance of Australia's universities, for example, is on a par with the American university average of licenses and spin-off companies; (1-2) per $100 million of research expenditure. It is a good base to spring from. But the best United States (US) practice is 5-20 times higher, with up to 27 spin-offs per $100 million of research expenditure in the best US universities.

The working group believes Australian research can reach this target, given adequate resources for commercialisation and through partnership with investors, new and established firms. Reaching the target could enable Australian entrepreneurs to build 200 large new export businesses, with a potential to earn up to $20 billion each year.

[1] A small but emerging trend claimed in the report on *Interactions between Universities and Industry* by the Coordination Committee on Science and Technology, 1999 and a subsequent ARC report.

1.1 The Meaning and Benefits of Commercialisation

What is commercialisation of research? The working group defines commercialisation as the process of transforming ideas, knowledge and inventions into greater wealth for individuals, businesses and/or society at large. The wealth comes in many forms: new products, services and business opportunities, which meet the public's needs, as well as possible benefits for research institutions.

This is demonstrated through the enormous benefits, enjoyed by all Australian taxpayers, flowing from the Government's yearly investment of $3 690 million in public sector research[2]. Our research institutions use this funding and contribute in a positive way to virtually every aspect of our lives—improved environment, health, education and training, free transfer of knowledge to service delivery, access to fee-for-service information, and technology transfer to industry.

There are many ways of delivering economic benefits to industry, including joint ventures, informal or semi-formal cooperative arrangements and other non-proprietary agreements. The working group acknowledges that these approaches all have their own merit and have been previously studied[3] as they also represent a return on public investment in research.

The group, however, decided to focus on two forms of commercialisation that have been used successfully in the public research arena—licensing and the creation of spin-off firms. The group made this decision because licensing and spin-offs provide the clearest path to the greatest industry/economic benefit through new and established industries. The performance of licensing and spin-offs can also be most systematically measured. The working group has discerned a big gap between our 'average' performance and the world's best.

But licensing and the creation of spin-off firms have already delivered big wins for this country. Indeed, five Australian commercialisation success stories featured at the end of this chapter, illustrate the big returns when public sector research links with the private sector to market ideas.

Tens of thousands of people around the world enjoy better hearing, sleeping, general health and physical security thanks to the pioneering efforts of the small group of Australian researchers and entrepreneurs with the skills and vision to form such internationally successful companies. Their products are often market leaders.

Three of these companies—Cochlear Limited, ResMed and Vision Systems Limited—are now collectively achieving annual world sales approaching $500 million (over 80 per cent of sales are exports). They directly employ around 1 500 Australians, and many more through outsourcing and supplier relationships. Each maintains strong collaborative research and development links with Australia's public sector researchers. Two of the companies, Cochlear and ResMed, have market capitalisations ranked around the top 50 Australian companies (see Appendix 3).

[2] Source: *Science and Technology Budget Statement 2000-01*

[3] For example, Productivity Commission Report on *Research and Development,* 1995 and various studies reviewed by Salter, J.A., Martin, B.R. 2000, *The Economic Benefits of Publicly Funded Basic research: A critical review.*

1.2 Direct Measures of Public Sector Research Commercialisation

Data on commercialisation is thin on the ground. A survey by the Australasian Tertiary Institutions Commercial Companies Association (ATICCA), gives a qualified basis for comparing universities with those surveyed in the United States (US) and Scotland by the Association of University Technology Managers (AUTM).

The average for US and Australian universities appears to be one to two 'start-up'[4] companies per $100 million of research expenditure[5]. But a few of the best overseas universities achieve 10 times the average numbers; for example Stanford University generates 20 start-ups per $100 million of research. Analysis is needed to compare how many spin-offs in the best and 'average' universities prosper over the long term.

The working group concluded that there are currently few direct measures of research commercialisation in Australia due to inconsistent definitions and a lack of readily available data. This means Australia cannot systematically track how research is being applied, including the number of licenses issued and how many spin-off companies are formed and maintained. Neither can we yet collect data on the overall amount of wealth generated from commercialising Australian ideas.

Without the benefit of consistent data collected over time to show trends, the working group relied on a limited snapshot of the performance of universities, the CSIRO and the Defence, Science and Technology Organisation (DSTO), based on licences and spin-offs (see next page and details in Appendix 4).

The encouraging conclusion to drawn from such data, which is consistent with studies cited in this report, is that commercialisation activity is on the rise.

The working group received presentations from a wide variety of public and private stakeholders, indicating that universities, government agencies and their commercialisation offices are working with limited resources to boost current levels of commercialisation activity. All agreed, however, that there is ample room for improvement. Monitoring improvement involves performance measures in addition to direct indicators of commercialisation. Some comments on other measures of research commercialisation are at Appendix 5.

To comprehensively assess Australia's performance we should also seek to relate and interpret specific commercialisation indicators to broader economic indicators. For example, current data does not allow us to determine what portion of indicators such as new job creation or expansion of exports and business activity arises directly or indirectly from the commercialisation of public sector research.

The working group strongly believes that the economic benefits from commercialisation depend not only on how successfully the public sector and industry work together. Equally commercialisation depends on general economic conditions and how Australia encourages a culture of innovation.

[4] 'Start-up' companies is the terminology used in the AUTM surveys. This is often synonymous with 'spin-offs', but not always, an example of the definitional problems in comparing statistics.
[5] Chief Scientist, private communication: US sourced analysis of AUTM data.

Snapshots of Commercialisation Data

Australia has some wins on the board, but we need to stretch towards higher targets.

Licensing
The results of a survey conducted by the Australasian Tertiary Institutions Commercial Companies Association (ATICCA) showed that in 1998, 63 new licences and option agreements were negotiated with industry partners among participating Australian universities. At that time, these universities were managing a total of 231 current and active licences and options. CSIRO records approximately 300 current licence agreements. Since 1994, DSTO has increased its managed licences by 36 per cent (from 47 licences to 64).

Spin-off or Start-up Companies
Over the last 10 years some 250 spin-off companies have been formed by, or in association with, public sector research agencies, according to a private consultancy database originating from a study of CSIRO and CRC spin-offs. During 1996–98, 46 spin-off or start-up companies were formed from tertiary institutions. CSIRO IP and expertise has led to the launch of 50 companies[6] over the past 15 years.

Income Generated
Licence and spin-off income of more than $31 million (1998) was generated by Australian universities according to the ATICCA survey. CSIRO estimates its spin-offs have created more than 1 000 new jobs and have a combined annual turnover of more than $200 million. [7]

1.3 The Way Forward for Measuring Commercialisation Outcomes

To effectively determine whether commercialisation is occurring, and how to improve its outcomes for the future, we need to establish more comprehensive and systematic indicators for innovation, including some specific to commercialisation.

Some initiatives have already begun and others will be undertaken. These should provide a useful platform towards establishing these indicators. They are, (i) the ARC commissioned benchmarking study, (ii) the new IP Research Centre initiative announced in *Backing Australia's Ability,* (iii) the 1999 ARC and CSIRO commissioned patenting study and (iv) measuring and monitoring of *Backing Australia's Ability.*

ARC-Commissioned Benchmarking Study

On behalf of Government, the ARC, in conjunction with the National Health and Medical Research Council (NHMRC) is benchmarking the performance of our universities and health and medical research institutes in commercialising research and technology transfer and has commissioned a study to enable Australia to compare commercialisation outcomes from our universities, medical research institutes and CSIRO with similar institutions in Canada and the United States. The study also aims to identify the national economic benefits from research commercialisation and technology transfer.

This study is being carried out in cooperation with AUTM in the United States and Canada, using AUTM's world-renowned *Licensing Survey*, modified to reflect the characteristics of research commercialisation and technology transfer in Australia.

[6] Upstill, G. and Symington, D., *Generating New Companies from CSIRO Technology* August 1999
[7] ibid

The first year's data on commercialisation indicators from Australian universities and health and medical research institutions is expected to be available before the end of 2001.

IP Research Centre

Under *Backing Australia's Ability* a new IP Research Centre is being established to review, benchmark and incorporate world's best practice in IP administration into Australia's IP system.

The 1999 ARC and CSIRO Commissioned Patenting Study

In the area of patents, in 1999 the Australian Research Council and CSIRO commissioned a study into the character of Australian patenting activity[8], which set benchmarks for Australia's performance. The study found that a strong foundation of scientific research is necessary for patenting in high-tech industries and prosperity in the new economy. While the link between high-tech industries and research is stronger in Australia than in most countries, the study also found that patenting activity overall in Australia needs to be increased by 70 per cent to be at world average level as a proportion of gross domestic product GDP.

Patenting is part of the critical process of linking IP to market opportunity, discussed in detail in the next chapter. Patenting data is one of a group of indicators, which contribute, to measurement of commercialisation.

Measuring and Monitoring the Impact of Backing Australia's Ability

The Department of Industry, Science and Resources (ISR) is working with other agencies involved in implementing *Backing Australia's Ability*, the Productivity Commission and the Australian Bureau of Statistics (ABS) on developing a set of expected outcomes and performance indicators for innovation and the impact of the *Backing Australia's Ability* framework.

In May 2001 the ABS presented to ISR the first standard statistical survey of the Australian venture capital industry's investment in projects. A follow-up survey has been agreed for the current year.

Each of the above initiatives will deliver benchmarking parameters to help us measure the achievement of commercial objectives of innovation and take necessary policy decision in relation to gaps. The capability also to analyse commercialisation in public sector research institutions is, to the working group's knowledge, currently unavailable except in the area of patents.

Further action must be taken to extend the data being collected from Australian research institutions so we can accurately benchmark our performance.

[8] ARC / CSIRO: *Inventing our Future: The link between Australian patenting and basic science.* F. Narin et al. 2000.

Recommendation 1

The working group supports the survey of university and medical research commercialisation and recommends the survey should be annual or biennial with consideration also given to analysing this data in conjunction with innovation and R & D data collected in other surveys by Australian Bureau of Statistics and Department of Industry Science and Resources.

Consider including Commonwealth research agencies in the survey (as is the case with CSIRO), or extending and adapting their existing data collection procedures to more easily track Australia's performance on licensing and spin-off companies

1.4 New Wealth from Research-Australia needs 10 Times More

Australia should aim to build another 200 or more research-based companies of the type and scale illustrated by the following five success stories.

Case Study One: ResMed **Breathe Easy**

Between five and 10 per cent of adults experience obstructive sleep apnea, or disturbed breathing while sleeping, which can be a serious condition.

An Australian research team, led by The University of Sydney's Professor C. E. Sullivan, first invented a way of treating sleep apnea in 1980.

Several years later Dr P C Farrell of the *Baxter Centre for Medical Research* recognised the exciting possibilities and set the wheels in motion to commercialise Professor Sullivan's idea, by forming the ResMed group of companies.

ResMed has grown into an international success story—a $3 billion company with annual world sales of US$140 million (independent estimate for financial year (FY) 2001, growing at 30.5 per cent), after starting-up with $1.2 million from an original group of nine staff and several private investors. In May 2001, ResMed's share price reached US$58.96, or 20 times its listing price in 1995. The company is part of the new global 'sleep industry', which it helped to create, now valued at $1 000 million worldwide and growing at 20 per cent per year.

There are other benefits for Australia also. Of the 850 or so staff, 400 are located in Australia. All R & D and manufacturing is in Sydney, with 95 per cent of product exported to 50 countries. In FY 2000, ResMed spent US$8.5 million on R & D, paid $14 million federal tax, and $1 million payroll tax.

Case Study Two: Cochlear **Sweet Sounds of Success**

Research that began at The University of Melbourne 30 years ago is today changing lives right around the world. An Australian idea kick started the global company, Cochlear Limited—now the world leader in hearing implant products, providing cochlear implants for children who are born deaf and adults who have become deaf. Today Cochlear Limited is in the vicinity of Australia top 50 companies with a market capitalisation of over $1.8 billion and has projected sales in 2001 of $200 million.

Professor Graeme Clark, from the University's Department of Otolaryngology, started researching electrical stimulation of the inner ear in the early 1970s, trying to find a treatment for people with profound hearing loss.

By 1978 a prototype had been developed but the university needed a commercial partner. Paul Trainor and his company, Nucleus Limited, had considerable experience developing and commercialising implant devices such as cardiac pacemakers. So Nucleus, the University and the Commonwealth of Australia joined forces, signing a Collaborative Agreement to commercialise the cochlear implant. The Commonwealth's contribution to the agreement was through a grant to fund commercialisation in the public interest.

By the early 1980s, when the first Nucleus devices were being implanted, a separate subsidiary, Cochlear Pty Ltd, was formed. The company was sold to Pacific Dunlop with the Nucleus group in 1988 and was listed in 1995. Cochlear employs around 600 people, 350 of them in Australia, with head office, manufacturing, and the majority of R & D remaining here.

Case Study Three: GroPep **Growing for the Future**

Over the past 12 years GroPep Ltd has expanded to become an international biopharmaceutical development company in the area of growth factors and pharmaceutical cell culture. It has achieved a capitalisation of $100 million and employs over 50 people. Key in GroPep's success has been its long-term collaboration with CSIRO and its other parent organisations.

GroPep Ltd is a spin-off company set up by CSIRO and The University of Adelaide in 1988 to hold joint intellectual property on novel growth factors. In 1991, CSIRO and The University of Adelaide expanded their research collaboration, to include the Child Health Research Institute and the Dairy Research and Development Corporation, through the formation of the CRC for Tissue Growth and Repair. GroPep became the commercial arm of the CRC. When the CRC was renewed in 1997, the company became a full partner of the CRC that now also included Flinders University. In recent years the company has formed additional strategic alliances with other companies and organisations operating globally in the biopharmaceutical business. The alliance is aimed at the commercial exploitation of growth factors for wound repair, the treatment of diseases of the gut, agriculture including aquaculture and in the development of products for industrial scale cell growth.

GroPep has exclusive responsibility to commercialise pharmaceutical applications of the CRC's research output. Its successful products in the market place include a new growth factor for growing cells in culture. The factor is a non-animal derived protein that can be produced economically for use by the biotechnology industry for a variety of pharmaceutical applications.

The company was successfully listed on the Australian Stock Exchange in September 2000. CSIRO, and the other partners in the CRC, currently retain an equity share in the company.

Case Study Four: Vision Systems **Visionary Approach**

One of our country's science success stories, Vision Systems Limited, is based on smart Australians creating and selling smart products. With core capabilities in engineering and technology common to a wide variety of products, and to secure funding for future development, Vision Systems Limited is a science-based company whose products and R & D services are in demand all over the world.

The company was founded in 1987 with $5 million venture capital. It began as a contract R & D company with its sights set on becoming a world-scale business. The strategy was to sell services to other companies, while at the same time using the resource to springboard into high value new product opportunities for global markets.

Vision Systems' collaboration with public sector research over the last ten years has brought successes such as: the VESDA Laser plus smoke detection apparatus that will sell close to $100 million in exports next year (CSIRO); video based surveillance products and a Laser Airborne Depth Sounder Business, sold to Tenix last June (DSTO).

Of Vision Systems' $145 million projected sales for 2001, $125 million (or 86 per cent) will be exports from Australia—growing at 35 per cent per annum. Vision Systems has created more than 500 highly skilled jobs since 1993 and now has close to 4 000 shareholders. Vision Systems' key competitive edge is R & D and the extent of innovation in the product.

Case Study Five: Radiata **High Speed Mover**

The demand for wireless communications expanded rapidly at the end of the decade with a newly allocated radio spectrum in 5GHz range. Radiata Communications Ltd, an Australian company manufacturing chips for high-speed wireless networks, was well placed to take advantage of this growing market.

Radiata had its research origins in Macquarie University and CSIRO work on radiophysics and semiconductor technology. In 1997 Neil Weste and David Skellern formed a new company with a licensing agreement from CSIRO. The company was incorporated in the US in 1999.

Radiata Communications was taken over by Cisco Systems late in 2000 in a deal worth $570 million. Under the terms of the agreement, Cisco common stock was exchanged for all outstanding shares and options of Radiata. Cisco already had an 11 per cent investment in Radiata. The 53 employees were to join a newly formed business unit, the Wireless Networking Business Unit of the Ethernet Access Group, in Cisco's Commercial Line of Business.

CHAPTER 2: ISSUES IDENTIFICATION

The early stages of commercialisation (pre-seed, seed and start-up) are critical to the success of projects. These are the delicate periods between the birth of a great idea and the translation of that idea into a product or process ready for market. On the international scene, it is widely acknowledged that the pre-seed stage can be a bottleneck, which can prevent projects from progressing through the remaining stages of the commercialisation process.

In Australia this is certainly the case, which is why the working group concentrated on this stage. This chapter sets out what the group considers to be several important outstanding issues relating to pre-seed specific to Australia for further consideration. Stakeholders and recent reports draw the issues from the group's collective experience, as well as from presentations.

2.1 The Pre-Seed Stage of Commercialisation

For consistency, the working group relied on the following definitions of the three early stages of commercialisation:

pre-seed: Also known as proof of concept stage. Establish product concept and examine the costs and benefits of producing a marketable commercial product (feasibility study, and preferably a preliminary market survey). This leads to confirmation of the product concept.

seed: The period in which the initial business concept is formed, prototypes of the firm's products are developed and the management team is beginning to form.

start-up: Funds are provided for product development, staffing, initial marketing and other start-up costs. These firms have usually been in business for a short time; have a management team in place; and are positioning to sell their product/service commercially.

These definitions are based on those from the *Innovation Investment Fund* program, administered by the Industry Research and Development Board.

As an idea or concept moves its way through the commercialisation process its relationship with 'risk' changes. Initially, researchers face high technical risk since the performance constraints of the concepts have not been fully explored and as a result there is considerable uncertainty over whether the technology will become commercially viable.

High technical and market risks at this stage make investment in very early stage research a very high risk and therefore unattractive option not only for portfolio investors, but many venture capitalists as well.

However, as and when funds become available to further develop and test the idea, researchers and their backers can progressively resolve technical issues and become more confident in a concept's promise. The limits to success are more clearly defined and often diminished. The costs associated with further developing and ultimately producing the concept for commercial use also become more certain.

At this stage, technical risk is reduced, but there is greater financial exposure and the possibility of commercial failure becomes more predominant. On top of development costs, there are increasing marketing costs and risks, which continue to rise right though to product launch.

2.1.1 The Innovation Progression Gap

Due to reasons outlined below, the working group considers that the pre-seed stage of the commercialisation process is the most critical and vulnerable area for Australia. This is the vital stage during which an idea is born, an opportunity is recognised and concepts are tested and evaluated for their potential (see Figure 1).

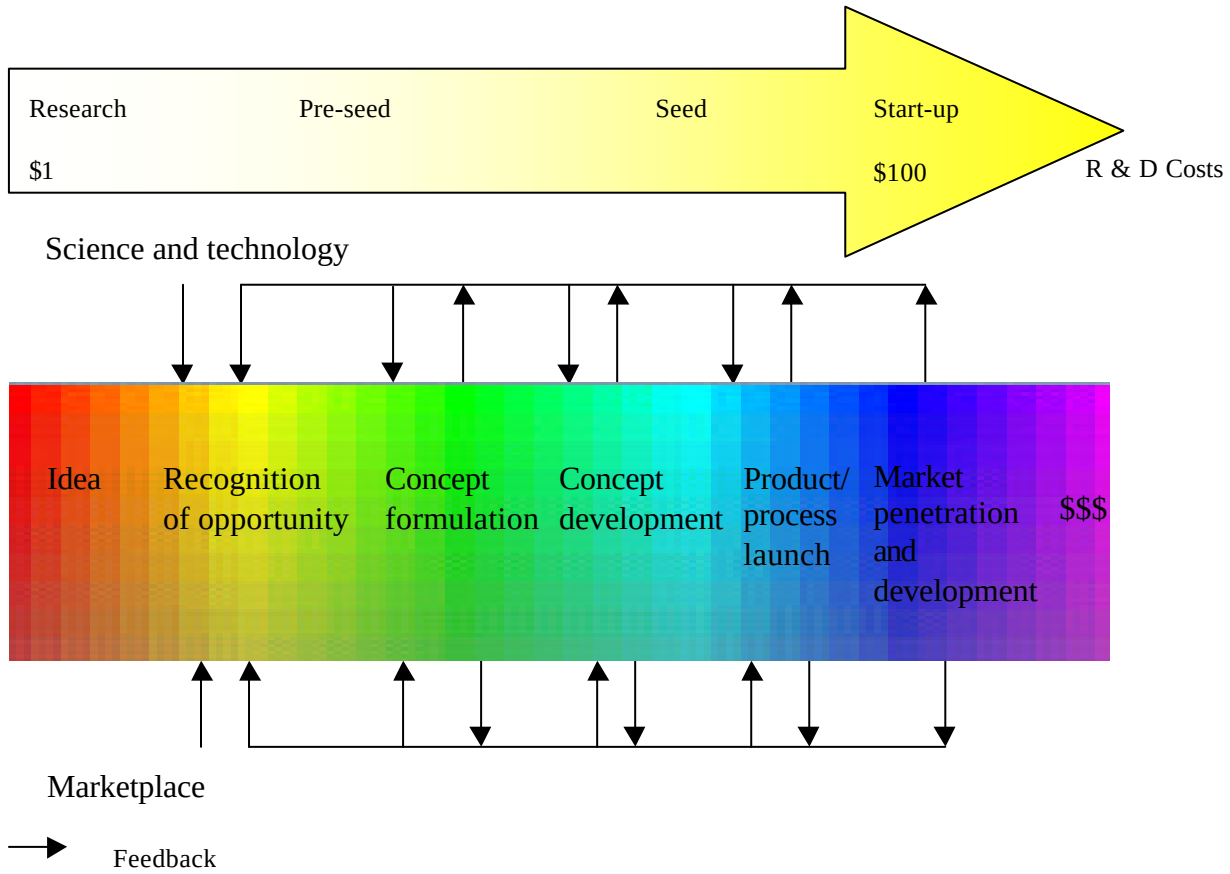

Figure 1: Stages for Commercialisation of Research

The average cost of bringing a project through the pre-seed stage is estimated at between $250 000 and $300 000, according to the Commonwealth Department of Industry, Sciences and Resources (ISR). This is not surprising given that working through the pre-seed stage can take anywhere from a few months to several years.

While many projects cost around $100 000, others, like biotechnology pre-seed stage projects, cost typically $500 000 to $1 000 000, and this is only the first in a series of investments needed to successfully commercialise a product, process or service through to market.

Currently in Australia, there is a gap in availability of private sector funding for public sector researchers to take research through the pre-seed (idea) and onto the start-up (products development/marketing) stages. The Australian Research Council calls this 'innovation progression gap.[9]

[9] NBEET. *Maximising the Benefits: Joint ARC/HEC Advice on Intellectual Property*. Canberra: National Board of Employment, Education and Training. 1995

The working group believes this is partly because Australia is not managing the interactions between research institutions, individual researchers and potential business partners as well as it could. In the US, on the other hand, there are well established networks of alumni and business angels which assist in identifying research with commercial potential and investing in its development.

Although there are an increasing number of recent initiatives in this area,[10] Australian research doesn't yet have strong networks of this type. We need to encourage them by promoting and expanding various forms of public-private sector partnerships that will not only help secure resources, but help improve the efficiency of processes that link researchers with commercialisation specialists, investors and other firms that may wish to license, acquire or share equity in developing their technology.

The Innovation Investment Fund has at least been successful in changing these interactions and processes in the later stages that follow pre-seed.

Similarly, adequate funding at the pre-seed stage of a project is essential for expediting each of the knowledge exchange processes discussed below. The way in which funding is sourced and managed may encourage, or limit, strategic alliances and building a critical mass of skills which ensure the project's long term success. The Government's Competitive Pre-Seed Fund is therefore, an important incentive discussed in the next chapter.

The working group determined that the costs and risks associated with the pre-seed stage comprise four major issues, leading to recommendations that could help to reduce or better manage them:

- Information exchange;
- Confidence to commercialise;
- Incentives for success; and
- International development.

This report's recommendations aim to bridge the innovation progression gap at the pre-seed stage, in order to stimulate up to a 10-fold increase in the number of projects and investment at the earliest stages of commercialisation.

[10] For example: *Uniseed* (Universities of Queensland and Melbourne); collaborative arrangement between Macquarie, Wollongong and Tasmania; work with alumni at Monash University

2.2 Issues Arising

Now, more than ever before, the realities of international markets and the development of new technologies dictate that if we do not act we will lose out on countless opportunities to transform our ideas into income and jobs at home in Australia. We cannot afford the excuse that 'average is OK.'

This requires immediate action to address knowledge, skill, incentive and investment gaps at the early stages of commercialisation. Recent progress has been made—governments have made a first step to close these gaps through a wide range of programs and initiatives, in particular through the new Competitive Pre-Seed Fund for Universities and Public Sector Research Agencies and the Biotechnology Innovation Fund established under *Backing Australia's Ability.*

2.2.1 Barriers to Information Exchange

One of the issues blocking Australia's success is that potential investors and small firms trying to commercialize technology with researchers, often find it too resource intensive to identify and assess research and IP opportunities for potential commercial value. While both parties may understand the need to open the doors of communication, and engage with each other, it is seen as a time consuming exercise that has no guaranteed results.

Another issue is that our research organisations have many different approaches to knowledge and IP management. As a result, investors are left to deal with myriad approaches to dealing with these institutions. The effort required is a serious disincentive. In addition, there can be complications associated with sharing information between researchers and their potential business partners, during the early stages of assessing commercial viability.

These problems are recognised by commercialisation officers in universities, private sector commercialisation brokers and government agencies that are trying hard to resolve them. However, further assistance and networking approaches are needed to make the most of existing resources and efforts to address these problems. Since commercialisation is a competitive field, such networks will typically need to be formed strategically and allow clustering of complementary skills and resources.

Another challenge is that even with the best risk management practices, investors in early stage research commercialisation claim a 'rule of thumb' that for every 100 research projects scanned for commercial potential, only 10 may justify further investment, research and the development of a business plan. Of these they claim, even a smaller number—perhaps only one or two—will have true potential to achieve strong financial returns. And these one or two projects still require additional research, development and marketing costs to see them to fruition—costs, which are likely to be around 100 times more than the cost of the original research.

The working group believes that with enhanced tools, skills and management experience it is possible to improve these 'struck gold' ratios, but a very large number of research projects will still need to be assessed to 'mine the lode'.

Related to all of this is the need to establish effective and efficient communication, identify and assess relevant research outcomes, and establish the ownership and transfer of IP. These are just a few of the more critical aspects of successfully linking IP and market opportunity.

More effective linkage also requires:

- attitudes to, and skills in knowledge sharing between potential partners;
- the need for researchers to appreciate the commercial realities of bringing ideas to market;
- the need for investors and other potential business partners of researchers to understand the complexities and global networks of the research process;
- resolving other cultural/attitudinal differences;
- interrelating institutional and business decision making and time scales;
- evaluating the compatibility of partners;
- undertaking 'due diligence';
- patenting; and
- contract negotiation.

As a significant impediment to linking IP to the market, the identification, protection and management of IP was closely considered by the working group. A broad range of IP initiatives and reforms are underway. In the short to medium term, these will foster much improved practice and lead to enhanced 'business process efficiency' for the mutual benefit of Australian industry and researchers.

These initiatives aim to increase:

- knowledge and understanding of IP;
- the number of institutions with effective IP policy/management mechanisms;
- patenting and licensing activities;
- the ability to attract funding from public and private sources; and
- the confidence of industry and venture capitalists, in investing in research.

These initiatives are summarised in Appendix 6. The ARC-commissioned AUTM-based survey should be able to measure, in part, the effectiveness of these initiatives (recommendation 1).

The working group recognises the significance of identifying, protecting and managing IP but given the action already in hand does not see the need to further examine IP processes in this report

The working group stresses the importance for existing and new IP initiatives to be promoted, encouraged and monitored at all levels of public sector research and by Government. The ARC/NHMRC AUTM-based survey (see recommendation 1) may in part determine the effectiveness of these initiatives.

Further opportunities for improving the culture and processes of linking IP to market opportunities are discussed in Chapter 3.

2.2.2 Lack of Skills and Confidence to Commercialise

The strong feedback on public sector research, presented to Australia's innovation and business communities through the Innovation Summit Implementation Group[11], was:

> *Where there is commercial orientation, there is often a lack of expertise in valuing and managing IP, business planning and business management*.

Public sector research institutions need to become as creative about using their knowledge for best practice commercialisation, as their staff are about using it for research. Commercialisation skills, experience and practical business knowledge must support this creativity.

This may include 'picking yourself up and trying again' after a start-up failure, an event that can raise eyebrows in Australia but recognised by successful countries abroad as a 'badge of courage' and an acceptable, and perhaps even essential, part of gaining entrepreneurial experience.

Australia also has a shortage of people skilled and experienced to facilitate commercialisation, in both research institutions and industry. An organisation with just one or two skilled commercialisation staff can only achieve so much. The group welcomes work underway to develop 'in-house' commercialisation offices and business development staff in universities and Government research agencies. The group is also encouraged by the emergence of more private sector firms offering commercialisation services to researchers and institutions to facilitate first investments in the pre-seed and later stages of commercialisation.

The emergence of a market for such a niche service clearly indicates a growing commercial orientation of public sector research and change in institutional attitudes.

2.2.3 Inadequate Incentives

Cultural and financial issues affect commercialisation in both negative and positive ways. The working group concludes that researchers are offered few 'carrots' to take a more commercial attitude to research. While, in some cases, they face 'sticks' if they adopt such an attitude and are even penalised if they are seen to fail.

Reproach from and restrictions by those who do not understand risk and how to manage it come from many sources, including cautious government and research institution officials fearful of a 'failure', politicians concerned about negative publicity, and even ambivalent peers and colleagues.

This cultural environment can strongly discourage public sector researchers from embracing a commercial outlook, even when they are confident their idea is worth pursuing. When researchers enter the commercialisation environment, they often risk personal financial security and rarely gain recognition for their achievements.

Australians and their institutions are becoming increasingly focussed on the importance of risk management. We need to educate our decision-makers to better understand and manage both technical and commercial risk to encourage researchers to participate in commercialisation of their projects and enthuse industry to invest in this early stage. Managing risk means better

[11] Innovation Summit Implementation Group (ISIG) 2000, *Innovation: Unlocking the Future: Final Report*, Canberra. ISIG was established to implement the recommendations of the National Innovation Summit, a joint business and Government initiative held in Melbourne in February 2000.

understanding all aspects of a project, including what may go wrong. This increases confidence and reduces the level of 'fear of the unknown', which is a disincentive for many people. Best practice risk management can also help to create a culture that has the courage to stand behind those who try, even if they do not at first succeed. This is needed to produce many more success stories on the scale of Cochlear Pty Ltd and ResMed. The working group believes that if there were around 250 more such successes, we could virtually remove our current account deficit (see Chapter 4).

The group is aware that some researchers are concerned about being 'forced' to be too commercial, being distracted by administration tasks and teaching instead of focussing on new ideas and concepts, or having to spend too much time applying for research or industry funding.

Funding pressures in research institutions can encourage commercialisation by acting as an incentive to search for end users of the research. It can also have a negative impact, creating a temptation to follow the shortest path to selling off IP cheaply[12]. This yields less financial return than licensing which could also give a quicker return than spin-offs (see the licensing case study 6).

Case Study Six: Monash University **Licensed to Succeed**

Melbourne's Monash University knows that commercialising through licensing agreements can be a quick, easy-to-negotiate and cost-effective way to act on good ideas for commercial advantage. The university developed preliminary immunity enhancement technology, which it knew had real potential. To gain early success from its ideas and to secure funding for future development, the university, agreed to licence the technology to a public company, Norwood Abbey Limited in January 2001. The agreement benefits both parties. The university receives around $500 000 over six months to complete proof of concept research and basic in-vitro clinical trials. Then Norwood Abbey Limited can license the technology for Monash and commercialise it in exchange for royalties.

Although in some cases commercialising through licensing may not be as lucrative as through a start-up company, not all researchers are interested in pursuing this option. Some may be more interested in continuing research and receiving additional research funds as a result of a licensing deal

This trend of IP sales is exacerbated by disincentives associated with retaining equity in commercialisation, which offers longer-term and larger returns, for the individual researcher, their organisation, entrepreneurs and the economy as whole.

The working group heard various examples that would explain why for example, a young modestly paid researcher may understandably shy away from an immediate tax obligation for accepting share options in a new company (this does not apply to statutory agencies which do not offer this incentive). In such a case, the tax treatment of longer-term options is a disincentive

[12] Broadly speaking, rights in IP may be exchanged in the following ways -

- Sold in return for research cash up-front-*gives a rapid, but mostly lesser return*,
- Licensed for some cash and percentage of returns in the future-*less cash now but greater returns in the long run if the firm with the license is successful*, and
- Trade IP in exchange for equity in a start-up or spin-off business-*generally the best return in the long run (if business is successful), but researchers will be cash-strapped in the short term.*

and, despite the chance of greater long-term returns from holding equity, a quick (although low-value) sale of IP may be more attractive to the researcher.

2.2.4 Constraints on International Development for Australia's Benefit

Australian researchers and industry need to be prepared to work collaboratively with foreign partners to achieve greater commercial outcomes for themselves and for Australia. International collaboration and strategic alliances are being used more and more for commercialisation in other countries, with proven success.

The working group received feedback that while the number of small high-tech Australian firms entering the United States and other large markets is increasing, many are still under-performing in overseas markets.

Many Australian high-tech companies succeed in international markets by establishing marketing and technical support overseas, while maintaining their research and development in Australia. Others find it necessary to establish themselves as a registered 'local' company overseas.

The key obstacles for new Australian companies offshore are market oriented and include:

- lack of early access to smart capital;
- lack of access to business connections and being able to build a presence;
- lack of access to management expertise for leading international growth;
- lack of a high profile for Australian technology in the overseas markets (especially when compared with other nations); and
- the small size of typical Australian technology companies.

A number of services provided by Austrade, and a range of approaches including strategies offered by venture capitalists, are currently available to help small, potentially high-growth companies expand overseas markets. The next chapter discusses enhancing such support mechanisms.

The working group heard of some concerns that the 'national benefit' criterion has been applied in a way that worked against international collaboration and commercialisation.

The working group notes that at least with the Industry Research and Development (IR & D) Board's programs, specifically through new ministerial directions on the R & D *start* program, that there are few, if any, restrictions on commercialisation through international activity. For example it is not mandatory for all manufacturing arising from a supported innovation to be undertaken in Australia.

It is important that in Australia we learn about, accept and apply a range of strategies to achieve maximum financial return on ideas and IP commercialised for overseas markets. For example, some technologies must be licensed to overseas companies, since there is no market or industrial capacity to develop them in Australia. In these cases, we must ask ourselves what the best strategy is for collaborating with the overseas licensor, so we maximise national benefit from the license.

Another important route for establishing Australian presence and demonstrating our technology in overseas markets is through international collaborative research and development projects undertaken by public sector researchers and/or Australian industry. For example, in large collaborative projects such as those funded by the European Union's (EU's) Framework Programs, Australian research partners' expertise is highly valued. However, there have been occasions when lack of funding has placed our researchers at a disadvantage compared to overseas partners who have both expertise and funds.

The working group welcomes the recent announcement of a significant and targeted fund for collaboration with the EU under the Commonwealth's Innovation Access Program.

Negotiating a beneficial IP agreement and/or equity position in international projects often depends on the size of the 'cash and in-kind' contribution, which the Australian partner is able to inject, beyond the value ascribed to the technology and IP which they bring to the project.

Members of the working group welcome the positive changes in the IR & D Board's guidelines and consider that outward looking and comprehensive definitions of 'national benefit should also be applied in other government programs.

The working group supports International development, which leads to benefits from the commercialisation of Australian research.

Outward looking and comprehensive definitions of 'national benefit' should be used in assessing government funding applications for research projects, recognising that international collaboration need not result in Australia losing its IP.

CHAPTER 3: BRIDGING THE GAP

To dramatically increase the number of research commercialisation projects proceeding through the pre-seed stage, Australia needs to bridge the innovation progression gap by dramatically improving:

- information exchange-linking IP to market opportunity;
- confidence to commercialise-critical mass of skills serving strategic networks;
- incentives to success-offer a greater range, reduce disincentives; and
- international development-collaborate as well as compete with international players to target larger markets and secure greater returns from commercialisation.

The initiatives proposed in this chapter are drawn out of the four key issues. They aim to encourage the development of policies against the background of a rapidly evolving and increasingly supportive attitude for commercialisation in research institutions. The proposed initiatives, adequately funded, should support institutions' responsiveness to commercial opportunities.

But, as mentioned before, the general economic and industry environment for R & D determines the other side of the partnership that will determine the final outcomes.

3.1 Information Exchange

There is a need to better understand the business requirements of commercialisation, to enable Australia to move more quickly on certain stages (such as developing in-principle agreements on approach) and be accepting of the amount of time required for other stages (such as the detailed and critical due diligence stage).

We need to develop tools and more skilled commercialisation specialists to help researchers and their potential business partners exchange information about respective capabilities and interests, more efficiently and quickly identify projects with strong commercial potential and kick-start them.

In a best case scenario, such as with Australia's ResMed success, it only took several weeks of discussion for entrepreneur Dr Peter Farrell and researcher Professor Colin Sullivan to develop an in-principle agreement on the way forward with their commercialisation project (case study 1). It took another three years of development and finalising due diligence and other matters before ResMed was launched, but an early and efficient start spurred Dr Farrell and Professor Sullivan on and added momentum to the project.

Commercialisation alliances between large public sector research agencies, such as the Defence Science and Technology Organisation (DSTO), and established private sector companies often evolve over long periods of time, during which staff and management on both sides work to build trust and become comfortable sharing knowledge and information. DSTO, for example, has collaborated with industry since the early 1970s to develop an Australian capability in advanced sonar systems (see case study 7).

Much of this collaborative research has been conducted through a licensing arrangement with Thomson Marconi Sonar, and the 'industry alliance' strategy adopted by both parties has led to export sales of approximately $40 million per year.

Case Study Seven: Sharing Knowledge to Create Wealth

DSTO's alliance agreement has proved a highly successful way of facilitating shared knowledge between DSTO and key Defence companies which has resulted in several successful commercial endeavours, including export sales of approximately $40 million per year in one case, and exports in another area which has made Australia the world's largest manufacturer of towed arrays.

In 1997, DSTO and the Royal Australian Navy signed a five-year Alliance Agreement with Thomson Marconi Sonar (TMS). This agreement allows for the exchange of information on sonar systems technology and trends, in an open but confidential environment.

Together, DSTO and TMS have developed a number of sonar products for defence applications, the Kariwara solid filled towed sonar array being one example. TMS has taken DSTO's Kariwara technology further under licence to produce new generation Sentry solid towed arrays for the world commercial seismic survey market. Sentry generates export sales worth approximately $40 million per year. TMS has gone further in developing the second-generation solid towed array called Guardian and has secured export orders for this latest technology.

More than 500 kilometres of towed arrays have been exported by TMS since 1996, making TMS in Australia the world's largest manufacturer of towed arrays.

The Alliance with TMS has also resulted in an agreement to collaborate on developing a new-generation system for the seismic market, known as FOTASS (Fibre Optic Towed Array Streamer System). The aim is to produce a low cost system that offers higher bandwidth and even better reliability than existing technology. If successful, this will reinforce Australia's reputation as a world leader in seismic array systems.

Improving the ease and quality of communication between individual researchers, business representatives and agents (such as staff in commercialisation offices or private sector brokers) is critical to public sector commercialisation. The working group notes that this is being addressed at the organisational level through seminars and courses offered by universities, other public sector agencies and the private sector. But still more resources and networks are needed (such as 'enterprise centres' and public-private investment vehicles like Uniseed[13]) to facilitate these links and create a more commercially focused culture among all parties.

To further develop the relationship between researchers and their potential industry partners, the working group recommends an annual 'trade fair of ideas' (see recommendation 2). The aim of this fair would be to improve access to information and build a better understanding, by researchers and partners, of each other's requirements.

The Commercialising Health Innovations Forum for example, helps to put health researchers in touch with venture capitalists interested in that sector. Some options for how a 'trade fair of ideas' could be developed are suggested in Appendix 7.

[13] Uniseed is a $20 million pre-seed and seed fund established in October 2000 as a joint venture between the commercial arms of the University of Queensland and the University of Melbourne.

The working group often heard questions about whether 'goldmines' of unexplored commercial opportunity existed in Australia. The working group believes Australia needs not only better tools but many more people who are skilled and experienced in commercialisation to quickly locate and assess research outcomes that may already be available or just emerging. All excellent research should be scanned for potential commercial application. But until we have better tools and the people working in the right networks we cannot be sure how big or accessible the 'gold mines' are.

To this end, the ARC has commissioned a study on 'research access mechanisms', which will enable researchers and industry to investigate the feasibility of developing and implementing ways to make information about the outcomes of ARC-funded research available to technology investors to assist in their investment decision-making.

The study will establish the level of interest by technology investors in accessing information that is held, or which could be collected, by the ARC. The consultants will also identify the potential risks and other impediments to releasing this information, and develop strategies to minimize or overcome these.

Recommendation 2

Improve access to information, linking IP to market opportunity through support for initiatives such as:

- Trade fair of ideas—to be developed from analogous models or integrated into existing industry-technology trade fairs. This initiative should be cross-sectional and designed to engage the interest of investors.
- ARC study on research access mechanisms—to assess whether information held by government funding agencies, such as the ARC, is of value to technology investors and, if so, examine the best way to provide investors with quick and easy access to the information

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The working group wishes to make special mention of the Cooperative Research Centre (CRC), a program that is unique to Australia. This program has been highly successful in bringing industry and researchers together in the push toward a greater amount of successful commercialisation of public sector research in Australia. It has also effectively promoted the development of commercialisation skills, and cultural change in how researchers interact with industry.

The working group welcomes the continued importance placed on the Government's continued commitment to CRC program by the Government, as indicated by the further support it received through *Backing Australia's Ability.* The working group is aware that the CRC Committee is looking to further enhance the CRC program to allow even greater output of commercial activity and for better access by SMEs.

3.2 Confidence to Commercialise

A commitment to invest a large amount in developing staff with the skills, knowledge base and depth of experience to manage Australia's commercialisation of public sector research is essential for our future.

These skills should be developed earlier and not just at the 'coal face' of commercialisation. Too often, those researchers wishing to pursue commercialisation are left to develop the necessary skills as they work through the process. They deserve to enter the process better prepared for the business of commercialisation, so they can recognise opportunities and operate more effectively overall.

The working group found that public sector research institutions vary in the way they manage commercialisation and some rely on small internal business offices staffed by people with a mixture of commercial and/or technical skills. Few staff, if any, have sufficient resources to research best practice (other than superficially) and few units are large enough to be able to afford to develop tailored training to enable them to better meet their needs.

Building a critical mass of commercialisation skills is vital. The working group noted that this may come through a multi-pronged approach, including cooperation with complementary organisations or through 'enterprise centres', which should:

- develop staff with scientific, technical and business skills backgrounds. This should build on a sound knowledge base, providing extensive 'hands on' experience. Ideally it would include experience in overseas start-up companies and, as accepted in the United States, may include experience with commercialisation that makes a good start but does not succeed. To this end, the NHMRC for example, has introduced Industry Fellowships, which offers an initial two years in an industry R & D setting in Australia or overseas, and two subsequent years in an academic research institution;
- deliver greater mobility between research institutions and business. This should be done using existing programs where possible. Two are the ARC linkage programs and the CSIRO leadership and training programs (see case study 8) which give opportunities for staff to participate in exchanges;
- develop stronger risk management skills in those researchers wishing to concentrate on commercialisation. This should lead to staff more able to recognise 'dead end' projects early enough to enable funds to be shifted into more promising projects quickly;
- develop broader training programs at the undergraduate level to instill confidence in researchers and teach them to scrutinize their research early for potential commercial opportunities. Such 'upgrade training' should provide exposure to the whole set of elements of commercialising research; and
- develop the specific skills relevant to nurturing and managing pre-seed activities (business courses often focus on the later stages of commercialisation).

Case Study Eight: CSIRO

Developing Commercial Skills for Researchers

CSIRO recognises the importance of effective commercialisation and in 1999 commissioned a program to develop the organisation's commercial awareness and skills.

The Commercial Awareness Development Program provides a suite of courses for all levels of the organisation, addressing networking, relationship building and secondments, as well as developing traditional business skills. The centrepiece of this program is a new course, which brings together research managers, scientists and commercial managers in a challenging and highly experiential learning environment.

The intention is that this course will become accredited as part of a Graduate Certificate/Diploma of Management.

The working group believes there is a need to leverage off existing resources, both financial and non-financial, and there are many ways this can be done. The national forum or network described in recommendation 3 is one example. This forum would enable participants to:

- discuss alternative approaches to commercialisation;
- benchmark themselves against the best practice in like organisations;
- develop broad guidelines on best practice, which in turn could attract more venture capital and overseas investment; and
- use the collective strength of the forum to sponsor specialist conferences and training courses, which smaller individual units could not afford to run in their own right.

One option is for the forum to run it through and build upon the Australian Tertiary Institutions Commercial Companies Association (ATICCA), in line with two of the Association's objectives, which are to provide:

- a stimulating forum for members and associates to share their ideas and experiences; and
- an advisory group of tertiary institutions and kindred organisations interested in establishing like services.

Another option might be to discuss with the United States Association of University Technology Managers (AUTM) the possibility of extending its international activities to include an Australian chapter. Now a large and mature organisation, AUTM has expanded to include bodies with similar interests in government and industry and is well regarded as having achieved a spirit of common purpose amongst its members. AUTM has recently appointed a Vice President International (Dr Cathy Garner, University of Strathclyde) to investigate and address the needs of international members and international collaborations. ATICCA and AUTM members have already exchanged visits and opportunities for collaboration are being discussed. Whichever approaches to networking are adopted, the Government should provide support at least in the early stages as members work through challenging issues such as benchmarking and developing best practice guidelines.

Research agencies experienced in commercialisation training recommend that short 'summer school' courses are cost effective, and have succeeded in educating research staff on how to respond to commercialisation opportunities.

Recommendation 3

Improve commercialisation skills through:

- Commercialisation sabbaticals—promote greater mobility between industry and researchers through exchange programs for senior staff (for example, extend existing ARC linkage, CSIRO leadership and training programs and the NHMRC Industry Fellowship scheme).
- Commercialisation forum—establish a forum for sharing information and experience in commercialisation, and for bringing together staff involved in the commercialisation and business units of publicly funded research organisations to a) identify best practice and b) sponsor activities to develop the skills of the staff.
- Short courses in basic business skills or commercial awareness to supplement undergraduate science, engineering and technology courses[14]. Similarly, the working group believes that business courses should include science awareness as a topic, to heighten our students' ability to understand and manage the technical risks associated with commercialising research.

3.3 Incentives for Success

The *University Research: Technology Transfer and Commercialisation Practices*[15] report, produced by the ARC, proposed strategic action plan for improving Australia's research commercialisation. Suggested actions on incentives included:

- increasing the opportunities and rewards for commercialisation institutions and individuals within them;
- addressing disincentives, such as finance allocation mechanisms, and promotion criteria that discount external research commercialisation activity; and
- encouraging and facilitating entrepreneurship.

The working group supports this approach and believes that a greater number of incentives should be available to researchers and their institutions to encourage them to apply their skills to the innovation progression gap, and encourages universities or Commonwealth research agencies to pursue this. For example, shareholder options in spin-off companies, or returning a significant proportion of royalties from IP to the research team are two ways researchers can be motivated to work towards commercialisation.

There is strong anecdotal evidence that the range of incentives for researchers is being limited by the taxation treatment of share options, which can result in excessive taxation liabilities prior to a researcher realising any rewards from commercialisation.

[14] As recommended in the Chief Scientist's report *The Chance to Change*, November 2000 and in previous PMSEIC reports, eg. *The Nexus Between Science and Its Applications*, May 1998.
[15] Australian Research Council: *University Research: Technology Transfer and Commercialisation Practices.* Commissioned Report No. 60. Nov 1999.

Recommendation 4

Improve incentives and reduce disincentives:

- Offer a greater range of incentives—to ensure that researchers can gain clear financial and non-financial benefits in pursuing commercialisation. There should be few, if any, restrictions on the opportunities for researchers to directly and personally benefit from the commercialisation of their work, through a share of royalties or equity in the venture or other means. Non-financial incentives are important as well. These include greater professional recognition of commercialisation activities in tandem with traditional academic indicators (such as publishing), offering 'commercialisation sabbaticals' with industry, and enhanced mobility out of and back into research.
- Reduce tax disincentives—the Government should remove the current disincentive created by the immediate taxation liability that is incurred when share options are granted to researchers in spin-off and start-up companies.

The public sector research and industry communities have welcomed the new Competitive Pre-seed Fund for Universities and Public Sector Agencies, being established under *Backing Australia's Ability* as a real incentive to raise the level of investment in early stage research commercialisation.

For example, Advanced Powder Technology (APT), described in case study 9, would not have proceeded without the pre-seed money contributed by The University of Western Australia. At the time of writing this report, the guidelines for the Competitive Pre-Seed Fund had not been published.

The working group believes that close attention will need to be paid to the way in which the fund is structured and managed, in order to ensure that its focus remains fixed squarely on the pre-seed stage of research commercialisation. One way to achieve this would be to structure the fund to provide incentives for clusters of organisations (for example universities and public research institutes) to establish strategic alliances to manage pre-seed investments.

These partnerships could be based on portfolios of investment in particular areas of technology (for example biotechnology, pharmaceuticals or telecommunications) and/or they could be regionally based.

Recommendation 5

The working group supports the initiative in *Backing Australia's Ability* to provide the Competitive Pre-Seed Fund for Universities and Public Sector Research Agencies.

It is important that the Competitive Pre-Seed Fund for Universities and Public Sector Research Agencies maintain a determined and ongoing commitment to investment in research commercialisation at its earliest stages and, at the same time, attract industry funds. The working group recommends that the pre-seed fund should provide incentives to augment collaboration between clusters of research organisations and their commercialisation entities, in order to establish critical masses of projects under professional management and the pooling of commercialisation skills.

Australian public sector researchers, in collaboration with investors and commercialisation specialists, and aided by the measures proposed in this report should attempt the spring to a ten-fold increase in the number of spin-off companies and other commercialisation projects. In succeeding, there would be a rapid rise in the demand for pre-seed funding. Governments should be ready to show leadership to the investment community to prime the spring forward. To achieve the goal of 200-250 new businesses from research outcomes will require supporting at least 2 000 pre-seed projects over the next 5 years. To leverage investor funds, the Government would need to increase its current investment of $75 million to between $250 and $500 million over five years. The key success factor however, remains the ability to select and support projects with commercial viability.

Case Study Nine: Advance Powder Technology (APT)

Western Australia's Advance Powder Technology (APT) is an example of proactive commercialisation by a university and the importance of pre-seed funding

APT has developed a new, low cost process for manufacture a wide range of ultra fine and 'nanoscale' powders. The enhanced chemical, mechanical, optical and magnetic properties of these powders open up a fresh range of potential uses and applications.

To assist with the commercialisation of APT, The University of Western Australia used professional external assistance and its own pre-seed funding of approximately $350 000. The basic research behind APT was supported in part by the ARC (out of a Special Research Centre) from 1990-1999. APT then attracted an investment of $7.5 million from Samsung Corning of which $6 million was used to set up a joint venture company called Advanced Nano Technologies. A pilot plant has been established by the joint venture in Perth and now employs 16 staff and is likely to be in production scale for many applications. The remaining $1.5 million invested by Samsung-Corning was used to buy them a 10per cent equity position in APT, thus valuing APT at approximately $15 million. The company has a strong board that includes members with substantial commercial experience.

In line with the university's IP and Revenue Sharing Policy, any financial returns associated with the original IP will be shared equally between the researchers and the university. The total equity position in APT for the university is approximately 75 per cent.

This case study demonstrates the need for and judicious use of pre-seed funding to take University spin-offs to the next stage of investor-readiness.

3.4 International Development

Australian researchers and their commercial partners increasingly know that, more often than not, it is necessary to launch new technologies directly onto the world market. This means targeting countries and regions that are most receptive to their offer while tailoring the offer to meet the client's expectations.

Case Study Ten: CSIRO and the Itochu Corporation

An International Alliance

In 1995, CSIRO and Itochu Corporation signed a Letter of Intent, which was reviewed in 1997 and extended to 2003. The initial focus of the relationship was on food technologies, seen as an area of special strength for both Itochu and CSIRO. The document was flexible and only indicated how the relationship was to operate within broad parameters. This allowed different business arrangements for different projects. For example, some arrangements involved supply of materials and equipment developed using CSIRO technology, other involved licensing CSIRO technology, and others involved CSIRO conducting R & D for the Japanese organisation.

The value to CSIRO has been over $6 million. In all cases, the Japanese partners paid full cost for the R & D projects the IP is the property of CSIRO. The licensing deals mean that the Japanese partners have rights to exploit the research results in Japan only, while CSIRO has the rights to all other territories. The CSIRO-Itochu agreement establishes an effective model for commercialising Australian technology in Japan in a way that can assist Australian industry. For instance, one of the Agreement projects involved CSIRO working with an Australian company on abattoir equipment. The company was then able to sell its equipment into Japan through contacts made at the time, and CSIRO developed new equipment that can be used in Australia, but would not have been developed without the Itochu agreement. This model can also be readily adapted to other parts of the Pacific Rim. The Australian Institute of Marine Science (AIMS) have recently executed a separate memoranda of understanding (MOU) with ITOUCHU to cover certain areas of biotechnology.

The working group supports, where appropriate, commercial ventures going global sooner rather than later to maximise the potential return on commercialisation of public sector research. The question is how best to go global?

- Market from Australia to the world;
- Establish offshore operations; or
- Dealing with an overseas company (sale, joint venture, etc).

Seeking offshore commercial partners at the early stages of commercialisation may ensure that some potential competitors are captured and the risks, as well as the returns of the commercialisation, are shared.

As pointed out in section 2.2.4, new high-tech Australian companies looking to start-up overseas face key obstacles that are market oriented, including access to business connections and being able to build a presence internationally. The concept of incubators has worked well in other areas and the working group suggests there is good reason for Australia to help translate this experience to companies tackling the greater complexities of commercialising directly into overseas markets.

In the United States, for example, there is an 'international incubator' in San Jose to assist companies enter the US market. Though it offers only basic facilities with little managerial support, gaining entry to the incubator is very highly competitive.

Recommendation 6

Facilitate international development for commercialisation through:

- Australian governments providing more support and direction to their export agencies such as Austrade, in collaboration with industry associations, private sector financiers and service providers, to: strengthen, coordinate and maintain over the long term, existing programs to position Australia as supplier of innovative solutions and facilitate the entry of our new high-tech firms to international markets; and
- extend the services provided to new Australian businesses offshore through business centres (physical and information infrastructure), and networks which provide a platform and supportive environment for accelerated learning about operating in international markets by Australian management teams.

Case Study Eleven: Redfern Photonics

Investing for Growth and Global Markets

Redfern Photonics Pty Ltd, a world-leading developer and manufacturer of optical telecommunications, was created in November 1998 to develop the commercialisation skills needed to build successful, investment ready, global start-up companies based on the research conducted within the Australian Photonics CRC (APCRC). Australia has world-leading IP in the photonics sector, technology critical in enabling future high bandwidth communications, components, systems and networks.

The group employs about 209 people, in Redfern Photonics itself and its subsidiaries, with that number projected to reach 350 by the end of 2002. Redfern is headquartered in Sydney with offices in California, US and Hamburg, Germany. It has created six vertically integrated yet separate entities with the rights to develop commercial products based on public and private-funded R & D. Redfern's mission is to successfully develop these companies until they can attract sufficient external equity to establish themselves as independent parts of an integrated Australian photonics industry. This is already the case with Nufern, in which Redfern has a 30 per cent interest. To June 2001, the Redfern group has attracted more than $220 million in private investment.

Redfern has recently completed its second major external investment funding from a group of internationally respected investors led by Deutsche Bank's private equity investment group, DB Capital Partners, Asia Pacific, totalling over $54 million (US$28 million). DB Capital Partners see their investment in Redfern as a part of their portfolio strategy to invest in high-growth technology companies that have experienced management teams and clear strategies for taking products to market. Redfern was benchmarked by DB Capital Partners against other global investment opportunities in optical networking and regarded as truly world-class. Redfern's unique relationship with the APCRC is the factor that will enable it to stay on the cutting edge. The APCRC, with a research staff of more than 60 full-time equivalents, is one of the largest photonics research operations in the world.

CHAPTER 4: CREATING A COMPELLING FUTURE

From the world's first mechanical refrigeration plant and the stump jump plough, to the first car radio and the heart pacemaker, Australia has a strong history of innovation. However, many of these early inventions were developed before we fully understood the importance and value of commercialisation. They were pushed through by the conviction of an individual, or small team, who believed in the potential of their idea. Today, with the ever-increasing pressures of globalisation, it is vital that we support our innovators and actively engage in commercialisation on a much larger scale—on a truly *national* scale.

We must get behind the future of commercialising Australian research in the same way that we pulled together as a nation for the highly successful 2000 Sydney Olympics.

We should encourage, enthuse and support our public and private researchers, engineers and technologists. We should learn about and celebrate our great commercialisation achievements.

Companies like those profiled in the case studies collected for this report should be widely recognised and applauded. These companies exist because in each case, Australia offered excellent research that was matched, from the beginning, with leadership and a technical and commercial risk taker.

Genuine entrepreneurs learn and profit from their experiences, including their failures. From 100 potential commercialisation projects, there may be only one or two successes. We need to encourage all who have been prepared to take a risk and who have learned from their experiences and support them to 'give it another go'.

The Government should support a vision for Australia as a successful research entrepreneur. And it needs to be done in a consistent and long-term way, as a nationally coordinated campaign.

Such a national campaign (from the classroom to boardroom) would build on the 'Promoting Young Entrepreneurs' initiative. The campaign would continue to support recommendations made on this theme at our National Innovation Summit and in previous PMSEIC reports. It would help us to recognise that people are Australia's most critical asset for commercialising ideas and creating new enterprises. Apart from our natural resources, Australia's competitive advantage comes from our world-class science skills, and one of the lowest cost industrial R & D capabilities in the world.

We can emulate the success of other small countries, like Ireland and Finland, which have addressed commercialisation weaknesses similar to ours, to change direction and become recognised for their previously 'hidden' strengths.

For example, Ireland has moved beyond its traditional image to become the economically successful 'Celtic Tiger'. This transformation involved a 15-year, bipartisan industry policy, leading to massive investment by corporations, trade surpluses, employment growth and increasing per capita community wealth. The fast growing pharmaceutical, electronics and software development sectors were targeted. A new tax regime and investing in a strong education system to train people in the necessary skills for new jobs were also critical.

Recommendation 7

Role models—remaking our image at home and abroad as innovators.

A national and ongoing campaign for entrepreneurial heroes should be instituted to boost local and overseas recognition of Australian researchers and entrepreneurs working together, taking calculated risks to develop their ideas for the market.

This could build on and strengthen existing programs at all levels of government, such as the entrepreneurial heroes element of the Commonwealth Government's Promoting Young Entrepreneurs initiative.

The vision to build a compelling future must be underpinned by challenging 'stretch targets' for commercialising public sector research. Australians must be motivated to imagine and work towards a future where our national debt could be eliminated over the next 10 to 15 years by supporting the growth of 200-250 more companies of the scale of Cochlear, ResMed, Vision Systems or Radiata.

With 250 new companies, each earning Australia yearly export incomes of $100 million and employing 500 people, we could earn at least $20 billion more each year and further reduce the national debt and the cost of servicing it.

The working group believes that the number of research projects required to fuel this growth in new start-up businesses exists. First we need to find enough potential start-up projects that are capable of attracting investment. For this, we need more skilled people at the interface of research and industry, as well as efficient processes and tools to routinely scan, identify and assess public sector research projects.

To grow that number of successful new companies over the next 10 years, entrepreneurs and investors must be encouraged to risk and invest in a new start-up businesses. Many will not succeed, but our innovation and industrial system will be richer for the experience. Governments on behalf of taxpayers and through a larger Competitive Pre-Seed Fund[16] can encourage, but not carry all the investment needed for this.

To achieve this vision, we must bridge the innovation gap in the ways recommended in this report.

Some of the resources for achieving it must will come from smarter networking and collaboration, some from redirection of existing priorities. But Australian taxpayers that will benefit from new businesses from research must signal to Governments that further investment in people and the right skills for commercialisation is warranted.

Through collaboration with AUTM, being undertaken by the ARC, we can identify the world's best practice and performance in research commercialisation, and set that as our target. It may now be Stanford University, US. Why not here in 5 years?

The Australian Chief Scientist's report, *The Chance for Change* challenged Australia to increase the numbers of spin-off companies every year by a factor of ten.

[16] Up to $500 million over 5 years to fund enough pre-seed projects to grow 200 big new firms.

As well, the recommendations in this report, if adopted, will facilitate licensing the results of publicly funded research where this is the appropriate course. The pursuit of other commercialisation strategies with new and established businesses, such as 'sheltered start-ups'[17] should also be encouraged and would help lift the 'strike rate'.

And, it is just as important to manage projects to maximise the value and economic returns from commercialising them, as it is to target increased numbers of projects.

To identify more commercially viable projects, industry must be able to scan and tap into the many research projects underway at any one time. We must encourage a culture of knowledge sharing between our research community and industry, so that our IP flows and grows through the commercialisation process and commands a high value through competition in the global market.

The Commonwealth Government, through its Innovation Statement, *Backing Australia's Ability*, has embarked on a course, which could lead to a new vision for Australia successfully commercialising its ideas.

It has put in place economic policy settings through which industry can derive benefit from the Innovation Statement initiatives. It is too early to say, however, exactly what the impact of *Backing Australia's Ability* will be on commercialisation outcomes, given the broader industry context. This will need careful monitoring to ensure the effectiveness of industry and innovation policy measures.

The working group recognises there is more to be done, both in areas of government policy, and also by those in research, industry and the investment community.

Government can lead, not only through vision and example, but through general economic policies which influence the health of the industrial R & D landscape, a critical component of the commercialisation process.

With these foundations in place, Government and industry can work together to create and sustain a compelling future for Australian innovation and commercialisation.

[17] A new division of an existing business.

GLOSSARY OF ACRONYMS

AIMS	Australian Institute of Marine Science
APT	Advance Power Technology
ARC	Australian Research Council
ATICCA	Australian Tertiary Institutions Commercial Companies Association
AUTM	Association of University Technology Managers
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DETYA	Department of Education, Training and Youth Affairs
DSTO	Defence, Science and Technology Organisation
FOTASS	Fibre Optic Towed Array Streamer System
IP	intellectual property
IR & D	Industry Research and Development
ISR	Department of Industry, Science and Resources
ISIG	Innovation Summit Implementation Group
NHMRC	National Health and Medical Research Council
PMSEIC	Prime Minister's Science, Engineering and Innovation Council
R & D	research and development
SMEs	Small and Medium sized Enterprises

APPENDIX

Appendix 1 Terms of Reference and Working Group Membership

Terms of Reference

The Prime Minister's Science, Engineering and Innovation Council (PMSEIC) was asked to explore the world of commercialising public sector research. Specifically, PMSEIC's working group was asked to:

- examine Australia's current performance in commercialising public sector research, to enable benchmarking against other countries and against best practice organisations;
- identify and examine barriers faced by individual researchers and public sector organisations, and ways in which they may be overcome; and
- report on case study examples of best practice and successful commercialisation of public sector research.

The working group focussed on the major impediments in the early stages of commercialising public sector research (Chapter 2). The group did not review all policies for innovation that impact on commercialisation.

Rather, it concentrated on the research carried out in universities and in the two largest Commonwealth research agencies: the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Defence Science and Technology Organisation (DSTO). The rationale for this focus, and a brief analysis of CSIRO and DSTO, are included in Appendix 4.

Membership of Working Group

Mr MA (Tim) Besley AO (Chair)	Chairman, Leighton Holdings Limited	(an ex-officio representative on PMSEIC, as President, the Australian Academy of Technological Sciences and Engineering)
Dr Ian Chessell	Chief Defence Scientist	Defence Science and Technology Organisation
Mr Maurice Hermann	Assistant Secretary Science Industry and External Relations	Defence Science and Technology Organisation
Dr Geoff Garrett	Chief Executive CSIRO	(an ex-officio representative on PMSEIC of CSIRO)
Mr Stephan Wellink	Principal Commercial Adviser, Agribusiness	CSIRO Executive.
Professor Vicki Sara	Chair Australian Research Council	(an ex-officio representative on PMSEIC of ARC)
Professor Deryck Schreuder[18]	Vice-Chancellor and President	The University of Western Australia (and Vice President, Australian Vice-Chancellors Committee)
Ms Alison Crook AO	Deputy Vice-Chancellor and Vice President (Resources)	Monash University (and a director of Montech, the commercialisation office of Monash University)
Mr Hutch Ranck	Managing Director Du Pont-Australia and New Zealand	(an ex-officio representative on PMSEIC of the Business Council of Australia)
Dr Jim C Fox	Managing Director Vision Systems Limited	(and a member of the Victorian Council for Knowledge, Innovation, Science and Engineering)
Dr Michael S Hirshorn	Chief Executive St George Innovation Fund Nanyang Ventures Pty Ltd	(and a member of the IR & D Board's Biological Committee)

The working group was assisted by the PMSEIC secretariat located within the Innovation and Science Division of the Department of Industry, Science and Resources.

[18] Representing Professor Ian Chubb AO, ex-officio PMSEIC member as President of the Australian Vice-Chancellors Committee (AV-CC).

Appendix 2 Stakeholder Sessions

The Working Group conducted three stakeholder sessions in Canberra, Melbourne and Sydney in April/May 2001.

Participants agreed with the working group's focus on the pre-seed stage of the commercialisation process and the four themes:

- Information exchange;
- Improving skills;
- Cultural and financial incentives/disincentives; and
- International development for Australia's benefit.

Participants agreed that universities and other public sector agencies need to aim to match 'best of the US' in terms of numbers of licenses and spin-offs, but thought that allowances need to be made, e.g. if benchmarking. Australia should also compare the quantity and quality of inputs (i.e. do US universities get more resources from industry than Australia, do they have more experienced staff to manage commercialisation). Time should also be allowed for needed cultural change in Australia-i.e. not right to immediately blame universities and public sector agencies for their caution engendered by risk averse Australian governments, media hounding of 'failures' etc.

About half of the participants expressed concern that the working group's definition of commercialisation should be made a bit broader to include non-licensing and non-spin-off strategies (e.g. joint ventures, collaborative alliances) used by CRCs with offshore partners (or companies such as Boeing).

There was a consistent view (in regard to changing the culture) that Australia needs some sort of an ongoing campaign to celebrate our research and entrepreneurial heroes so that young SET graduates and others will be more inclined to 'feel good' about devoting time and taking professional/financial risks to engage in commercial activity around their research-the *Backing Australia's Ability* Innovation Awareness program should provide resources to enable this to happen.

Most participants agreed that needed improvements to commercialisation practices are starting to happen at quite a good rate, but one stakeholder questioned whether the 'harmonisation' work which is under way on IP principles would be enough-he felt there was still a big cultural gap between researchers' tendency to overvalue their IP on the one hand (forgetting that 10x the cost of the research done must be spent just in the early stages of commercialisation) or, at the other extreme, too ready to 'flog it off' for a few quick dollars at the very early stage, because they are desperate for money to fund their ongoing research (rather than concentrate on commercialising).

Participants

Canberra, 30 April 2001

PMSEIC Working Group members

- Mr MA (Tim) Besley, Chair of the Working Group, President, ATSE
- Prof Vicki Sara, Chair, ARC
- Dr Ian Chessell, Chief Defence Scientist, DSTO

Prof Brian Anderson AO	President	Australian Academy of Science
*****Dr Anne Campbell	Executive Manager	CRC Association Inc
Mr Peter Core	CEO	RIRDC
Ms Karen Curtis	Deputy Executive Officer	Australian Chamber of Commerce and Industry
*****Dr David Evans	Chief Executive	Uniseed
*****Mr Sandy Lolicato	Business Manager	Land and Water Australia
Mr Alan Newton	Executive Director	Rural Development Corporations
Prof John O'Callaghan	Executive Director	Australian Partnership to Advanced Computing
Mr Malcolm Palmer	Senior Policy Analyst (Government)	The Institution of Engineers, Australia
Mr Angus Robinson	Executive Director	Australian Electrical and Electronic Manufacturers' Association
Ms Clare White		The Group of Eight
Mr Doug Cooke		NT Office of Communication, Science and Advanced Technology
*****Ms Sue English		AIMS
*****Dr Peter Isdale		AIMS
Ms Jude Mulcahy		NT Department of Industries and Business

Melbourne, 2 May 2001

PMSEIC Working Group members

- Mr MA (Tim) Besley, Chair of the Working Group, President, ATSE
- Ms Alison Crook, Deputy Vice Chancellor, Monash University

Mr Murray Arthur-Worsop	Principal Policy Manager	Industry Policy and Planning SA Department of Industry and Trade
Dr Andrew Barnard		DSTO
Mr Gareth Dando	General Manager Ventures Division	Melbourne Enterprises International Ltd
*****Dr Carol Halsall	Manager Commercialisation Science, Technology and Innovation	Department of State and Regional Development
Mr Russell Joshua	Manager, Commercialisation	Department of State and Regional Development
*****Mr Geoff Klestadt	CEO	Montech Pty Ltd
Mr Ian Mair	CEO	CRC for Advanced Composite Structures
Mr Rod Mattick		Business Council of Australia
Mr Ian Midgley		Melbourne Enterprises International Ltd
Dr Elizabeth Monger	CEO	RMIT Innovation Ltd
Dr Jim Parsons	Business Development Manager Animal Industries Group	Agriculture Victoria
Dr Geoffrey Vaughan	Chair	CRC Committee
Dr John Zillman, AO	Director	Bureau of Meteorology
Ms Caroline Camm		Tas Department of State Development

Sydney, 3 May 2001

PMSEIC Working Group members:

- Mr MA (Tim) Besley Chair of the Working Group, President, ATSE
- Mr Hutch Ranck, Managing Director, Du Pont Australia and New Zealand
- Mr Stephan Wellink, CSIRO, Principal Commercial Adviser (Agribusiness)
- Mr Maurice Hermann, DSTO, Assistant Secretary, Science Industry and External Relations

Dr Claire Baxter	Director	Business Liaison Office UNSW
Dr Steve Brodie	Manager	Business Support Linkwest Ltd
*****Dr Rod Shaw	Managing Director/CEO	AMBRI Pty Ltd
Dr Roger Edwards	Executive Director	Food and Packaging CRC
*****Mr Andrew Green	Executive Director	Australian Venture Capital Association
Mr Roger Grey		ANSTO
Dr Simon Hawkins	Program Manager	Mathematical and Information Sciences CSIRO
Mr David Henderson	CEO	Uniquest Pty Ltd
Mr John McFarlane	Manager	Industry Division NSW Department of State and Regional Development
*****Mr Colin Melvin	Chairman	ATTICA
Mr Mike Quinn		Innovation Capital
Ms Heather Ridout	Executive Director	Public Policy and Communications Australian Industry Group
Dr Denis Wade	Chair	NSW Innovation Council Johnson and Johnson Research Pty Ltd
Mr Richard Walker	Executive Director	Macquarie Research Ltd
Ms Janet Caffin	Technology Manager	Division of Research and Advancement Queensland University of Technology
Mr John Kenny	Director	Bioindustries Taskforce Queensland Department of Innovation and Information Industries

Written Contributions and Presentations

The working group gratefully acknowledges information received from a wide variety of sources and presentations made at its meetings by both Government officials and non-Government stakeholders. A number of those listed above who also provided written inputs are identified by an asterisk (*****)**.** In addition, contributions in writing, and/or presentations to and materials used by the working group were obtained from the following persons:

Dr Robin Batterham	Chief Scientist of the Commonwealth of Australia
Dr Charles Barnes FTSE	ResMed
Mr John Parker	SVP/Chief Operating Officer, Cochlear Limited
Mr Kevin Phillips	Australian Innovation Investments Pty Ltd
Mr Craig Scott	Australian Innovation Investments Pty Ltd
Dr Lyndall Thorburn	Advance Consulting and Evaluation Pty Ltd
Mr Peter van Bruchem	Intellectual Property Support Program Department of Commerce and Trade (WA)

Appendix 3 Three Private-Public Commercialisation Successes

ResMed

Between 5-10 per cent of adults experience a significant degree of sleep disordered breathing (SDB), resulting in excessive daytime sleepiness. Working at The University of Sydney in 1980, Professor C E Sullivan and colleagues invented a method of treatment of one of the major causes of this disorder, obstructive sleep apnea (a-pnea = *without breath*).

In 1989, Dr P C Farrell began the formation of the ResMed group of companies to commercialise Sullivan's device. Starting-up with $1.2 million from its original 9 staff and several private investors, ResMed has become a $2.5 billion company with annual world sales of $US 115.6 million (growing at 30.5 per cent). ResMed has some 850 employees with over 400 in Australia, and is cash flow positive with little debt. It specialises in products to treat SDB, part of a new global 'sleep industry', which it helped to create, valued at $1 000 million in 2001 worldwide and growing at 20 per cent per year. In February 2001, its share price reached a record US$47.25 or 17 times its listing price in June 1995 (the NASDAQ index increased about 2 times in the same period). ResMed is in the top 50 Australian Stock Exchange (ASX) companies by market capitalisation.

Dr Farrell was Foundation Professor of Biomedical Engineering at The University of New South Wales before leaving Australia and becoming Vice President of Research of *Baxter Healthcare*, a US hospital supply company. He returned to Australia in 1986 to establish the *Baxter Centre for Medical Research* with a budget to support Australian medical research projects with commercial promise.

It took only several weeks discussion in 1986 between Sullivan and Farrell to agree on the way forward for commercialisation, but another 3 years to work through the details to establish a company. By the time a marketable device was developed, the parent company, *Baxter* did not wish to proceed with commercialisation and sold to Farrell's fledgling company (then *ResCare*) the IP developed by the *Baxter Centre*, as well as Sullivan's patents, previously acquired from Sullivan's University. Its start-up investment enabled ResMed make to this purchase plus pay license fees to the University.

A key ResMed strategy was to 'think global' from the outset. 2001 marketed products marketed in over 50 countries by wholly owned subsidiary distributors as well as licensed distributors. This helps to ensure that ResMed supplies the right products to the right markets.

Sales began in Australia in 1989, in the US later in the year, and in Europe in 1990. Research was partially aided by an IR & D Board grant of $150 000 in 1989, and sales, by an Austrade International Business Development Grant of $110 000 in 1990. Distribution rights to the US and Europe were sold to Medtronic Inc, a large US medical device manufacturer for US$1 million. In 1992, this distribution agreement was terminated and *ResCare* staff and investors bought back the shares from Medtronic for US$2 million. *ResCare* began selling direct to the US market in June 1992, incorporated in Delaware in 1994 and listed as ResMed Inc on the NASDAQ exchange in June 1995, raising US$24 million. In 1997 an R & D *Start* grant of $2.6 million was obtained and in late 1999 ResMed transferred to the New York Stock Exchange and later co-listed on the Australian Stock Exchange (ASX). In 2001, a major acquisition was made for US$70 million of a German competitor with excellent technology and market-leading shares in Germany, Austria and Switzerland. ResMed is now the SDB market leader in Europe.

All ResMed's R & D and-manufacturing facilities are located in Sydney, and all products are made to its designs with about 85 per cent local content. ResMed generally manufactures to its

internal sales forecasts and fills orders as received. As a result, there is usually no significant backlog of orders.

ResMed spends 7-8 per cent of revenues on R & D (US$8.5 million in FY2000). Most clinical research is by independent practitioners in Australia, US, United Kingdom and Germany. ResMed has Medical Advisory Boards made up of clinicians who meet twice a year with research staff and associates from Australia, US, UK, Germany, and Switzerland.

Cochlear Limited

Cochlear Limited is a born global company, which produces cochlear implants for deaf born children and adults who become deaf. Professor Graeme Clark at the Department of Otolaryngology, The University of Melbourne, started research on the cochlear implant in the early 1970's with the aim of treating people with profound hearing loss. Until the advent of the Cochlear Implant these people could not be treated.

By 1978, a prototype had been developed and a commercial partner was needed. In 1981 Nucleus Limited formed a collaborative agreement with The University of Melbourne and the Commonwealth of Australia to commercialise the Cochlear Implant. Nucleus, under the leadership of Paul Trainor had considerable experience developing and commercialising implantable devices through its successes with Telectronics cardiac pacemakers.

A number of technological hurdles had to be overcome including the development of a reliable multichannel ceramic feed-through for a hermetically sealed device and the development of a reliable multichannel intracochlear electrode. In 1982 the first Nucleus devices were implanted in Melbourne and a separate subsidiary Cochlear Pty Ltd was formed the next year. In 1983 the first devices were implanted in the US. FDA approval was achieved in 1984.

Venture capital investment was obtained at a Cochlear value of approximately $10 million in 1985 and the company was sold to Pacific Dunlop for $30 million within the Nucleus Group in 1988. The company grew in the US, Europe and Japan with direct distribution in all regions and by 1995 the company had worldwide sales in excess of $50 million and listed on the ASX at a value of $125 million.

In the current financial year (2001) sales are expected to be in the vicinity of $200 million. Cochlear presently employs approximated 600 people, 350 in Australia. Ninety five per cent of sales are outside Australia. The market capitalisation is over $1.9 billion. The head office, manufacturing, and the majority of R & D remain in Australia

Vision Systems Limited

Vision Systems Limited (VSL) is a science based company built on smart Australians creating and selling smart products and R & D services all over the world. It was founded in 1987 with $5 million of venture capital as Invetech, a contract R & D company with the objective of developing a world scale business. The strategy was to sell services to other companies while at the same time using the resource to springboard into high value new product opportunities aimed at world markets.

Of $145 million in projected sales for 2001, $125 million (86 per cent) will be exports from Australia, growing at 35 per cent per annum. Now with 3 800 shareholders, Vision Systems has created over 500 highly skilled jobs since 1993. The challenge for Vision Systems remains that Australia is a long way from major markets and its credibility as a supplier of high technology products and services can never be taken for granted.

Vision Systems' collaboration with public sector research over the last ten years has brought successes such as:

- the VESDA Laser plus smoke detection apparatus that will sell close to $100 million in exports in 2002 (CSIRO);
- video based surveillance products; and a
- Laser Airborne Depth Sounder Business sold to Tenix June 2000 (DSTO).

Vision System's success formula is:

People + science + international plan + guts + investment = jobs + exports + wealth creation

1. Target at least 75 per cent of sales from US, Europe and North Asia.

If R & D is the competitive edge, then products will be innovation intensive, with high R & D costs on each product. With Australia's 2 per cent share of the world's GDP, it is hard to get an acceptable return on a market about the same size as New York. Market research is therefore done in the US, Europe and Asia to define the products that will be developed.

2. Manufacture/distribute high value (>$1 000), high margin products (>50 per cent) plus contract R & D services.

High R & D expenditure requires high margins. To compete in distant markets necessitates airfreight, which means that high value density ($/m^3) products are essential.

Operate the company's R & D resource (Invetech) as a stand-alone business serving external customers as well as being the innovation engine for VSL.

Vision Systems aims to achieve '1+1 = 3' by sharing overheads with world scale facilities on which to draw new products and technology exposure. Staff have the stimulation of a wide variety of projects.

4. Revenue mix by geography and market sector

Core capability is engineering and technology that is often common to a wide variety of products. What is always different is the route to market. For contract R & D this is not an issue. Diversity is a hedge to start up activities and we promote it.

5. Invest 10 per cent + of sales in new product R & D

If the key competitive edge is R & D and the extent of innovation is the product, then exercise it. Vision Systems also spends 20 per cent of every sales dollar on offshore sales, marketing and technical support people and facilities. This is often overlooked at the planning stages of small companies given they actually need to invest before generating the sales. Route to market is actually the highest risk component of the process, higher than targeted R & D.

6. Create an environment where the top quartile of available people seek to work

Vision Systems has worked to achieve this and has been conscious of individual rewards, peer group interaction and the environment where people work.

7. Invest in IP and sales and marketing and be a virtual manufacturer

Vision Systems dedicates capital to the creation of IP and to sales and marketing, while outsourcing the fabrication of all components and sub-assemblies. Final assembly and test is in-house only, thereby retaining the ultimate quality check and process IP in-house.

Appendix 4 Public Sector Research Organisations

The PMSEIC Working Group on Commercialisation of Public Sector Research focussed on research carried out in universities, and in the two largest Commonwealth research agencies: the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Defence Science and Technology Organisation (DSTO). Taking into consideration feedback from stakeholders, findings of other recent reports on commercialisation and the combined size and influence of the above entities in the totality of Australia's innovation system, the working group considers that its observations and recommendations are likely to be relevant for public sector research in general.

It should also be noted that commercialisation of research in the medical and health fields was considered as part of the Wills Report on Health and Medical Research (1999), and in a recent follow-on study[19], as well as in presentations on related topics to PMSEIC, e.g. a report on Molecular Medicine, to the 6th PMSEIC meeting, 30 November 2000.

Investment in Public Sector Research

In the most recent figures available (1997-98), of Australia's gross expenditure of $8 849 million on R & D (1.49 per cent of GDP), about 29 per cent was undertaken in higher education, 13.5 per cent in other Commonwealth funded sectors, and 10 per cent in state government agencies[20]. The remaining expenditure is business sector expenditure with a small component relating to the private non-profit sector. The Federal Government's decision to further invest $2.9 billion in research and innovation activities, was linked in the Innovation Statement *Backing Australia's Ability* with the expectation that the agencies which produce knowledge from that wealth, will pursue reforms 'so that commercialisation of public research matches the world's best'.

In the 2000-01 financial year[21], the Commonwealth was expected to make the following investments in research:

	Estimated Accrual Value-$m	per cent of *CPSR*
Higher Education R & D	1787.6	48.5
CSIRO	615.8	17
DSTO	263.5	7
Other *CPSR*	1019.5	27.5

Table A4.1: Budget estimate 2000-01(accrual basis)

CPSR-Commonwealth funded public sector research. 'Other' includes: National Health and Medical Research Fund, Cooperative Research Centres, Rural Industries R & D, and 'other' R & D agencies and grants.

A conceptual framework for categorising two key objectives of research in the public sector is suggested in the table below. Both objectives of research are pursued in most public sector research institutions, but to varying degrees.

[19] Department of Education, Training and Youth Affairs (DETYA): Enabling the Virtuous Cycle – Identifying and removing barriers to entrepreneurial activity by health and medical researchers in the higher education sector. Ron Johnston, Mark Matthews, Mark Dodgson. 00/14. Nov 2000.
[20] ABS Catalogue No 8112.0 *Research and Experimental Development all sector summary 1998-99.*
[21] Ibid.

	Basic Research	Research for Commercialisation
R & D investment	Investment is in SET and is primarily on the basis of scientific excellence	Investment is in S and T and is predominantly (but not exclusively) on the basis of technology utility and market demand (e.g. through sector process in CSIRO)
IP transfer	At end of pipeline, i.e. after research and IP development	Commercial receptor often involved at start of research, with technology transfer activities throughout the process

Table A4.2: Conceptual framework for public sector research

The following summarises some of the key commercialisation practices in universities, the CSIRO and DSTO and provides snapshots of their performance. There is little systematically collected data which could show trends in performance over time.

Universities

Australian universities undertake a diverse range of activities with commercialisation and the creation of new ventures to exploit research findings where this is a strategic objective.

Commercial Approaches

The ARC's report *Research in the National Interest*[22], characterises the general environment:

> *The cultural gap between universities and industry is being reduced. Whilst it is important that the boundaries between universities and industry are retained to reflect their respective missions, new ways are being found to work across those boundaries. Universities are also starting to operate more like businesses. …Universities are also now actively managing their investment portfolios to encourage technology-intensive businesses to locate and collaborate with their research and development capability*

However, at the same time:

> *…many smaller research centres within universities still have much to learn about working with business.*

Acknowledging the rapidly changing research and business culture in universities, DETYA's report *Identifying and Removing Barriers to Entrepreneurial Activity by Health and MedicalRresearchers in the Higher Education Sector*[23] also concluded that:

[22] ARC: *Research in the National Interest-Commercialising University Research in Australia.* Commonwealth of Australia. July 2000.

[23] Johnston. R., Matthews. M and M Dodgson. Nov 2000. *Identifying and Removing Barriers to Entrepreneurial Activity by Health and MedicalRresearchers in the Higher Education Sector.* A report funded under the Evaluations and Investigations Program by the Department of Education, Training and Youth Affairs.

> *Assessment of the performance of Australian universities in research commercialisation needs to recognise the very considerable extent of experimentation and change which has occurred over the past 1–2 years.*

This experimentation includes:

- Greater emphasis on start-up or spin-off companies—a growing view (based on US and some Europe experience) that generating new enterprises to exploit IP can be more effective than licensing to existing companies.
- Decentralised mechanisms for research commercialisation—*e.g.* Universities of Melbourne and Queensland decentralising scanning and screening; staff of the commercial arm being located within faculties to improve capture of research outputs (expand the potential portfolio)-while negotiation and management is retained in the central organisation for access to skills and judgement in commercial negotiation.
- Transfer of ownership from the institution to the inventor—e.g. University of Melbourne/MEI, closer to arrangements at MIT/Cambridge.
- Abolition of monopoly in commercial arm operations—the extent of real competition, or the time it will take to establish genuine market conditions for this service is still unclear.
- Direct provision of capital—ANU, Curtin moving to strategies which, permit a certain level of investment (of non-Commonwealth funds) in equity in university-originated start-ups, or JV capital raising with investment firms.

There are also some new collaborative approaches between universities and other agencies to pool resources for commercialisation activities, e.g. a strategic alliance funding approach between Macquarie University, The University of Wollongong, The University of Newcastle and The University of Tasmania.

Such changes in Australian universities according to the DETYA report *Identifying and Removing Barriers to Entrepreneurial Activity by Health and MedicalRresearchers in the Higher Education Sector*:

> *signal a significant shift about the perceived potential of commercialisation …under the new conditions of the global knowledge economy and …global markets for research.*

Snapshot of Universities' Commercialisation Performance

The ARC report, *Research in the National Interest,* cited an indicator of improving performance in commercialising research:

> *The trend for firms to allocate a growing proportion of their R & D investment to university based projects is indicative of growing linkages between the two sectors. … on 1996 data, the proportion of all university performed R & D …funded by business, is 5.2 per cent, an increase from 3.9 per cent in 1994.*

The Australasian Tertiary Institutions Commercial Companies Association (ATICCA) surveyed its members in November 1999 and obtained data on 1997-98 licensing income from 20 of the 37 universities.

Patenting and Licensing

Those that participated in the survey reported that in 1998 they had evaluated the commercial potential of a total of 274 new inventions, filed 161 new patent applications and were granted 103 new patents. Negotiations between universities and industry partners resulted in the signing

of 63 new licenses and option agreements, making a total of 231 current/active licences and options being managed by Australian universities.

The survey also found that research commercialisation in Australian universities generated income of more than $31 million in 1998 from the adoption by industry of university scientific and technological innovations.

Spin-Off Companies

In the period 1996-98, 46 spin-off/start-up companies were formed from tertiary institutions. This represents '1 new start-up company per $100 million dollars of research funding to Australian universities', which ATTICA suggested was comparable with figures reported by the US equivalent; Association of University Technology Managers AUTM.

In reply to an article in the *Business Review Weekly* (23 February 2001) criticising Australian universities' research commercialisation performance, ATTICA noted that many universities have reported an increase in the number of spin-off companies formed since its 1999 survey. Some additional (unpublished) analysis has been done, which favourably compares Australian data with that obtained on North American universities by ATTICA's US counterpart, which has been collecting data systematically for 9 years. It should be noted that the AUTM analysis was done on a large number and range of American universities.

A focus on the best of the US universities however, shows figures of 20 and 27 'start-ups' generated per $100 million of research expenditure, which is 10 times or greater than the average value cited for Australian and US universities. It is claimed that many US universities do not pursue commercialisation at all, but Australia should aim to compare itself with those that do it well.

In the DETYA report *Identifying and Removing Barriers to Entrepreneurial Activity by Health and MedicalRresearchers in the Higher Education Sector*, it was noted that:

> *with regard to start-up companies, it would appear that about one-third of technology start-ups in Australia in 1997 originated directly from universities. The only reliable conclusion is that the rate of formation of technology-based star t -up companies arising from university research is increasing.*

CSIRO (Commonwealth Scientific and Industrial Research Organisation)

The transfer of technology to users in the private and public sector is central to CSIRO's primary functions, as set out in its Act, namely to carry out scientific research which assists Australian industry and furthers the interests of the Australian community, and to encourage or facilitate the use of the results of such research.

CSIRO is in the business of intellectual property generation and technology transfer and does it in a number of ways including licensing, contract research, collaborative R & D and through incubation/start-up/spin-off ventures. It forms alliances with organisations globally (increasingly with an emphasis on territory/regional management) and in particular looks to combine complementary assets with our partners to address issues of importance.

CSIRO aligns its research portfolio with industry user needs in its triennial priority setting and budget processes, by drawing on guidance from industry-led advisory committees for each of the 22 sectors addressed by its research. It is strongly committed to the CRC program and is a member of a high proportion of current centres. Unlike other organisations within CRCs,

present policy does not, however, permit CSIRO researchers to remain within the Organisation and to take equity in spin-offs.

Following the arrival of the new Chief Executive, Dr Geoff Garrett, early 2001, work has been underway to develop a new Strategic Action Plan for CSIRO, which will, inter alia, streamline and strengthen CSIRO's commercial activities.

Commercial Operations

Core elements include:

- Increasing emphasis on market evaluation prior to undertaking certain research and development projects in divisions;
- A robust risk assessment and audit process for contract evaluation;
- Post project reviews with clients;
- A Commercial Practice Manual , setting out commercial policies and practices for the organisation;
- Professional patent portfolio management through the company Intellectual Property Management;
- A more streamlined process of contract development with the introduction of Standard Form Agreements;
- Commercial skill enhancement through Leadership, Career and Team Development programs and sponsorship of selected staff to external relevant management courses;
- Secondments of staff to our major clients (e.g. Boeing, British Aerospace, Itochu) so that we can better-understand their business imperatives;
- Establishment of Key Account Management principles; and
- Development of a new approach to the adoption of e-commerce.

Snapshot of CSIRO's Commercialisation Performance

CSIRO's research has acquired a much stronger user-focus over the past decade, responding to external earnings requirements set by government. This involves a wide range of commercial linkages with some 2 500 industry and government clients. (Figure A4.1, shows the distribution of CSIRO's external earnings-$249.5 million for 1999/2000) About 50 per cent of CSIRO's external earnings, or 16 per cent of total CSIRO funds is sourced from the private sector.

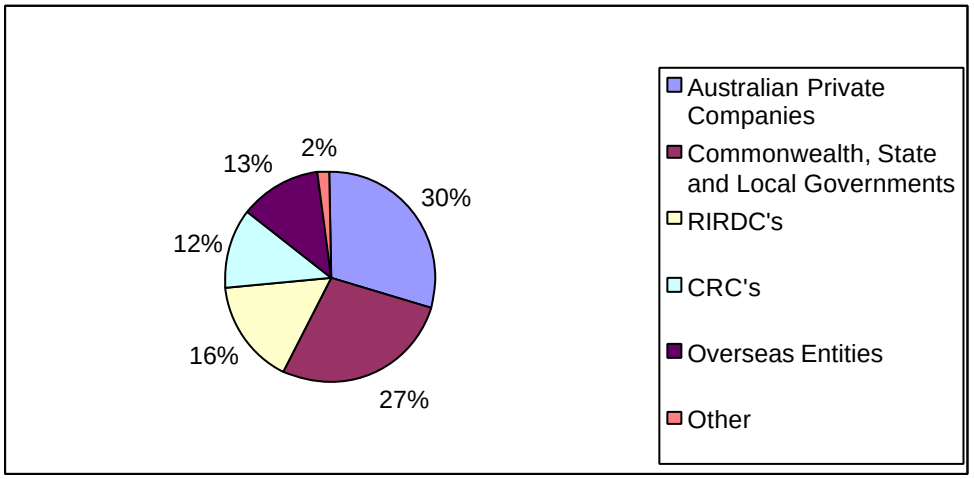

Figure A4.1: CSIRO external revenue-1999/00 ($m)

New Companies

- Radiata, a company with research origins in Macquarie University and CSIRO work on radiophysics and semiconductor technology (for wireless communications) was spun-off in 1997 and bought out by Cisco Systems in late 2000 for $570 million.
- Gropep (a biotechnology products company) and Lake DSP (audio equipment) both of which have market capitalisations in excess of $100 million

In addition a number of other companies have been established based on CSIRO technology:

- Biota, has co-developed the new anti-influenza drug Relenza with Glaxo Wellcome, based on CSIRO research on the surface protein neuraminidase.
- the Australian Magnesium Corporation, has been formed by Normandy Mining and Queensland Magnesium Corporation to progress a 100 000 tonne per annum magnesium smelter in Queensland, based on novel CSIRO magnesium smelting technology

Over the past fifteen years 50 direct spin-off companies have been established using CSIRO intellectual property (IP) and expertise. Annual turnover of these companies is estimated at over $200 million with new employment at over 1 000 jobs.

Patenting and Licensing

CSIRO has produced 318 Australian-invented US patents over 20 years.[24] The total number of Australian and foreign patents and applications (excluding PCTs) held at 30 June 2000 was 3 436. CSIRO records approximately 300 current licence agreements.

- Cotton-Australia's cotton crop is now worth around $1.9 billion per annum. Over 93per cent of the current national crop is grown from seed types tailored by CSIRO to deliver high yield and fibre quality in local conditions, while resisting pests and diseases. Seeds of these varieties are also now being sold internationally with returns to CSIRO from commercial arrangements including licensing.

- Dairy – A process for the manufacture of a substitute for young cheese in processed cheese was developed by CSIRO and commercial partners. Royalties from the US company Schreiber Foods Inc. have exceeded $4million over the past decade.

Alliances

CSIRO has a number of international strategic alliances:

- the alliance with Itochu covers a range of technologies and is a leading example of technology based collaboration with Japanese business;
- Boeing and CSIRO have collaborated over the past decade in a series of projects valued at over $20 million in areas of aerospace and related research; and
- the relationship with Du Pont includes a joint company Dunlena, established in relation to agrichemical development and links with the US company in relation to specialist polymer development.

Defence Science and Technology Organisation

DSTO's objective is to give advice that is professional, impartial and informed on the application of science and technology (S & T) that best suits Australia's defence and security needs.

[24] *CSIRO Connections – Contributions to Innovation in Australia*. (www.csiro.au/connect)

DSTO's activities include:

- influencing the framing and implementing of defence policy for the use of S & T;
- positioning Australia to exploit future developments in technology which show promise for defence applications;
- ensuring that Australia is an informed buyer of its defence equipment;
- developing new capabilities, especially where there are special national demands including those related to Australia's unique environment;
- supporting existing capabilities by increasing operational performance and reducing the costs of ownership; and
- collaborating internationally, both regionally and with Australia's traditional friends and allies, and in support of the Government's broader international objectives.

In terms of capability development, DSTO tends to focus on systems, not individual products, to provide maximum scientific benefit to defence.

DSTO works to improve its relations with industry/customers to enhance Australia's defence capabilities and to contribute to national wealth creation, including through the support of exports. DSTO also has external relations with universities and other research agencies. These relations aim to leverage the national scientific capability for the benefit of Australia's security.

DSTO interacts formally with industry and external agencies through a range of collaborative and commercial mechanisms. DSTO figures on the numbers of collaborative and commercial agreements entered into since 1994 are shown below.

DSTO's collaborative interactions include involvement in:

- seven Cooperative Research Centres;
- the Command, Control, Communications and Intelligence Research Forum; and
- the Defence Capability and Technology Demonstrator Program.

DSTO's commercial interactions include:

- research agreements;
- Technical Support Services Contracts;
- Centres of Expertise, and
- commercialising intellectual property through the transfer of IP through licence agreements and establishment of start-up companies.

DSTO also has a number of Alliances, which have proved particularly useful in allowing the exchange of knowledge with industry. In a number of instances, this has also led to collaborative research and the generation of new intellectual property.

From 1994, there has been a marked increase in industry alliances (7 to 18), memorandums of understanding (MOUs), and collaborative arrangements (11 to 45) and, commencing in 1996 in collaborative research agreements (2 to 17). There has also been a 38 per cent increase in the number of licenses being managed (47 to 65). DSTO has found that the sometimes limited market for its technology combined with the degree of internal 'product' development often makes licensing a more viable option than promoting start-ups.

Collaborative Arrangements

DSTO's collaborative arrangements constitute agreements in which two or more parties work together to achieve an agreed outcome and optimise the use of resources by combining forces.

Collaboration is an effective means for leveraging research and development (R & D) effort and sharing risks and benefits. DSTO has 49 active collaborative agreements, of which 17 are research agreements with universities.

Other Collaborative arrangements include:

- Involvement in seven Cooperative Research Centres;
- Involvement in 18 Industry Alliances. Most of these are bi-lateral, capability-focused alliances, in some cases including the ADF;
- The 1997 established Command, Control, Communications and Intelligence Research Forum (C3IRF), a unique industry-led initiative which supports early identification of key C3I technologies; and
- The Defence Capability and Technology Demonstrator Program, key mechanisms for industry involvement in defence capability development at an early stage.

Commercial Agreements

DSTO's commercial arrangements occur when DSTO sources products and services from industry in support of its activities or those involving transfer of knowledge, expertise and technology from DSTO.

In 1999/2000, DSTO spent $24 million sourcing R & D and technical support from industry and other external organisations, representing 10.6 per cent of the program's budget. During FY1999/2000, DSTO's commercial activity generated $1.2 million in revenue.

Licensing Agreements are an example of commercial arrangements with industry partners willing to develop, utilise and market intellectual property developed by DSTO. DSTO currently has 65 licence agreements, 7 of them signed during FY1999/2000.

Centres of Expertise (COE) are also a commercial arrangement. DSTO contributes approximately $750 000 per annum to foster six COEs. These are arrangements for contract research in specific areas of technology centred within Australian universities.

DSTO also provides support to defence exports by assisting Australian companies to exploit commercial opportunities overseas and by providing technical expertise.

Current Issues

DSTO regards successful commercialisation as where *'Australian' Defence Industry*':

- is created and/or sustained in technology areas of importance to the Australian Defence Force due to DSTO activities—e.g.-*AMRAD Pty Ltd*;
- grows through technology-transfer and knowledge exchange with DSTO IP—e.g.-*Hue Technologies; Daronmont; Helitech (Crack Patch Technology)*; and if
- DSTO has financial returns—e.g.-*Helitech (Crack Patch Technology)*-> $770 000 in royalties; and *AMASS (ADI)*-> $1 million in royalties

Snapshot of DSTO's Commercialisation Performance

DSTO figures on the numbers of collaborative and commercial agreements entered into since 1994 are shown in Table A4.3, grouped in 7 categories, involving: industry alliances; centres of expertise; Cooperative Research Centres; licenses; MOU/collaborative arrangements; research arrangements; and start-up companies.

Notes on DSTO Data on Collaborative and Commercial Agreements (Table A4.3):

Annual figures are collated as:

- Number of current Agreements signed prior to the year (Left-hand corner);
- Number of Agreements signed in that particular year (Middle); and
- Total Number of Agreements active for any part of that particular year (Bottom Right-hand corner).

Definitions of Terms:

- **Industry Alliance** – A non-exclusive agreement between DSTO and one or more parties, which is designed to facilitate communication and the exchange and disclosure of information under confidentiality arrangements in one or more defined Focus Areas. The improved communication may lead to identification of opportunities for further activities, which would be subject to other specific agreements. The term of an Industry Alliance is typically three to five years.
- **Centre of Expertise (COE)**-An arrangement for contract research in specific areas of technology, which establishes formal long-term links in technology areas with external research agencies, particularly universities. COEs are usually funded for five years, subject to satisfactory performance review. This long-term partnering perspective provides an opportunity for forward looking research to be carried out, while giving defence the best value for money.
- **Cooperative Research Centre (CRC)** – A Government initiative for engaging the national innovation system in the achievement of national R & D objectives, bringing together researchers from universities, CSIRO and other Government R & D agencies and private industry.
- **Licence** – An agreement involving the transfer of knowledge, expertise and technology from DSTO to industry partners willing to develop, utilise and market intellectual property developed by DSTO for Defence and commercial application.
- **Memorandum of Understanding (MOU) –** A formal mechanism to encourage collaboration between parties, and also provides an opportunity for information exchanges and exchanges of personnel.
- ***Collaborative Arrangement* –** An arrangement in which two or more parties agree to work together to achieve an agreed outcome and optimise use of resources by combining forces. The parties might not contribute equal resources, but each would expect to derive benefit from collaboration, in support of their individual and common objectives**.**
- **Research Arrangement –** An arrangement between DSTO and one or more parties, which has a clearly defined mutual research interest. In a Research agreement, exclusively the university undertakes the work.
- **Start-up –** A company established for the purposes of commercialising technology.

Agreement Type	94	95	96	97	98	99	00	Total Currently being Managed	Comment
Industry Alliance	6 1 7	6 6 12	12 7 19	16 4 20	17 3 20	17 3 20	18 0 18	17	
Centre of Expertise (COE)	0 1 1	0 0 1	1 1 2	2 3 5	5 1 6	6 1 7	5 1 6	6	
Cooperative Research Centre (CRC)	6 0 6	6 0 6	6 0 6	6 1 7	7 0 7	7 2 9	9 0 9	7	
Licence	41 6 47	44 12 56	55 10 65	60 16 76	58 9 67	56 8 64	59 5 64	64	
MOU/Collaborative Arrangement	9 2 11	7 3 10	9 8 17	16 10 26	21 15 36	31 16 47	38 5 43	41	
Research Arrangement			0 2 2	2 1 3	2 4 6	6 8 14	12 4 16	16	Prior to 1996, there was no separate Research agreement category.
Start-up	3 0 3	3 0 3	3 0 3	2 0 2	1 0 1	0 0 0	0 0 0	0	

Table A4.3: DSTO agreements by calendar year As at 19 January 2001

Appendix 5 Other Measures of Research Commercialisation

Analysis of Spin-Off Companies across Agencies

Historical information about some 250 spin-off companies generated by public sector research agencies around Australia over the last 10 years is contained in a database, developed and maintained by a consultancy firm[25], which originated from a survey first conducted for CSIRO in 1997. In October 2000, the firm was commissioned by the Chief Scientist's Australian Science Capability Review to undertake a further survey to establish some baseline data on spin-off companies arising out of federally funded Cooperative Research Centres (23 spin-off firms from 13 CRCs were identified).

Most of the CRC spin-offs (12) were based in Sydney and 58 per cent of the total were engaged in the information and communications technology (ICT) sector, with biotechnology applied to environmental and agricultural sectors next most numerous.

The database on spin-off companies continues to be updated by this firm and allows for a broad range of analyses to be attempted, including of the types and success of commercialisation strategies adopted by the spin-off companies.

Economic Measures of Commercialisation

An imprecise trend indicator of commercialisation (and general innovation) activity might be provided by statistics on Australia's balance of trade in royalties and licensing. Such transactions reflect activities, which include but are clearly much broader than research commercialisation per se (see Figure A6.1).

In a country which produces around 2 per cent of the world's research output, and in common with their overseas counterparts, Australian businesses must use many technologies sourced from abroad, paying license royalties or dividends on profits of foreign owned operations.

In 1999-2000, Australia used imported technologies and copyrighted material for royalties and licensing income and payments[26] totalled $1.8 billion (6 per cent of all services imports).

Income earned from the corresponding export of licenses was $0.6 billion (2 per cent of our service exports). No growth rates are cited for royalties and license income payments, but the following graph (Figure A6.1) gives an idea of the trend since 1979.

As the case studies in the report suggest however, Australia can benefit most from IP not by exporting licenses but by generating exports of goods, services and processes based on Australian IP. Licensing of our IP offshore may need to occur in some cases when economic or structural factors preclude growing an Australian business from the IP.

[25] *Advanced Consulting and Evaluation Pty Ltd, Queanbeyan, NSW.*

[26] Royalties and licence fees cover the exchange of payments and receipts between residents and non-residents for the authorised use of intangible, non-produced, non-financial assets and proprietary rights, and the use, through licensing agreements, of produced originals such as manuscripts or films. It includes the use of: patents, industrial designs, industrial know-how, manufacturing rights and prototypes; trademarks and franchising fees; computer software; computer design and hardware; and other royalties. The above does not include distribution and licence fees sold to the media for a limited number of showings in specified areas for films, television programs, videos, multimedia and music. It is not possible to further refine the data to exclude franchises.

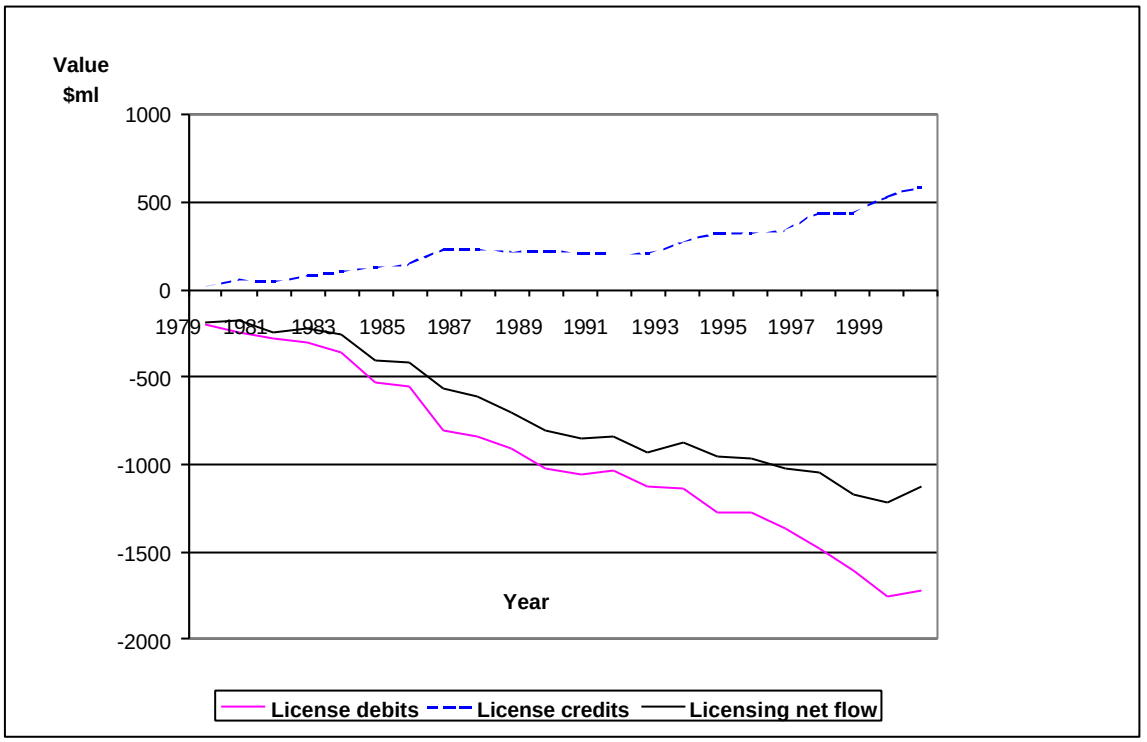

Figure A5.1 Royalties and licensing flows-trade balance.

How do we turn the Flow of Wealth from Licensing Technologies back to Australia

Researchers and their business partners must increase the number and value of technologies licensed or sold/exchanged for equity in existing and new industries serving high-growth markets. This is the front-end of the innovation process, that must then be managed through to market in a way that maximises the return on the R & D investment ($100 on development for every $1 on research is typically cited)

Appendix 6 Management of Intellectual Property

Recognising that knowledge and research findings constitute a most critical resource (IP), and are key elements in a new business paradigm for economic development, a group of Commonwealth and tertiary sector agencies[27] is working to develop a set of principles and mechanisms to promote the best practice IP management. The aim of the proposed *National Principles of IP Management for Publicly Funded Research* is to provide guidance at the national level while allowing agencies, universities, institutes and research centres to develop their own IP policies and requirements.

The *National Principles* should assist researchers and their institutions, by ensuring they have access to best practices for the identification, protection and management of IP, and therefore, to maximise the returns from public investment in research. The *National Principles* should also assist potential industry partners by promoting more commonality in approaches by researchers and institutions to IP management (yet retaining a diversity of strategies). This should increase the confidence of industry (especially venture capitalists) investing in research.
The *National Principles* clearly state that while encouraging research commercialisation, the public research funding agencies will continue their support to advance quality research to the economic, social and cultural benefit and the wellbeing of the community.

Expectations

The *National Principles* are likely to be finalised by the end of 2001, and an incentive-based implementation framework will be developed. They are expected to evolve over time in the light of the experiences of the funding agencies, administering institutions and researchers.
It is expected that the National Principles would have an impact on the following:

- increase in knowledge/understanding of IP;
- increased number of institutions with effective IP policy/management mechanisms in place;
- increased patenting and licensing activities;
- increased ability to attract funding from public and private sources; and
- increased confidence of industry/VC, in investing in research, etc.

Related Initiatives

The Government will respond to recommendations from the recent *Intellectual Property and Competition Review Committee* report, which are:

- raise thresholds for granting patents;
- maintain distinction between discovery and invention (a 'public right of way' between private IP); and
- make changes to the Trade Practices Act on licensing and assignment of IP; and, Period of grace for researchers to publish before patenting.

A response to the Advisory Council on Intellectual Property's review of patent enforcement is also in hand.

Under *Backing Australia's Ability,* the Government will implement its higher education research and training policy statement through amendments to the *Higher Education Funding Act 1988*,

[27] The Australian Research Council (ARC), the National Health and Medical Research Council (NHMRC), the Australian Vice-Chancellors' Committee (AVCC), the Department of Education, Training and Youth Affairs (DETYA), the Department of Industry, Science and Resources (ISR), IP Australia and the Australian Tertiary Institutions Commercial Companies Association (ATICCA).

requiring universities to prepare a Research and Research Training Management Plan to be eligible for Commonwealth block funding. These plans will be published, including universities' IP policies and commercialisation strategies.

The Government will also implement an improved IP awareness strategy aimed at the tertiary and research sectors. Awareness activities delivered through a national program in 2001 and beyond will include seminars, a supporting web-site, which provides a lecture data base, lecture material and case studies.

A Case Study of IP Policy-Western Australia

The Western Australian Government Intellectual Property Policy 2000 (which replaced a 1997 Policy), is a whole of sector high level IP, which covers all forms of intellectual property created within the public sector or through contracts with the private sector and owned by public authorities, including software, educational and training materials and IP arising from scientific endeavours.

The IP Policy encourages agencies to recognise the value of their intellectual property assets and, through responsible management, work to maximise the benefit to the State from the protection, management and commercialisation of their intellectual property assets. The Policy recognises that IP commercialisation is generally ancillary to core business and should be conducted in a way that does not divert significant resources from, nor interferes with, core business and service delivery.

IP is developed in the course of Government's activities and commercialisation is generally not, nor should it be, a driver in the IP asset's development. Instead the IP is valuable because the needs of the WA government agencies prompting the IP assets development are the same as others' needs.

The state's IP initiative has seen many successful commercialisation projects delivering a range of benefits to the State including many millions of dollars in additional revenue, and many projects are currently in the pipeline.

Some benefits of the approach taken in Western Australia are that the Policy:

- is not limited to IP from Scientific research or to crown copyright;
- recognises the importance and value of all forms of intellectual property assets;
- recognises that all government agencies many generate valuable intellectual property assets in the course of their operational activities;
- provides a responsible framework for IP management in a public sector environment (as opposed to the University or Public funded research institute environment) where IP management and commercialisation issues should generally not be key drivers in IP asset development; and
- leaves responsibility for the IP assets with the agency in which they are developed and recognises that they should have access to revenue from the commercialisation of those assets.

Steps have been and are continuing to be taken to increase awareness and understanding of IP, including the continued development and delivery of a series of seminars designed specifically for the Public Sector, a website: www.ip.commerce.wa.gov.au, and release of useful publications including comprehensive IP Guidelines, soon to be released in 3rd Edition.
Advice and assistance is also available to all WA government agencies from the Government's Intellectual Property Support Program (IPSP), located within the Department of Commerce and

Trade. The IPSP also provides executive support to the Government Intellectual Property Policy Council (which oversees the implementation of the IP Policy) and works with central agencies to address obstacles to the Policy's implementation.

Issues being addressed include:

- the manner in which IP is addressed in government contracts;
- powers of agencies to engage in commercialisation activities;
- payment of rewards to innovators;
- how to best use competitive processes to commercialise IP; and
- how to utilise the commercialisation of government's IP to benefit local industry.

Appendix 7 A Trade Fair of Ideas

Trade fairs are a proven way of bringing together 'buyers' and 'sellers'. The trade fair provides the opportunity for face-to-face interaction between different players in the marketplace. These events are not just focused on display booths demonstrating products but also provide a networking forum through organised meetings and ad hoc discussions. A 'trade fair of ideas' could be used in the same way, bringing together researchers and potential industry partners to develop a better understanding of the requirements of both parties. A trade fair of ideas could be established as a new event, or through feeding into an existing industry-technology trade fair.

Establishing a new event in the calendar can be approached in a variety of ways. For instance, Portugal is holding its first Science, Technology and Innovation fair in November 2001. The fair is intended to promote Portugal as an innovative economy. Other events around the fair include seminars, workshops, demonstrations by exhibitors, a contest between schools and post-fair school trips to companies and exhibiting entities; similar to activities in Australia's national science week.

A different approach taken by the North American Venture Capital Association (NVCA) could be adapted to bring together researchers and venture capitalists. One activity of the NVCA is to host regional venture capital/entrepreneur networking luncheons in order to facilitate the networking between venture capitalists and entrepreneurs. Each luncheon features a keynote presentation by a high profile individual in the entrepreneurial community and is attended by venture capitalists, entrepreneurs and service professionals.

As an example of the potential for these types of activities in Australia, the Chief Scientist, Dr Robin Batterham, was recently invited by the Superannuation Industry Forum, sponsored by Zurich Scudder Investment Australia, to speak to funds managers and other interested parties to encourage greater investment in R & D at a series of seminars around Australia.

A third option is to establish a virtual trade fair. An example is the Biomedoz site (biomedoz.com.au), a joint initiative of B. Norrman and Associates and Intermission Australia Pty Ltd. It is a primary internet-based news, information and communication vortal (vertical industry portal) for those who work in, invest in and benefit from the biotechnology industry in Australia. A strong emphasis is placed on promoting and facilitating business development and investment opportunities both within Australia and internationally. The site includes finance and funding information and investor information. A similar site Science.com (www.science.com.au) is an initiative of Westwick-Farrow but appears to be more focused on exchanging news between researchers rather than offering assistance in commercialisation, as is the case for Biomedoz.

Alternatively, instead of establishing a new forum to encourage greater communication between investors and researchers, activities could be fed through an existing event such as the annual exhibition for the professional science industry, Science 2001. Science 2001, as with most trade fairs/exhibitions, has associated seminars and forums which could be a good starting point for building up industry investment in the pre-seed stage of commercialisation.

All the above options will have an associated cost including establishment and on-going administrative costs. There are questions of who will be responsible for managing the event; whether a new event, feeding off an existing fair or going virtual. It is also important to note there is a long lead time between establishing a trade fair and it becoming a key national event for the relevant parties regardless of whether it is a new event or feeding off an existing program.

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