Australian Academy of Science

Research and innovation in Australia: a policy statement

November 2005

President's foreword

On behalf of the Fellows of the Academy I have congratulated Professor Barry Marshall and Dr Robin Warren on their award of the 2005 Nobel Prize for Physiology or Medicine. The prize recognises their research that led to the identification of the bacterium *Helicobacter pylori* as a major cause of gastritis and peptic ulcers.

While based on research carried out over 20 years ago, this award symbolises the continuing strength of Australian medical research, and demonstrates that scientists do not have to head overseas to do award-winning research. While the results of the research have been integrated into the mainstream of medical practice around the world, the length of time between the original research, and its ultimate recognition in this spectacular way is a strong indication of the need for research funding and planning to be based on long time horizons.

The two years since the Academy's 2003 policy statement has seen some consolidation of the national activity in science, engineering and technology with the flowthrough of the commitments under the government's *Backing Australia's Ability* packages.

The level of business investment in R&D remains a great concern.

Recognising that government expenditure on R&D as a percentage of GDP is relatively high among OECD countries, the very low level of business expenditure on R&D (BERD) drags the national gross expenditure (GERD) well down the OECD table of national data. This situation has pertained for many years, with some minor variations, and represents a real disengagement by industry from leading-edge scientific input to the industrial process.

The reasons behind the relatively low level of BERD are complex, but any change will have to come from government initiatives, rather than relying on so-called market forces, that have been unable to deliver any real change so far.

In terms of government expenditure on R&D, both in universities and publicly funded research organisations, the Academy remains concerned that the level of government investment as a percentage of GDP remains essentially static, and many areas of weakness in the national science, engineering and technology (SET) environment are apparent.

These weaknesses include serious and growing skills shortages in the science and engineering fields, and the low level of employment of R&D personnel in the private sector.

The skills shortage particularly derives substantially from the low level of enrolment in mathematics and science subjects at high school. The Academy is pleased with the success of programs that it initiated in this area, *Primary Investigations* and *Primary Connections*, and with the recent commitment by the Minister for Science, Education and Training to fund Stage 3 of the *Primary Connections* program. Continued effort is required in this area if we are to achieve change at the national level.

The Academy is pleased to note the realisation of its 2003 recommendation to establish an ongoing program to follow on from the Major National Research Facilities program, with the establishment of the National Collaborative Research Infrastructure Strategy (NCRIS) Advisory Committee, and the allocation of ongoing funding to support the establishment and operation of national research facilities. The Academy looks forward to working with the Advisory Committee to develop the operational framework for these facilities.

However, these initiatives do not change the overall funding envelope in any substantial way. The Academy contends that there is a real challenge for government to determine whether the current science and technology funding framework is capable of taking Australia forward in the global economy of the next few decades, to continue to develop as a competitive knowledge-based economy, and remain a paid-up member of the first world.

The Academy continues to play an important role in international science arrangements that are critical to the maintenance of Australia's involvement in global scientific activities.

The Academy argues that the learned academies generally could play a greater role in fostering not only scientific links with international academies and other similar organisations, but in the development of scientific linkages between Australian and overseas industry and industry bodies. The Academy will be developing a specific proposal to pursue this concept.

Dr Jim Peacock, AC PresAA FRS FTSE
President
Australian Academy of Science

Recommendations

1. That government increase its support for Australia's R&D effort, building on the National Research Priorities, to ensure that Australia retains an internationally competitive science capability, capable of supporting Australia's industrial, commercial, environmental and economic position among leading world economies.
2. That government examines the implications of the continuing relatively low level of private sector investment in R&D to determine which policy initiatives might be necessary to address the issue.
3. That government provides funding to publicly funded research organisations sufficient to enable them to maintain their core capabilities, on which their competitiveness as world-class research providers depends.
4. That government maintains a long-term commitment to research funding in universities, and ensures that the implementation of the Research Quality Framework be appropriate to meeting the stated objectives of the initiative.
5. That government increases the level of funding for university operating grants to ensure that universities have the capacity to maintain key services into the future.
6. That government further addresses the problem of the availability of suitably qualified science and mathematics teachers, and expands programs to encourage high school students into the science and mathematics streams.
7. That government develops a dual funding strategy for the maintenance of national research infrastructure facilities.
8. That government at least maintains its level of support for the Cooperative Research Centres (CRC) program, and encourages the maintenance of the ongoing bi-partisan support for the program.
9. That the government provides additional support for the learned academies to allow a greater engagement with the international scientific community, and to support the development of international scientific-industrial linkages.

Building a competitive Australia

Recommendation 1

That government increase its support for Australia's R&D effort, building on the National Research Priorities, to ensure that Australia retains an internationally competitive science capability, capable of supporting Australia's industrial, commercial, environmental and economic position among leading world economies.

The Academy welcomes the continued support for research and development with the flow-through of funding commitments announced in the *Backing Australia's Ability* (BAA) packages, as announced[1] by the Minister for Education, Science and Training following the release of the Commonwealth's 2005–2006 Budget. Along with the Minister, the Academy continues to believe that 'it is our scientists and researchers who will help us understand and address the economic, social and environmental challenges we face. Whether it be the issues faced by an ageing population, land degradation or climate change, it will be scientists who will guide our response.'

In relation to the economy, the Academy also endorses Dr Nelson's comments that 'the significant commitment by the Australian Government to science and innovation... underlines the importance of R&D and innovation in enabling key sectors of the Australian economy to maintain competitive advantage in an increasingly globalised environment.'

The Academy also notes that total Commonwealth expenditure on R&D at $5.5 billion was a record level in real terms, and the level of government expenditure on R&D as a percentage of GDP remains around the fourth or fifth highest among OECD countries.

On the less positive side, the Academy remains concerned that the level of Commonwealth expenditure on R&D as a percentage of GDP is not increasing, with government expenditure as revealed in the 2005–2006 Budget remaining close to the 2004–2005 figure of 0.6 per cent.

When coupled with the historically low level of business expenditure on R&D (BERD), Australia's gross level of expenditure on R&D (GERD) as a percentage of GDP continues an inexorable downward trend even including the BAA funding commitments.

The Academy understands the argument that input measures do not necessarily equate to outputs. However, governments around the world continue to equate investment in R&D with future economic development. The EU has targeted GERD at 3.0 per cent of GDP by 2010.

In comparative global terms, the situation is serious. The closest Australia's GERD (as a percentage of GDP) approached the OECD average was in 1995–1996 at 1.71 per cent as compared with the OECD average of 2.21 per cent. The latest comparable data are for 2002–2003, which shows Australia at 1.62 per cent compared with the OECD weighted average of 2.3 per cent. Estimates based on current projections of expenditure and GDP growth indicate that the gap will continue to widen.

The Academy remains concerned that the sustained boom in primary exports, with the consequent robust growth in GDP is masking an underlying weakness in our strategic capacity to develop knowledge-intensive industries and to address pressing environmental, social and other issues.

As discussed under specific recommendations below, this weakness manifests itself in a number of ways, including an increasingly apparent shortfall in graduating scientists and engineers, falling university enrolments in the enabling sciences and engineering, the continuing decline in the relative level of funding available for university research, a very low number of researchers employed by industry compared with world standards, and a dramatic fall-off in the number of high school students opting for the hard-core science subjects.

These same weaknesses impact on Australia's ability to address the major environmental and other social issues on the national agenda. The Academy is concerned that the discussion of environmental issues often becomes separated from their significance in terms of sustainability of rural and other industries and economic growth generally.

It could be argued that the government should be taking advantage of the current healthy economic conditions to strengthen Australia's export competitiveness in the non-primary goods sectors, in order to protect the economy against future further deterioration in the global terms of trade in primary exports.

[1] The Hon. Dr Brendan Nelson, Minister for Education, Science and Training, press release 10 May 2005. See also *The Australian Government's 2005-06 Science and Innovation Budget Tables*, available at www.dest.gov.au.

Private investment in research and development

Recommendation 2

That government examines the implications of the continuing relatively low level of private sector investment in R&D to determine which policy initiatives might be necessary to address the issue.

The Academy notes from the latest available report from the Australian Bureau of Statistics[2] that business expenditure on research and development (BERD) grew by 10 per cent from 2002–2003 to 2003–2004, and as a percentage of GDP, rose slightly from 0.87 per cent to 0.89 per cent over the same period.

While not over-interpreting small year-to-year variations, the Academy remains concerned that the level of BERD remains well down in the bottom half of OECD countries.

As previously noted[3], some 30 years of essentially bi-partisan support for measures to increase the relative level of BERD have had little effect, although under the 150 per cent tax deduction regime that existed prior to 1996, BERD had been rising slowly but steadily. There is little doubt that the decision to reduce the 150 per cent tax deduction in the 1996–1997 Budget had the effect of reducing BERD significantly, and any recent improvements are relative to a lower baseline than existed under the previous arrangements.

The Academy is heartened by the findings contained in the ABS report[4] *Innovation in Australian Business* released in February 2005[5], that Australian business levels of innovation are relatively high among OECD countries. However, it is noted that several of the countries that are ranked above Australia do not feature highly in OECD tables of performance as knowledge-based economies[6], and many advanced countries including the USA are not on the list.

The data show varying trends across industry sectors, but there was actually a decrease in the proportion of businesses, including manufacturing businesses, that introduced new or significantly improved goods and services compared with the period 1991–1994.

In this analysis, the definition of innovation is very broad, with total expenditure on research and experimental development at about 30 per cent of total expenditure on innovation and related activities.

A further indication of the declining situation with industry investment in research and development is contained in data released by the Department of Education, Science and Training[7], which shows that 'the manufacturing sector has devoted a generally increasing proportion of R&D expenditure towards low technology manufactures, rising from 37.2 per cent in 1987–1988 to 56.5 per cent in 2002–2003.'

The Academy joins with the Australian Business Foundation[8] in recognising that innovation leading to improved economic performance is not necessarily a science-led activity. However, the Academy is concerned that some discussion of these issues downplays, or even dismisses the role of scientific R&D in the innovation equation.

The current resources-boom masks the underlying downward trend in manufacturing exports, particularly in advanced and elaborately transformed manufactures.

Overall, the conclusion that there is a serious under-investment in R&D by Australian business is inescapable, and warrants some serious government attention.

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[2] *Research and Experimental Development, Businesses, Australia, 2003-04*, Australian Bureau of Statistics (Cat no 8104.0) September 2005.

[3] *Policy statement on research and innovation in Australia, Recommendation 2*, Australian Academy of Science, September 2003. (www.science.org.au/reports/10september03.pdf)

[4] *Innovation in Australian Business*, Australian Bureau of Statistics (Cat no 8158.0) February 2005.

[5] *Australian spirit of innovation soaring*, The Hon. Ian MacFarlane, MP, Minister for Industry, Tourism and Resources, press release, 17 February 2005.

[6] OECD *Science, Technology and Industry Scoreboard 2003 – Towards a Knowledge-based economy*, available at www.oecd.org/publications. All references to OECD data are obtained from this source, unless otherwise noted.

[7] *Australian science and technology 2004, Research and experimental development by sector of performance, Table 32*, Department of Education, Science and Training, available at www.dest.gov.au.

[8] *The hidden realities of business innovation*, Narelle Kennedy, CEO, Australian Business Foundation, Presentation to Australian Technology Park Innovations, April 2005, and references therein, available at www.abfoundation.com.au.

Publicly funded research organisations

Recommendation 3

That government provides funding to publicly funded research organisations sufficient to enable them to maintain their core capabilities, on which their competitiveness as world-class research providers depends.

The Academy maintains its conviction that the CSIRO and other publicly funded research organisations comprise an important part of Australia's research and innovation system. The role of these organisations is different from but complements that of universities. They have a clear responsibility to maintain core competencies in strategic research relevant to Australia's economic, environmental and industry priorities. The Academy's National Committee for Earth Sciences has conducted a strategic review of research in geosciences in Australia and has clearly identified the role of Geosciences Australia in long-term, visionary research.[9] Publicly funded research organisations must be able to invest in long-term research that is not readily supported by short-term competitive research grants from funding agencies.

The Academy welcomes the return to triennial funding for CSIRO in the 2004–2005 Commonwealth Budget, but notes that funding levels for the publicly funded research organisations remain essentially flat, especially when allowance is made for special appropriations to cover such things as the absorption of the National Measurement Laboratory into CSIRO, and the construction of the new reactor by ANSTO. The Academy is also concerned that funding support for the CSIRO flagship programs does not compromise ongoing strategic research programs at the divisional level.

Revenue data published by CSIRO[10] indicate that the base level government appropriation is falling below the CPI adjusted level based on the 2003–2004 allocation, and that the level of external earnings is increasing, showing at 37.6 per cent of total revenue in 2004–2005, and projected to rise to 41.2 per cent in 2006–2007.

All of these facts have to be considered in an environment in which the cost of maintaining a world-class research capacity rises faster than the general cost of living, as new technology enhances the capability of research equipment and facilities necessary to retain that world parity.

The Academy reiterates its position, expressed in 2003, that to the extent that the aim of growing the total resources available to CSIRO is driven by internally imposed earnings targets, the Academy has the same concerns it raised in connection with the previous mandatory target[11]. It is important that CSIRO has the capacity to maintain its core strategic research capabilities, and that its ability to enunciate an independent research-based position on important issues, for instance related to the environment, is not compromised through too heavy a reliance on the financial support of the private sector.

A further concern is that servicing too high a level of external research contracts could have the effect of drawing down the intellectual capital of the organisation, thus weakening its capacity to service that activity in the longer term.

University research

Recommendation 4

That government maintains a long-term commitment to research funding in universities, and ensures that the implementation of the Research Quality Framework be appropriate to meeting the stated objectives of the initiative.

The Academy welcomes the increased Commonwealth research grant funding now flowing through to universities from the *Backing Australia's Ability* packages. The latest data published by the Australian Vice-Chancellors' Committee[12] for 2002–2003 show the level of competitive grants at $650 million, up 24 per cent on the previous year.

Interestingly, the proportion of research income derived from competitive grants grew only 2-3 per cent over previous years, due to continued

[9] www.science.org.au/natcoms/earth-strategic.pdf.

[10] CSIRO Strategic Plan 2003–2007.

[11] *Submission to the Review of the External Earnings Targets Policy applying to the Science Authorities (CSIRO,ANSTO and AIMS)*, Australian Academy of Science, 18 December 2001. (www.science.org.au/reports/earnings/htm)

[12] *University research income – growing for the future*, Australian Vice-Chancellors' Committee, press release, 4 February 2005.

growth in income sourced from other areas, particularly the private sector, which rose 6 per cent over the previous year, and represents 31 per cent of total research income in 2003.

While the proportion of funding sourced from competitive grants will presumably increase somewhat further as the increases in ARC and NHMRC funding flow through, the substantial income derived from research arrangements with the private sector is a strong indicator of the growing involvement of universities with industry.

However, the Academy warns against an expectation that an ever-increasing proportion of funding can be obtained from the private sector. The ability of a university to attract private sector research contracts or grants depends on the quality of its core research capability, which is largely driven by public sector funding, especially competitive grants.

In that context, the Academy reiterates the point made above, that the cost of maintaining a world-class research capacity rises faster than the general cost of living, as new technology enhances the capability of research equipment and facilities necessary to strive towards that world parity.

Attempting to increase the level of private sector sources to too high a level would have the effect of 'quarrying' the intellectual capital of the university, ultimately compromising the integrity of its core research capability, thus reducing its capacity to provide the quality research required. The current figure of about 30 per cent as the proportion of research funding derived from private sector sources would seem about optimal.

The Academy reiterates its support[13] for the concept of a research assessment process within the framework of the higher education system, now being implemented as the Research Quality Framework (RQF). The Academy's comments on the preferred model have been made available.[14]

The Academy welcomes the consultative approach that is being taken in developing the RQF, and has provided input at various stages of the process.[15]

The Academy looks forward to engaging in the continuing discussion of the recently released preferred model[16], noting that many aspects of that model are in accordance with the views forwarded by the Academy.

Two principles of concern to the Academy are that the concept of excellence is central to the definition of quality of research, regardless of where the research is undertaken; and that the RQF process is intended to inform the allocation of block infrastructure grants, including research infrastructure block grants and the Institutional Grants Scheme, to universities, and is not an input to the processes of the ARC and NHMRC in assessing individual research proposals.

Higher education

Recommendation 5

That government increases the level of funding for university operating grants to ensure that universities have the capacity to maintain key services into the future.

A strong university sector is at the core of Australia's capacity to maintain and develop the level of education among the population appropriate to a first-world country, including the skills base necessary to address the needs of industry and the plethora of environmental issues that remain unresolved.

The Academy welcomes the (modest) increases in operating grants funding under the Commonwealth Grants Scheme, and notes that the total funding per Commonwealth-funded student place increases significantly towards 2008, with the increased upper limit on student charges providing most of the increase.

However, the Academy also notes the concern expressed by the Australian Vice-Chancellors' Committee[17] that the value of this funding will decrease in future years unless the level of funding is indexed at a higher rate than currently applies.

The Academy notes that a significant fraction of the increased funding available to universities derives from the income from full fee paying

[13] *Policy statement on research and innovation in Australia, Recommendation 6*, Australian Academy of Science, September 2003. (www.science.org.au/reports/10september03.pdf)

[14] www.science.org.au/reports/4october05.htm.

[15] Establishing a research quality framework (RQF), Australian Academy of Science submission (to Department of Education, Science and Training), 28 April 2005, with attachments, available at www.science.org.au/reports/28april05.rtf.

[16] *Research quality framework: assessing the quality and impact of research in Australia; the preferred model*, endorsed for released by the Expert Advisory Group for the RQF, September 2005, available at www.dest.gov.au.

[17] *Laying the foundations: the AVCC submission to the Review of Indexation of University Funding*, Australian Vice-Chancellors' Committee, December 2004.

students, either domestic or from overseas. While the generation of external income is to be applauded, the Academy is concerned to ensure that the process is fully costed, so that the excellence of the research and teaching base on which the international competitiveness of the institution relies is maintained.

In this context, it should be noted that countries such as Singapore and China, from whence many international full fee paying students originate, are rapidly building up their own national university capacity, and will thus become more competitive in terms of attracting their own students, or even competing for international students from the region. It is probably safe to assume that the respective governments will set the cost of admission to their universities so as to be competitive in that international market.

In Australia, there is no indication that any 'profit' from these external revenue generating activities finds its way into supporting the core science and research programs of the universities.

The Academy remains very concerned that there does not appear to have been any progress on problems previously identified. The staff/student ratio continues its inexorable rise, and the level of academic salaries remains internationally uncompetitive.

These issues must be addressed if Australian universities are to maintain their current international standing, let alone improve their position.

The deteriorating situation regarding the lack of graduates in the science and engineering fields has been clear for years. The latest OECD data[18] show that Australia is very near the bottom in the percentage of university students in engineering, physics and mathematics. A large turn-around is necessary if Australia is to compete internationally in knowledge-based industries, as well as maintain an internationally competitive research capability, both in universities, and publicly funded research organisations.

While the figures vary somewhat in successive data sets, OECD data show that Australia ranks about seventh with the number of researchers per thousand of the labour force at 7.2, but the number employed in industry is only 1.7 per thousand of the overall labour force, which ranks Australia at about nineteenth.

This situation reflects the situation in terms of the disparity between public and private expenditure on R&D, discussed above. It highlights the weakness of the private sector in advancing knowledge-intensive industry in Australia.

Another manifestation of the problem is that both the private and public sector employers of research staff are finding it difficult to recruit qualified scientific and engineering staff.

There is a perception that 'the best and brightest' Australian graduates tend to head overseas. The question of the supposed 'brain drain' has been a somewhat vexed issue over many years. Some studies based on data obtained from immigration information provided by travellers in and out of Australia suggest that there is in fact, a net 'brain gain'. There is much anecdotal evidence to suggest that there is a real issue of quality not resolved in this analysis[19].

The weakness in R&D employment in the private sector, in engineering particularly, is compounded by the process of privatisation of public enterprises that had previously provided a large employment base for graduates, and served an important role as part of the supply chain of experienced engineers for industry.

The conclusion is inescapable that the Australian university system is struggling to provide the throughput of numbers, and the quality of graduates required to service our public sector research capability, or a growing knowledge-based industry, and that current measures are not providing a solution to the problem.

The Academy welcomes the establishment by the Commonwealth government in April 2005 of an *Audit of Science, Engineering and Technological Skills*, and is a member of the steering committee for that audit. It is hoped that this audit will build on the 2003 report *Mapping Australian Science and Innovation*[20], and provide some definitive answers to the key questions about the demand and supply of skills in these areas, that in turn provide the basis for concrete steps in the management of the issue into the future.

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[18] *Education at a glance 2004, Table A4.1;* OECD.

[19] *International mobility of the highly skilled: an Australian perspective*; Graeme Hugo, in 'Beyond brain drain' – mobility, competitiveness and scientific excellence, Fiona Q Wood Ed, University of New England, 2004.

[20] *Mapping Australian science and innovation*, published by DEST, October 2003.

School level science and mathematics education and awareness

Recommendation 6

That government further addresses the problem of the availability of suitably qualified science and mathematics teachers, and expands programs to encourage high school students into the science and mathematics streams.

A direct link in the causal chain leading to the looming shortage of scientists and engineers is the lack of high school students opting to study science subjects. The 2003 mapping report states that 'participation by Year 12 students in science subjects is a significant factor in ensuring not only a supply of candidates for undergraduate science degrees, but an adequate level of S&T literacy amongst the population as a whole.' The report then goes on to point out that 'physical science enrolments have fallen from 81,842 in 1991 to 66,504 in 2000, while total Year 12 enrolments have increased from 183,257 to 185,810 over the same period.'

The sheer numbers alone are cause for serious concern.

Another Commonwealth government report[21] highlights the insufficiency of highly trained teachers in science, technology and mathematics, and a number of factors mitigating against the effectiveness of science teaching in schools as currently practised.

A more recent paper[22] again highlights the low level of science training among high school science teachers, for example 25 per cent of Year 12 physics teachers have not studied physics past the first year of university.

Another recent study[23] lays the blame with the way science is taught in schools.

The Academy notes that there are programs in place to raise high school student awareness and interest in science generally, such as the national Innovation Awareness Strategy, implemented as part of the *Backing Australia's Ability* package, but also notes that this strategy was basically a continuation of previous science awareness programs that had targeted high school students, particularly at the period around Years 9 and 10 when they are considering career decisions. In order to assist students in making choices, there should be strong links between any major awareness programs and a nationally coordinated set of curricula for the sciences.

There has been some action in this area at the primary school level. In 1994, the Academy initiated a program *Primary Investigations*[24] that provides primary school teacher resource books and student books, coupled with inservice training and support for teachers, to guide a process of 'hands on' activities designed to stimulate understanding and knowledge of basic scientific principles.

This program is widely regarded as being very successful, and has been further developed as *Primary Connections*[25], that links the teaching of science with the teaching of literacy in primary schools. The program is a partnership between the Academy and the Department of Education, Science and Training. It has been developed in collaboration with a large number of key groups involved with the teaching of science and literacy.

The Academy is very pleased with the positive conclusions of a recent independent review of the *Primary Connections* program[26], and is especially pleased that the Minister for Science, Education and Training, the Hon. Dr Brendan Nelson MP, has approved funding for Stage 3 of the project.

The Academy is looking at ways in which these models might be extended to the secondary school level, and looks forward to discussing the development of suitable programs with the Commonwealth and state governments.

[21] *Australia's teachers: Australia's future – advancing innovation, science, technology and mathematics*; committee for the Review of Teaching and Teacher Education, DEST October 2003.

[22] *Who's teaching science: meeting the demand for qualified science teachers in Australian secondary schools*; Centre for the Study of Higher Education, University of Melbourne, April 2005.

[23] *New insight into school science decline*; Dr Terry Lyons, University of New England, September 2004.

[24] www.science.org.au/pi.

[25] www.science.org.au/primaryconnections.

[26] *Primary Connections Stage 2 Trial: Research Report*, Australian Academy of Science, October 2005. (www.science.org.au/reports/pcreport1.htm)

National research infrastructure

Recommendation 7

That government develops a dual funding strategy for the maintenance of national research infrastructure facilities.

The Academy is pleased that its 2003 recommendation to establish an ongoing commitment to maintaining the national research infrastructure has been given effect with the establishment of the national Collaborative Research Infrastructure Strategy (NCRIS) Advisory Committee, with an ongoing commitment of around $100 million per year, effectively replacing the previous level of funding for the Major National Research Facilities (MNRF) program and the Systemic Infrastructure Initiative. The certainty of longer-term funding will provide a sound basis for the Advisory Committee's work.

Clearly, this strategy requires a different approach from the MNRF program. The Academy has provided a comprehensive submission[27] to the Advisory Committee that included a scoping study of the infrastructure and personnel needs of the research areas covered by the Academy's National Committees for Science.

The current five-year commitment of funding, together with a well-crafted implementation strategy, should remove much of the uncertainty created by the *ad hoc* nature of the former MNRF program, which was characterised by tight time-frames for the preparation of proposals, and the limited potential to engage the states and territories, or overseas organisations, in the process.

The Academy sees that there are two models for major research facilities, and that the Advisory Committee should adopt a dual approach to the method of funding these facilities.

In one model, in which it is feasible to attract international funding partners, then a facility should be fully funded by those partners, with access granted free of charge based on the scientific merit of proposals to use the facility. A standard protocol could be developed to cover these arrangements, based on a contractual relationship between the partners that establishes a relationship between the proportion of the cost of the facility provided by the partner, and the proportion of facility capacity used by that partner. There are existing international models of this type, including, for instance, the Anglo-Australia Telescope.

The other model is similar to the existing MNRFs, for which the users are required to meet at least part of the operating costs. In this model it is critical that ARC or NHMRC research grants that require access to a particular MNRF include a line item to cover the cost of that access.

In the longer term, it is important to note that, in order to maintain research facilities as world class, the cost of infrastructure rises faster than the CPI, and it is important that the level of funding of infrastructure support remains under review, to ensure that the overall infrastructure inventory remains world class, and able to leverage international collaboration, both in terms of overseas participation in Australian facilities, and Australian access to international facilities.

Cooperative Research Centres program

Recommendation 8

That government at least maintains its level of support for the Cooperative Research Centres (CRC) program, and encourages the maintenance of the ongoing bi-partisan support for the program.

The Academy has previously[28] expressed its strong support for the CRC program, believing that it remains a world leader in fostering collaboration between research providers and research users in both the private and the public sector.

The Academy welcomed the announcement in the first *Backing Australia's Ability* (BAA) package that the funding level for the CRC program would, by year 5, '...been increased by 80 per cent', but is disappointed to now find that the actual funding profile rises to a level about 65 per cent above pre-BAA levels in 2005–2006, but falls to essentially the pre-BAA level in 2010–2011.

The most recent review of the program[29] was generally supportive of it, but made a number of

[27] *Australia's Major National Research Facilities: A submission to the National Collaborative Research Infrastructure Strategy Advisory Committee (NCRIS)*, Australian Academy of Science, February 2005.

[28] *Policy statement on research and innovation in Australia, Recommendation 10*, Australian Academy of Science, September 2003. (www.science.org.au/reports/10september03.pdf)

[29] *Evaluation of the Cooperative Research Centres Programme*; Howard Partners Pty Ltd, July 2003, available at www.dest.gov.au.

recommendations that resulted in a major revision of the guidelines and selection criteria. The most significant of these changes was the removal of the option for public good outcomes as the main objective of a CRC, and a requirement that there be at least one commercial entity among the core participants in a CRC.

The Academy has no problem with the concept of encouraging the commercialisation and utilisation of CRC research outputs, but is concerned that these changes do not result in a focus that is on short-term commercial outcomes at the expense of the more long-term strategic research objectives. Commercial or other outcomes are generally achieved outside the CRC framework itself, that is, by the users of the research taking up the research outputs of the CRC. The government is urged to limit its expectations of short-term commercial outcomes to be achieved by CRCs themselves.

In this context, the Academy is disappointed at the exclusion of public good outcomes as the main focus of a CRC. The Academy sees the CRC program as an effective mechanism to maximise the national benefit from research in both the public and private sectors. Enhanced environmental and social outcomes have long-term economic benefits, and the Academy urges the Government to review its position on this restriction.

Another pressure on the CRC program arises from the increased financial pressure on universities and publicly funded research organisations as described under Recommendation 3 above, that result in a decreasing flexibility in their ability to allocate resources to CRCs. This financial pressure exacerbates legal and other factors that add complexities to participation in CRCs as is described elsewhere[30].

The Academy is concerned that the combination of these factors does not erode the effectiveness of the core concept of the CRC program, that can be summarised as 'enabling the participants to achieve their objectives more effectively than working alone, or in one-on-one relationships'[31].

Maximising the benefits from Australia's formal linkages to global scientific activities

Recommendation 9

That the government provides additional support for the learned academies to allow a greater engagement with the international scientific community, and to support the development of international scientific-industrial linkages.

In this era of globalisation, the internationalisation of science assumes an increased importance.

As is well understood, Australia, with its indigenous capacity at about 2 per cent of the global scientific effort, relies heavily on its linkages with the global community to ensure access to the other 98 per cent of the world's scientific developments. The Academy plays a key role in this process, as it provides the formal link with the corresponding academies around the world. It also provides the formal link between international scientific unions and their national discipline-based committees.

A recent report by the Academy[32] maps the extent of Australian involvement in international collaborative scientific activities, and the benefits that flow from that involvement. The report also provides an inventory of opportunities to enhance the scope and effectiveness of that involvement.

Approximately 100 major global scientific organisations are identified, as well as many more significant activities and organisations that fall under these major organisations, with which Australia is formally engaged.

An important component of these international linkages are those arrangements that provide access for Australian scientists to major international research facilities, such as the European Organisation for Nuclear Research (CERN), the Gemini telescope, the synchrotron light sources in Tsukuba, Japan, and Argonne in the USA; and the Global Biodiversity Information Facility. Some of these arrangements (Gemini, Tsukuba, Argonne) are funded through the current

[30] *Evaluation of the Cooperative Research Centres Program; Submission from the University of Sydney*, June 2003.

[31] A paraphrase of a statement by Professor Peter Robinson, then Deputy Vice-Chancellor, University of Wollongong, CRC Association Conference, Brisbane, May 1998.

[32] *Maximising the benefits from Australia's formal linkages to global scientific activities*; Australian Academy of Science, April 2005. (www.science.org.au/reports/linkages.htm)

Major National Research Facilities program. It will be important to continue and expand these arrangements to include facilities such as the US Ocean Drilling Program.

It is also important that resources are available to provide for local and reciprocal international access to major Australian facilities, such as the Australia Telescope National Facility, the Australian Nuclear Science and Technology research reactor, and the Australian Synchrotron, currently under construction.

In addition to benefits that directly increase Australia's scientific capacity through these international arrangements, other benefits include the fact that there is a relatively large number of Australians in leadership roles in global scientific organisations, and Australia has hosted a large number of major international scientific conferences, including the general assemblies of almost all of the International Council of Scientific Unions (ICSU) member unions.

Another benefit from these formal arrangements that has the potential to become very significant is that academies in other countries often have strong links with industry in that country. In the case of China, for instance, its academy of science is the major operator of national research organisations, which, in turn, are affiliated with major industrial enterprises.

Increasingly, the Academy has been using its international contacts to foster science-industry partnerships. For instance, the Academy recently facilitated an agreement between the Chinese Academy of Sciences and BHP Billiton to undertake joint research, development and education in scientific and technical areas related to the minerals and energy industry.

The Academy organised a joint scientific and industrial mission to China in October 2005, which involved several companies in the biotechnology and nanotechnology area. This model holds great promise for developing international industrial linkages, particularly in scientifically intensive industries.

In addition to scientific and industrial links, international science relations should be seen as an important part of Australia's international and trade relations generally. Scientific issues are increasingly influential in matters of national security; for instance, studying bio-terrorism, infectious diseases and military technologies. Science plays a key role in the consideration of a range of economically important issues, including trade in genetically modified foods and products, international telecommunications, and microelectronics, to name a few.

Science is critical to national credibility on a range of global environmental issues, including climate change and the protection of biodiversity.

The Academy believes that Australia could achieve far greater benefits than is currently the case with an increased use of the opportunities available through the international scientific linkages that exist. These opportunities are ripe for development.

The Academy will look to working with the Department of Foreign Affairs and Trade to develop further the framework for these activities.

Abbreviations

ABS	Australian Bureau of Statistics
ANSTO	Australian Nuclear Science and Technology Organisation
ARC	Australian Research Council
BAA	*Backing Australia's Ability*
BERD	Business expenditure on research and development
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
GDP	Gross domestic product
GERD	Gross (national) expenditure on research and development
OECD	Organisation for Economic Cooperation and Development
NCRIS	National Collaborative Research Infrastructure Strategy
NHMRC	National Health and Medical Research Council
MNRF	Major National Research Facility
RQF	Research Quality Framework
SET	Science, engineering and technology

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