PRIME MINISTER'S SCIENCE, ENGINEERING AND INNOVATION COUNCIL

FIRST MEETING, 29 May 1998

Canberra

UNIVERSITY-INDUSTRY LINKED RESEARCH IN AUSTRALIA

Introduction

Research is one of the major drivers of Australia's economic growth and competitiveness in the global market. The success of Australia as a knowledge based economy will depend upon our ability to innovate – to generate new knowledge, ideas and technologies through research.

Research may be driven by curiosity or influenced by specific industry needs. The innovations arising from this research activity must be utilised to achieve economic, social and cultural benefits.

It is now recognised that the generation of knowledge and its development into new technologies for commercialisation can only be considered in terms of the national innovation system and that the key to successful innovation is the flow of creativity, ideas, skills and people between players in the innovation system, namely the universities, public research institutes (primarily CSIRO) and private enterprise. Understanding this system can help identify leverage points for enhancing innovative performance and competitiveness.

This paper, prepared by the Australian Research Council, emphasises:

- the importance of basic research for our economic competitiveness; and
- the success of targeted industry linkage programmes – particularly the importance of skills transfer and personnel movement in linking science and industry.

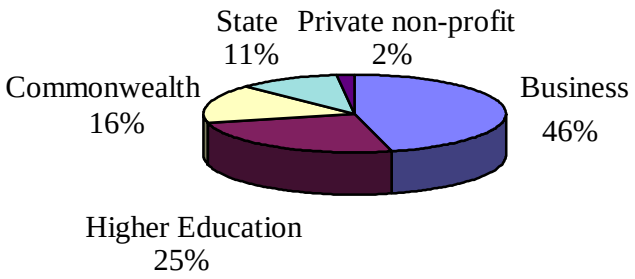
Presentations to the 29 May PMSEIC meeting were made by Professor Vicki Sara, Chair, Australian Research Council; Professor Martin Green; and Dr Jon Hronsky.

University research in a national and international context

Universities are major players in the innovation system – both in performing research and training skilled personnel. The higher education sector represents one-quarter of the national research and development (R&D) effort.(Figure 1). Universities account for 78% of basic research and 39% of strategic basic research.

The paper was prepared by an independent Working Group for the PMSEIC and the views so expressed are those of the Working Group and not necessarily those of the Commonwealth.

Figure 1 Expenditure on R&D by Sector,



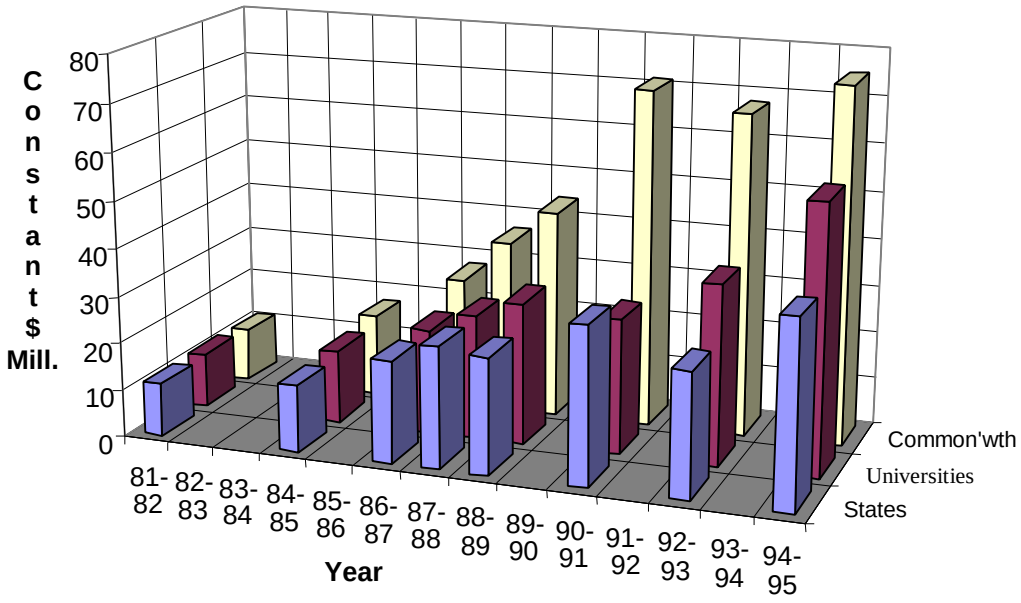
Source: Australian Bureau of Statistics, *Research and Experimental Development All-Sector Summary, 1994-95*

This compares with an OECD average share of total R&D expenditure by higher education of 17.8%, and an EU average of 20.6%. It is on the high side of average, close to that of Canada (23.8%), below the Netherlands (28.8%) – the most comparable country in GDP per capita terms - and above the United Kingdom (17.5%) and the United States (15.6%) (OECD, 1996).

The share of university research financed by governments has been declining and universities are seeking new sources of support and a new basis for that support. Private industry is funding an increasing share of research in universities, but this nevertheless remains relatively modest at 5% or less in the vast majority of countries (OECD, 1997a). Figure 2 indicates an increasing trend in Australia in recent years, albeit from a low base.

Figure 2:

Business Funding of Public Sector R&D in Australia 1981-1995 (Commonwealth and State Government Organisations and Universities)



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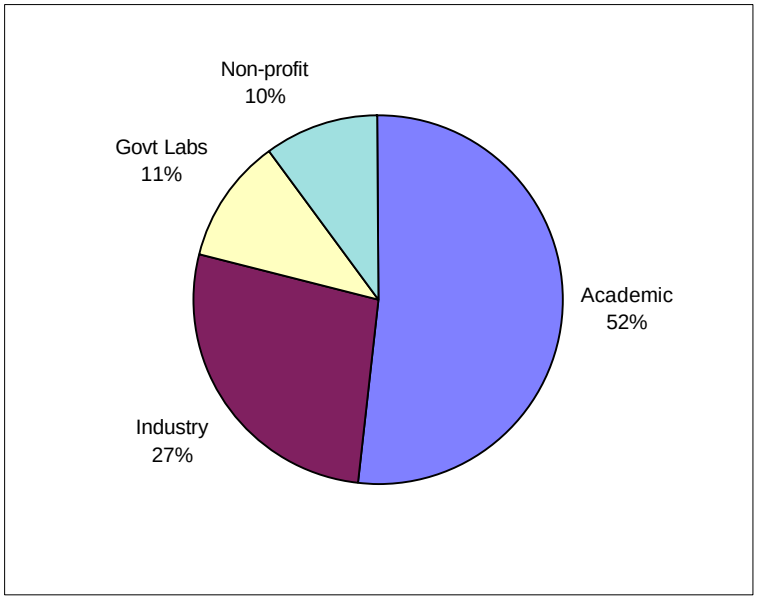
The Japanese Government has recently recognised the importance of a balance between basic and applied research and has boosted its R&D efforts in the area of basic and university research. The increase – a rise of eight per cent, directed at academics and researchers at national institutions to stimulate basic research – is seen as a remedy for a stalled economy (Normile, 1997).

Basic research and economic performance

University research plays a key role in enabling technological advances in the private sector. Linking citation between US patents and scientific research papers provides one way of examining the contribution of publicly funded research to industrial technology. In the US, 73 per cent of the papers cited by US industry patents are public science (33 per cent of which are foreign science) authored at academic, governmental and other public institutions; only 27 per cent are authored by industrial scientists. The cited US papers are from basic research, in influential journals, authored at top flight research universities and laboratories (half of the US papers cited in US industry patents, are authored at academic institutions) relatively recent and heavily supported by the National Institute of Health, the National Science Foundation and other public agencies (Narin 1997, Figure 3).

Figure 3

Source of Scientific Papers Cited in US Industrial Patents



The citation rate for US patents granted to Australia is comparable with those of most other developed countries. Japan holds the major share with 60 per cent (Bureau of Industry Economics, 1996).

According to the National Science Board's *1996 Science and Engineering Indicators*, economists have found high rates of return to private R&D investments. These estimates are in the order of 20 to 30 per cent annual return on investments to firms and approximately 50 per cent to society

overall. For some specific products, rates of return have been remarkably high. Returns from information technology are estimated to have exceeded 80 per cent per year between 1987 and 1991 (NSB, 1996).

In 1996 the United Kingdom Treasury commissioned a study of the relationship between publicly funded basic research and economic performance. The report notes that there are two main views of the economic benefits of basic research:

- to perform economically useful research which firms will not undertake because they cannot exclusively capture the benefits (the 'market failure' or 'public good' argument), and
- to provide research training and maintain access to international networks.

The UK study examined the econometric literature, and while it reports a positive rate of return (of 28 per cent) the work is beset with measurement and conceptual problems.

Turning to surveys of R&D managers and case studies, the UK study identified six main forms of economic benefit from basic research:

1. discovery of useful information,
2. creation of new instrumentation and methodologies,
3. development of new skills among researchers and graduate students,
4. particularly those involved in solving complex problems,
5. providing access to networks of experts and information, and
6. the creation of 'spin-off' companies (Martin and Salter, 1996).

These benefits were illustrated to the PMSEIC meeting by Professor Martin Green from the ARC Special Research Centre in Photovoltaics. Professor Green has been funded through ARC basic research programmes since 1975 In 1991 he received the ARC's premier award – a Special Research Centre with funding of approximately $1 million per year. The objective of this scheme is to develop national centres of excellence. His research has placed Australia at the world's leading edge in solar energy technologies.

Targeted University-Industry Research Schemes

As indicated above the quality of our research and its links to industry is one of our most important national assets for innovation – the success of innovation will depend upon knowledge flows stimulated by such mechanisms as joint industry research, public/private sector partnerships, technology diffusion, shared infrastructure and movement of personnel.

Attempts to link knowledge flows to firm performance show that high levels of technical collaboration, technology diffusion and personnel mobility contribute to the improved innovative capacity of enterprises in terms of products, patents and productivity. In most studies of technology diffusion, it is shown that the skills and networking capabilities of personnel are the key to implementing and adapting new technology.(OECD, 1997b).

Australia has a diverse range of programmes to enable interaction with industry. Major programmes are the Australian Research Council's Strategic Partnership in Industry Research and Training and Key Centres schemes, and DIST's CRC and R&D START programmes. Attachment 1 contains further detail on the DIST schemes. Attachment 2 contains a table showing programme, discipline focus and linkages for the range of schemes, each of which is building links in different sectoral niches.

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Strategic Partnership in Industry Research and Training Scheme

The ARC's key industry linked scheme is the Strategic Partnership in Industry Research and Training (SPIRT) scheme which encourages a flexible approach to university-industry collaboration in research and research training. It has several elements: Collaborative Research Grants; Australian Postgraduate Awards (Industry) and Australian Postdoctoral Awards (Industry).

The aim of the SPIRT scheme is to:

- introduce a flexible approach to R&D project development and implementation which is responsive to market demand;
- stimulate university/industry research and training linkages; and
- encourage the development of long-term strategic alliances between university research providers and industry partners to utilise the available intellectual capital to meet the demands of economic and social development.

SPIRT partnerships between industry and universities provide benefits to industry including access to specialist expertise, improved capacity to solve problems and industry focussed research training. The success of the scheme is demonstrated by the increase in the number of Collaborative Research Grants (CRGs) from 40 for 1992 to 340 for 1998, following a substantial funding increase in the 1996 Budget.

The following table shows funding sources for SPIRT grants for 1998:

Table 1

	Commonwealth funding	**Industry contributions**
New SPIRT grants 1998	$17 891 480	$25 958 660
Total SPIRT funding 1998 (includes continuing grants)	$44 000 000	$60 000 000

Approximately 750 applications for SPIRT funding were received for the 1998 round of which 45% were successful. The applications included industry funding commitments of approximately $50m in cash and $103m in in-kind contributions. In 1998 only 17% of this potential industry funding could be accessed through the scheme because of limitations on the amount of grant money available. Therefore, there is considerable scope for increasing the size of the scheme to leverage additional industry money.

Key Centres Scheme

The Key Centres programme was established in 1985, to provide a cornerstone for the initial development of linkages for contract and cooperative ventures between universities and industry, including the generation of industry research funds. A number of centres which were originally established as Key Centres are now operating as self-funded centres, drawing their funding from a variety of sources, including industry.

Key Centres have a dual objective of contributing to industry through teaching and research. Their teaching function is focussed in particular on training graduates for future employment in industry sectors. In the evaluation survey described below, one centre indicated that over 80 per cent of the mid-level executives in its state industry sector were former graduates.

In 1998, there are 15 Key Centres covering a range of research fields and socio-economic objectives, with total Commonwealth funding of $2.9m. Key Centres vary in the amounts they leverage from industry, depending in part on their discipline area. Thus one Centre which operates in the Social Sciences area receives $340 000 in ARC funding and $800 000 in industry support, while another Centre in the physical sciences gained $418 000 in ARC funding and $1.23m in industry support.

Evaluation of ARC targeted industry linked schemes

The ARC's industry-linked programmes were recently reviewed in a soon to be published report (Turpin,1998) These schemes are shown to have different but complementary roles to other industry-linked schemes and:

- involve a range of industry partners – especially a significant number of small to medium sized enterprises (SMEs);
- initiate new industry research that would not otherwise occur;
- provide skilled personnel with access to broad national and international networks and resources.

A range of industry partners

The SPIRT scheme attracts some of Australia's top R&D performers as shown by a comparison with the *R&D Scoreboard* (Attachment 3). Large companies are the dominant participants in CRGs, with 57% of all CRGs from 1992-97 (Figure 4). The SPIRT scheme, however, also attracts enterprises with a smaller R&D budget. It has been instrumental in bringing SMEs into research and research training partnerships with universities, particularly through the post graduate linkage scheme Australian Postgraduate Awards (Industry) (APA(I)s. 51% of APA(I)s go to SMEs (Figure 5). However, a small group of firms, including BHP, Amira, Comalco, ALCOA, CSL, and WMC, dominate the list of partners for both CRGs and APA(I)s.

FIGURES 4 AND 5: LARGE COMPANIES AND SMES PARTICIPATION IN CRGS AND APA(I)s 1992 - 97

Figure 4: Participation in CRGs

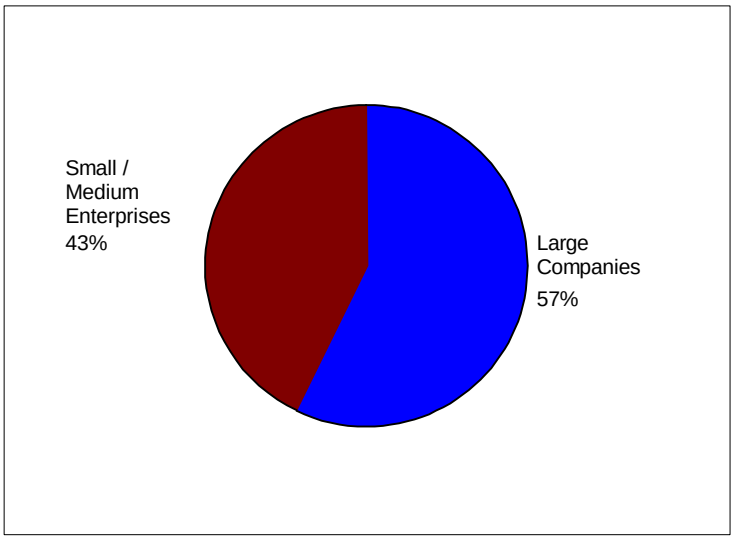
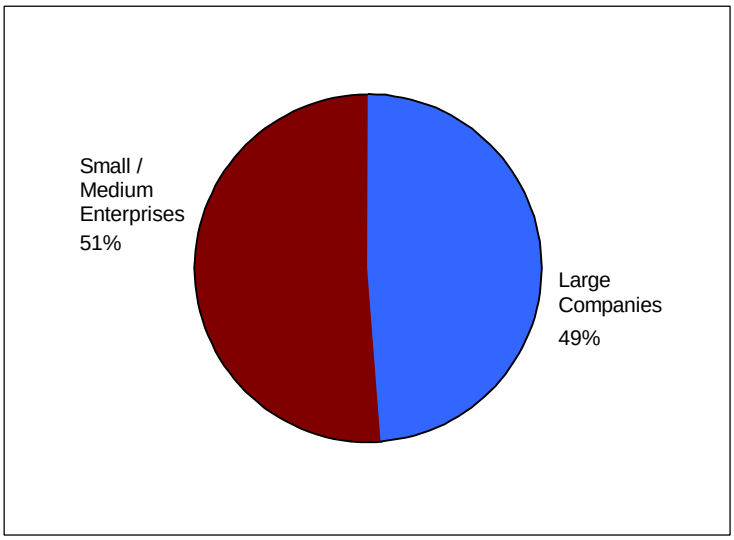


Figure 5: Participation in APA(I)s



New industry research

The evaluation study indicates that industry participants become involved in ARC schemes: to capture scientific expertise not available in-house - usually to solve a particular problem or for the training and employment of research staff; to access core research in the field and capture potential flow-ons from basic research; and to complement in-house industry research, which tends to be more applied and conducted in a shorter time frame.

The targeted industry schemes have built closer alliances between the sectors by initiating 'first-time' collaborative activities and by extending existing partnerships. They have improved research understanding, cooperation and communication between the sectors through access to know how, expertise and infrastructure.

Training of skilled personnel

One of the most important aspects of the SPIRT scheme is the training of industry focussed personnel and stimulating the movement of people between industry and universities. Dr Jon Hronsky from Western Mining Corporation is a former APA(I) holder under the SPIRT scheme who returned to industry. Dr Hronsky outlined the benefits of the APA(I) scheme from the perspective of the industry partner, in a presentation to the 29 May PMSEIC meeting.

Conclusion

Research funded through either the ARC's basic research programmes or a range of targeted industry linkage programmes, provides vital long term benefits to our economic growth and competitiveness. One of the most important ways of linking science and industry is through the movement and interaction of personnel within the national innovation system.

The material presented from the evaluation of the ARC's industry-linked schemes indicates that there is as yet unrealised potential for industry, particularly small to medium enterprises, to be drawn into collaborative research activities which provide them with access to expertise, problem solving abilities and training.

In encouraging stronger links between universities and industry we do not need to shift the balance of funding support for university research away from basic research in the direction of applied research. The Australian Government has strengthened both university research and industry R&D through programmes which encourage the flow of knowledge and skills between the two sectors. The aim should be to create a seamless web of activity in which movement and flow of knowledge and skills is not impeded by barriers and impediments to productive university industry interaction.

The maintenance of a diversity of funding schemes within the national innovation system, necessitates strong bilateral and multilateral coordination mechanisms which enhance the most effective use of publicly funded resources.

With a broad membership representative of the national innovation system, the ARC can act as a catalyst and play a broad brokerage role in matching the needs of government and industry to the excellence of Australian research.

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Attachment 1

Programs to support the development of linkages between the university and industry sectors provided through the Department of Industry, Science and Tourism

Research and Development (R&D) Start Program

The *R&D Start* program provides flexible funding arrangements for small to medium enterprises to undertake industrial research and development and related activities. *R&D Start* is a competitive scheme that provides a mix of support including grants and loans of up to $15 million for R&D projects. Funding, for up to three years duration, is provided for expenditure up to 50% of the eligible project costs. Proposals are assessed by the Industry Research and Development Board against published criteria, with the most meritorious being offered support.

The objectives of *R&D Start* are to:

- increase the number of private sector R&D projects with high commercial potential;
- foster greater commercialisation of outcomes from R&D projects;
- foster collaborative R&D and related activities both within industry and between industry and research institutions; and
- increase the level of finance sector funding of R&D and its commercialisation.

R&D Start currently has five elements:

1. Grants for R&D projects undertaken by small and medium enterprises (SME) to achieve internationally competitive products, processes or services which demonstrate significant commercial potential.
2. Grants for graduate based R&D related projects, to promote new and appropriate linkages between industry and tertiary/research institutions.
3. Grants for collaborative R&D projects between research institutions and companies to encourage collaboration on high technical risk projects with substantial national benefits.
4. Concessional loans to support small companies in the early commercialisation of technological innovation in goods and services.
5. The Innovation Investment Fund which aims to stimulate early stage venture capital for small technology based companies.

In its December 1997 Industry Statement, *Investing for Growth*, the Government announced an additional $556 million over four years through the *R&D Start* program, bringing total expenditure under this program to $739 million over the period to June 2002. Eligibility requirements will be revised to allow virtually all Australian companies to apply.

The new competitive *R&D Start* program will have three main components:

1. a core grants element *R&D Start SME*, which provides grants of up to 50 per cent of the project cost for eligible firms with a group turnover of less than $50 million a year, and will

provide flexible support for other aspects of R&D and innovation in small businesses;
2. a new *R&D Start Plus*, which provides grants of up to 20 per cent of the project cost to large companies with a group turnover of more than $50 million a year; and
3. a new *R&D Start Premium*, which provides an additional amount of repayable assistance for projects of high merit.

125% Tax Concession for research and development

The R&D tax concession was introduced in 1985 to increase the level of R&D conducted in Australia. It enables eligible companies to claim 125 per cent of their industry R&D expenditure as a tax deduction, subject to meeting legislative requirements. This reduces the cost of their R&D to 55 cents in the dollar. Companies can also contract out R&D activities to other companies or approved Registered Research Agencies (RRAs) which have the expertise and facilities to do specific types of R&D on behalf of others. A minimum R&D expenditure threshold of $20,000 applies to companies undertaking their own R&D. This threshold is waived if the work is contracted to an approved RRA.

Expenditure eligible under the concession at 125 per cent includes salaries, wages and overhead costs which are directly related to the company's R&D activities, contract expenditure, and capital expenditure on R&D plant, including pilot plant. Special expenditure provisions apply to other costs such as core technology, feedstock and interest.

Section 73B(1) of the *Income Tax Assessment Act 1936* defines eligible R&D activities as systematic, investigative and experimental activities that involve innovation or high levels of technical risk and are carried on for the purpose of:

- acquiring new knowledge (whether or not that knowledge will have a specific practical application); or

- creating new or improved materials, products, devices, processes or services.

Also eligible may be 'supporting activities', ie any other activities that are carried out for a purpose directly related to the carrying out of the 'core R&D activities' mentioned above.

The R&D must be carried out by or on behalf of the company claiming the concession, it must have an adequate Australian content, and its results must be exploited on normal commercial terms and for the benefit of the Australian economy. If software R&D is claimed, a 'multiple sale' requirement may apply.

Technology Diffusion Program

The Program is a major new initiative by the Australian Government which will give industry access to leading edge technologies.

Under the new Technology Diffusion Program a total of $108 million will be provided to industry, universities and research agencies over the four years to June 2002.

The Program will increase industry's ability to absorb new technology and strengthen alliances nationally and internationally between Australian science, engineering and technology agencies and industry. It will focus particularly on small and medium enterprises (SMEs).

The Program will have three related components:

- Technology Alliances;
- Technology Transfer; and
- Online Business.

Cooperative Research Centres Program

The CRC program's overall objective is to strengthen long term collaboration between research organisations, and between these organisations and the users of research, in order to obtain greater benefits from Australia's investment in R&D. Importantly, it also seeks to contribute to postgraduate education in a user-oriented collaborative environment, and to training of users to raise awareness and transfer knowledge. A CRC is a bridging mechanism linking public sector research and higher education organisations and the users of new knowledge, from the private and public sector.

The program commenced in 1990, with the first CRCs established in 1991. Further selection rounds were held in 1992, 1994 and 1996, and another is scheduled for 1998. The selection process is highly competitive - there have been a large number of applications for new centres at each selection round since 1991. CRCs are generally established under contracts that run for seven years. There are now 62 Centres with a further five in the process of formation.

The CRC program addresses important weaknesses in the national innovation system, in particular the disincentives to collaboration among research providers and Australian businesses, the weak links between research organisations and users, the lack of critical mass due to the institutional and geographical dispersion of Australian research and research application, the lack of mobility of personnel between government research, academia and industry, and the challenges of effective international links for a country isolated from the international centres of research and innovation. The program complements the work of the universities, CSIRO and other research organisations.

Attachment 2

Programme and discipline focus for SPIRT, Key Centres, CRCs and R&D START programmes.

Programme Title	Programme Focus	Targeted Linkage	Major Discipline Focus
SPIRT	research and research training	university-industry	all disciplines, particularly applied sciences, chemical and mathematical sciences, humanities and social sciences
Key Centres	research, research training and teaching	university-industry	all disciplines, particularly applied sciences, and cross-disciplinary research
CRCs	research and development, research training	university-industry-government-research institutions	agribusiness, technology, health and pharmaceuticals, mining, energy, environment
R&D Start	research and development, commercialisation	industry-research institutions	applied, engineering and information sciences

Attachment 3

Firms/Agencies which use ARC Collaborative Schemes ranked by R&D Scoreboard and CRCs

Firms Ranked by R&D Scoreboard	Firms/Agencies Ranked By ARC Industry Schemes User	Firms/Agencies Ranked by CRC Industry Partners
Telstra	BHP	BHP
BHP	AMIRA	Queensland. Dept. of Industry
General Motors Holden	Comalco	Digital Equip. Corporation
CSR	CSL	Agriculture WA
Ericsson	ALCOA	NSW Agriculture
Ford Motor Company	Telstra	Telstra
Rio Tinto	Pacific Sola	AMIRA
Alcatel Australia	Bresatec	Bureau of Meteorology
Optus Communications	Bureau of Meteorology	Melbourne Water
ICI Australia	Queensland Dept. Environ. Heritage	Arnotts
Fujitsu Australia	SA Mines and Energy Dept.	Fujitsu
Qantas Airways	WMC	Goodman Fielder
ERG	Australian Defence Industries	ICI
CSL	NSW Roads & Traffic Authority	Australian Defence Industries
Newcrest	WA Department of Education	CSL
Conaco Australia	Fauldings	Agriculture Victoria