

**PRIME MINISTER'S SCIENCE, ENGINEERING
AND INNOVATION COUNCIL**

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AUSTRALIA'S INNOVATION FUTURE

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The Vision for Australia in the 21st Century

Business's ability to innovate is vital to its global competitiveness. It is only by continually developing new products, processes and services that business can gain the competitive edge necessary for the increasingly global economy. R&D (research and development) is a key component of this, helping to generate the advances that lead to new value-added products and enabling people and capital to be more effective.

*Lord Sainsbury
Britain's Science Minister*

To be successful in the 21st century Australia will need to develop an ideas-based, can do economy and society. This means an economy and society that is proficient at both creating ideas and translating a substantial proportion of them into new business opportunities - the pay-offs are jobs, wealth and a better quality of life. Australia will be a nation where the words science, innovation and entrepreneurship are synonymous with excitement.

In the last five years many OECD countries and the rapidly industrialising countries in Asia have already concluded that their future relies on increasing investment in the underlying capability of the knowledge economy and creating an environment favourable to the rapid translation of new ideas into new business opportunities.

The recent visits by the Chief Scientist to a number of countries in North America and Western Europe revealed there were common perceptions about what was needed for future global competitiveness and the importance of the science, engineering and technology (SET) base as integral to effective national innovation systems.

Box 1: Common Themes Emerging Around the World in Relation to the SET Base

Many governments are reacting to the pressures of globalisation and the transition to the knowledge-based economy primarily through implementing policies designed to improve their domestic innovative capacity.

They are:

- investing in research institutions to create a vibrant research base;
- investing in people and promoting the development of a highly skilled labour force;
- addressing any systemic failures that prevent different parts of the innovation system from working together;
- improving the environment for the flow of knowledge from the research base to business; and
- enhancing the conditions that govern the commercialisation of research from the SET base through the creation of spin-off companies.

Different countries are making sizeable investments in their SET base to underpin national innovation performance. For example, the Canadian Government has introduced:

- CAN\$1.9 billion infrastructure fund to strengthen research infrastructure in universities, hospitals and other institutions;
- CAN\$900 million funding for 2000 new Research Chairs;
- a new CAN\$1 billion per annum R&D tax credit scheme; and
- a major injection of funding for the three research granting councils¹.

If Australia is to take its place among the top ten countries in the world at creating ideas and successfully turning them into businesses, jobs and wealth, an effort must be made which matches those being made by the leading countries in the world. Just as we have had success in the sporting arena we can have success by investing effectively in research and training over a number of years, Australia can be amongst the top performers at a level much higher than that expected for a country of our size.

The lesson from our sporting success is that top class performance goes to those that not only pick up ideas from the rest of the world, but also to those who can easily access a base and use it as a springboard to strike out in new directions, pushing the frontiers of knowledge and achievement.

In the field of technological innovation, the real action takes place where new ideas are emerging from cutting edge research. The experience of firms such as Cochlear, ResMed and CSL demonstrate the benefits that can flow from Australian research leadership. While Australia can't be at the cutting edge of all research fields, we can be up with the best in a number of fields and leaders in selected fields. The performance of cutting edge research conducted by star researchers and research teams is a precondition for being at the leading edge in new areas of activity. To accept that the best Australia can do is to be a fast adopter of new technologies developed elsewhere in the world is, in the long term, a certain recipe for second class status. Although Japan's strategy of exploitation of imported knowledge seemed like a winning one at the time, especially when combined with advanced manufacturing production systems, it has ultimately failed. This is a fact now widely recognised in Japan.

¹ Expanding Canada's Knowledge Base, *Nature*, Volume 397, 11 February 1999

Australia must be at the leading edge of research in a range of new economy activities, biotechnology, information and communications technology (ICT), including digital content, software and services, and, of course, leading edge innovative activities to keep our existing industries world competitive. This can and should involve whole of government priorities.

The vision is an ideas-based economy with:

- high growth in new economy activity to balance our support for existing industries;
- start-ups and spin-offs common place; and
- Singapore like success in attracting global giants to undertake R&D in Australia.

This can be the reality across a broad range of activities — biotechnology, ICT and defence.

The Australian Science Capability Review (ASCR) and the Innovation Summit Implementation Group (ISIG) have identified the following target areas:

- culture and image
- skills
- generating ideas
- commercialisation

The target areas for support involve some additional investment. This investment must be closely monitored to ensure that the community receives a good return. Any outlays must be competitive, outcome focussed and conditional on performance.

The Importance of the SET Base to Australia's Future

Australia's future will be dependant on the strength of its national innovation system. The greater part of the economic growth that has taken place in the post war period is due to technological innovation. The companies and countries that will do best in the future are those that create the most attractive environment for innovation.

We are presently in the middle of scientific revolutions in areas such as information and communications technology, genomics, biochemistry and nano-technology that will change the way we live and work. The world stock of knowledge is **doubling** approximately every seven years, driven by the substantial commitment by the technologically advanced countries to invest in knowledge generation and workers of all kinds. Analysis of the US economy suggests that in the last decade the growth of the information technology and communications industries have accounted for about one third of economic growth in that country. The last few years has seen a significant increase in the value of intangible capital, which is reflected in stock market valuations.

The intangible investment in human capital, creation of ideas and new business and organisational forms is now being recognised as much more important than physical capital, unskilled labour and raw materials for a strong knowledge-based economy. Intellectual property and the ability to create and exploit it will become key national resources for the future.

As shown by the experience in the US, companies and businesses that are at the cutting edge of developments in these technologies will have a strong competitive edge that will lead to the generation of new jobs, new businesses and greater wealth for the community.

The emergence of a knowledge-based economy means that the presence of a strong and excellent SET base is of central importance to the achievement of economic growth, new jobs, and the achievement of social and regional goals.

It also means that the returns on basic research and knowledge generation in the next decade are expected to be even greater than they were in the 1990s.

Special Aspects of Globalisation

The powerful forces associated with globalisation of trade, direct investment, financial flows, technology flows and increasingly movements of highly educated and trained researchers, mean that domestic policies for SET and innovation cannot be developed in isolation.

The US is growing its economy by assisting the growth of new businesses underpinned by research and education in the US universities, and by sustaining a dynamic venture capital market. Powerful regional clusters of new business creation have occurred around key research universities such as MIT in Massachusetts, Stanford University in California and the University of Texas.

The incentives and culture of the leading US research universities lead to a powerful connection between them and the business community. The universities are increasingly becoming centres of wealth creation as well as centres of education and research.

This new role for universities has been complemented by the emergence of a dynamic, and now large, venture capital industry in the US. Successful new business entrepreneurs have provided an important source of venture capital. Such bodies do not merely bring finance to the business development process, but also deep knowledge of the business growth process and the ability to marshal a range of complementary services.

Many of the research and technology-based US companies have become globally active and are locating significant research and production facilities offshore. Countries in western Europe and Asia are competing strongly to attract the research activities of US companies.

Our business environment must be internationally competitive if Australia is to compete successfully to attract research based investments by the US companies. Such investments will enhance the quality and competitiveness of Australia's R&D capabilities and the business environment.²

Globalisation provides threats as well as opportunities. Well educated and trained people have become highly mobile in search of challenging professional opportunities and high incomes. There is a risk that Australia will lose its well known star researchers able to operate at the cutting edge of technology to North America and elsewhere.

Building On What Has Been Done So Far

Major improvements have been made in the framework supporting the generation and translation of ideas into commercial reality.

² OECD, *Globalisation of Industrial R&D: Policy Issues*, 1999

Many of the issues associated with higher education, research and research training were considered by the White Paper, *Knowledge and Innovation*, which is leading to significant changes in the way higher education research and research training is organised and financed.³

Most notably, the White Paper has led to the consolidation of the Australian Research Council (ARC) competitive grants system to support discovery projects and linkage projects. Changes have also been made to the way block grants are funded and the accountability provisions.

The Wills review of health and medical research resulted in significant changes to the NHMRC competitive grants system as well as a doubling of financial resources over the next five years.⁴

The philosophy of the Wills Report is to increase the role of contestability by shifting the balance of funding from block funding of institutions to contestable grants. This will see an increase in the number and funding of peer-reviewed, excellent research projects. The increased investment in the health and medical research system will generate significant returns to the community. This is expected to be from exploitation of the bioscience revolution for both health outcomes and building innovation-based businesses as part of a virtuous cycle of government, research and industry.

There have been a number of other changes on the Australian business landscape:

- the recent changes announced to the capital gains tax as part of the Ralph Business Tax Review should result in an expansion of funds available for new business creation;
- the Building IT Strengths program involves the establishment of a national set of incubators to provide seed capital and business services to emerging companies in the ICT sector; and,
- the establishment of the Innovation Investment Fund.

The result is that the situation for venture capital in Australia is better than it was, but still lags behind the US situation, especially in the area of access to pre-seed capital.

The ASCR and ISIG show that while good progress has been made, further reforms are needed to ensure that the vision of an ideas-based, can do economy and society can be realised.

³ Minister for Education, Training and Youth Affairs, Senator the Hon Dr D A Kemp, *Knowledge and Innovation: A Policy Statement on Research and Research Training*, December 1999

⁴ P Wills and others, *The Virtuous Cycle: Working Together for Health and Medical Research, Health and Medical Research Strategic Review*, 1999

The Importance of Innovation and SET

The high level of economic growth that springs from a dynamic and responsive national innovation system and the SET base is dependant on a high rate of creation of ideas and their effective translation to commercially viable products and processes. SET is integral to the national innovation system, especially for creating opportunities for new business growth. An important issue for the effectiveness of the national innovation capacity — defined as the economy's potential to produce a stream of commercially relevant innovations — is the productivity achieved by the SET base.⁵

People

The nation's SET base is held together by "ideas workers". These are people who contribute to the creation of new ideas and the effective application of the existing global stock of ideas. Most international comparisons of "ideas workers" includes people qualified in the natural and physical sciences, engineers and technologists. The capacity of the SET education and training system to add to and renew the nation's stock of ideas workers is a crucial component of the national innovation system. Innovation requires a broad range of skills, not just in SET, but also in management, problem solving and risk taking. A successful business environment is one which employs people with all these skills.

Infrastructure

Leading-edge research requires leading-edge infrastructure. Some impressive facilities have been developed in Australia, but these facilities have not been developed on an internationally competitive time-scale. Excellent research facilities attract business investment and the potential for significant industry clustering. Australia's major SET institutions have a major investment in equipment of all kinds and, in particular, computing and communications equipment. Some facilities needed to conduct large scale research cost billions of dollars and is clearly outside Australia's capability. In this situation, access arrangements to expensive equipment located offshore become important.

Institutions

The creation of new ideas and their application is generally carried out by a set of crucial SET institutions. The main institutions and their most important functions are listed in Table 1.

Table 1 SET INSTITUTIONS AND KEY FUNCTIONS

Universities	<ul style="list-style-type: none"> – Training/education – Research for advancement of knowledge (the universities conduct about 60 per cent of Australia's basic research)
Government Funded Research Agencies	<ul style="list-style-type: none"> – Applications-based research – Technology transfer – Contract research
Cooperative Research Centres	<ul style="list-style-type: none"> – Linking universities, government funded research agencies and business
Medical Research Institutes	<ul style="list-style-type: none"> – Applications-based health and medical research
Businesses	<ul style="list-style-type: none"> – Applied research directed to introduction of new products and processes (business conducts the great bulk of Australia's experimental development)

What Needs to be Done

⁵ S. Stern, M. Porter and J. Furman, *The Determinants of National Innovation Capacity*, National Bureau of Economic Research, September 2000

Because we are dealing with a complex national innovation system, it is not realistic to think in terms of identifying one action that can shift the performance of the whole system to a much higher level. The ASCR and ISIG demonstrate that an integrated package of measures is required if the performance of the national innovation system is to be significantly improved.

There needs to be a change of culture, operating principles, a greater emphasis on contestability and investment outcomes. The package of measures proposed by the review focus on four main areas:

Culture and image

Australians have already demonstrated a capacity for cultural change, for example, the long term success of drink driving campaigns and, the wearing of seat belts. For an innovation culture the Australian government, business, educational institutions and research agencies need to:

- capture young people's interest in entrepreneurship and innovation;
- encourage students in the enabling sciences;
- make research careers in Australia more attractive; and
- improve our capacity to measure innovation performance.

Building enterprise and innovation skills

Australia must build enterprise and innovation skills by:

- enhancing Australia's skill base, especially in areas such as mathematics and information technology;
- encouraging more innovative learning and teaching in Australian schools;
- facilitating teacher work experience and learning about innovation; and
- making it easier for business to employ SET graduates.

Generating ideas

Australia needs a strong research capability to generate ideas with centres of research excellence at least equal to those in other countries. This will require:

- increasing investment in high quality basic research;
- improving research infrastructure;
- correcting the downward trend in business investment in R&D.

Commercialisation

We must achieve action from ideas, translating them into profits using both private and public sector incentives and encouraging the necessary alliances, connections and partnerships. We can do this by:

- improving the commercialisation rate of universities and Government Funded Research Agencies;
- encouraging the formation, growth and competitiveness of new hi-tech firms;
- expanding existing research collaboration with industry; and
- increasing the attractiveness of Australia as a place for the world's leading knowledge-based companies to locate research-based investments.

Where are the Areas of Greatest Need and Opportunity

The universities

A key finding that has emerged from observation of policy developments in the leading OECD countries is that the universities are increasingly taking on a new role beyond their existing roles as education and research institutions. The new role sees them as “dynamos of growth”.⁶

In order for the universities to play this role, three conditions are necessary. First, they must have the human, financial and physical resources necessary to conduct cutting edge research. Second, they must be well linked to the other elements of the national innovation system. Third, excellence in research and teaching needs to be matched with excellence in commercialising research.

Measured against the first requirements, our universities are showing:

- worrying signs of an ageing research infrastructure;
- internationally uncompetitive research grants; and
- a tendency to lose star researchers to leading overseas institutions, especially in North America.

Unless action is taken to reverse the current trend, Australia will start to lose touch with the front runners in a world of ideas driven growth and the universities will be less well placed to play their new role as centres of wealth creation.

Government-Funded Research Agencies

The Australian community has traditionally invested in a public sector science function. These agencies are required to respond to the unique problems resulting from Australia’s geography, biodiversity and economic base. They are, in general, focussed on researching areas relating to the natural resource-based and the environment where the private sector lacks the incentives to undertake research of national significance. Since the late 1980s, these agencies have received government funding in the order of 90 per cent of the total required for their work.

There is a clear role for government in funding research and development activities which will not be undertaken by the private sector in the following areas:

- Providing advice to government and the community on issues which are essential to understanding our environment and which affect our health, safety and the quality of our lives like:
 - genetically modified food;
 - dryland salinity;
 - climate change;
 - the Antarctic region;
 - national measurement standards; and
 - health.
- Basic research, for which no one business can fully capture the benefits from its investment.
- Innovation facilitation by demonstrating technology platforms and other activities like network formation and technology diffusion that will not be undertaken by industry.

The situation facing the government-funded research agencies is different from that facing the universities where there are clear signs that capability is at risk unless a major investment is undertaken. The challenge with the government-funded research agencies is to create an

⁶ UK Government White Paper, *Excellence and Opportunity: A Science and Innovation Policy for the 21 Century*, July 2000

environment in which they play a much stronger role in the process of turning ideas into businesses and hence jobs and wealth.⁷

Business involvement in R&D

The business sector represents a significant part of Australia's SET capability in terms of people, infrastructure and research teams. The issues associated with the recent sustained fall in R&D by private business have been canvassed in the Innovation Summit and by ISIG and the ASCR.

Two matters do stand out. First, government needs to undertake additional action to ensure that small to medium sized enterprises perform more R&D and innovation. Many other nations are already adopting this strategy.

Second, the intense international competition to attract research-based investment by the world's leading knowledge-based companies means that Australia must ensure that its environment for such companies is attractive if it is to have a chance of securing such investment.

The Core Recommendations

ASCR and ISIG make a number of recommendations which are designed to strengthen Australia's SET capability and to ensure the effective operation of the process of transforming ideas into business opportunities, new jobs and wealth. A number of these recommendations are concerned with processes, for example, better intellectual property management, and do not in themselves involve a significant funding requirement.

Priorities

While accepting the judgement of previous reviews that Australia draws strength from our pluralistic system, there is a need to put in place a system for identifying and reviewing national research priorities to ensure emerging opportunities are capitalised on.

PMSEIC should conduct an annual review of research priorities that are reflected in the decisions of the different elements of the research system (eg, ARC, NHMRC, CSIRO, CRCs, RDCs, etc). These decisions should be tested against Australia's strengths and areas of emerging opportunities. This will provide a mechanism for government and business to respond to important emerging research areas.

Funding Proposals

The major recommendations of the reports of ISIG and the ASCR which require significant funding are:

People and Culture

- HECS scholarships for science/education and enabling sciences
- Double the number of Australian postdoctoral fellows
- Federation Industry Chairs
- Science Awareness Program

⁷ J Baker, *Creating Knowledge, Creating Wealth: Realising the Economic Potential of Public Sector Research Establishments*, August 1999.

- Enterprise and innovation scholarships
- Innovation Awareness Program
- Young Entrepreneurs Program
- On-line curriculum
- Government purchasing

Generating Ideas

- Double ARC competitive grants funding over 5 years
- Increase funding for university (RIBG) and non-university research infrastructure
- Program to support establishment of major new national research facilities
- Tax incentive cash-out for SMEs
- 200 % tax incentive or equivalent cash grant to attract major R&D projects
- Tax concession 130%
- Tax concession incremental
- “Deep” infrastructure program

Commercialisation

- Pre-seed capital for research institutions such as universities, Government Funded Research Agencies, CRCs etc
- Innovation Centres
- Redesigned R&D *Start* Graduate Program
- Expanded CRC program
- Incubators (6 year program)
- Increased funding for COMET
- Technology transfer — international R&D collaboration
- Technology transfer — international show-casing
- Technology transfer — mobility, exchange, S&T agreements

The Value Proposition

A return on investment in innovation and SET will occur by:

- increasing the creation of intellectual property by supporting excellent research wherever it might be performed;
- significantly lifting the number of spin-off and start-up companies based on technological innovation;
- strengthening the competitiveness of Australia's existing resource-based and service industries;
- increasing the attractiveness of Australia as a place for the world's leading knowledge-based companies to locate research-based activities;
- underpinning the perception of Australia as a serious player in the emerging knowledge-based economies.

The community, who will be financing the investment strategy proposed through their taxes, has a right to transparency in terms of the results being achieved by the investment strategy and the benefits to the community.

Accountability

The world is changing rapidly driven by a number of scientific and technological revolutions. Australia needs to be in a position to respond flexibly and appropriately to emerging opportunities and challenges in the future.

Well-functioning national systems of innovation should be kept under regular review to ensure that the community is benefiting from its investment and Australian companies keep pace with their competitors.