International Science and Technology

Its value to Australia and the role of the Academies

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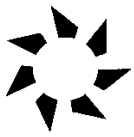

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Foreword

Building international networks is something Australian scientists have had to be good at to overcome the "tyranny of distance". As a result Australia has a valuable resource of a high-quality base of science, engineering and technology with extremely strong links to the rest of the world.

This paper is too short to show the richness of those interactions, but they are the basis for the view put forward that international collaboration in S,E&T is essential to Australia as well as to the progress of research.

The aims of this paper are to explore views about international cooperation in science, technology and engineering involving both public and private sector research, to assess the most useful roles for the Academies of Science (AAS) and Technological Science and Engineering (ATSE) and to assist the Academies provide advice to the Government. Both Academies are independent non-government organisations but are supported by the Government and work with Government Departments on international affairs (Attachment 1).

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ABBREVIATIONS

AAS	Australian Academy of Science
ACIAR	Australian Centre for International Agricultural Research
ANSTO	Australian Nuclear Science and Technology Organisation
APEC	Asia Pacific Economic Cooperation
ARC	Australian Research Council
ASTEC	Australian Science, Technology and Engineering Council
ATSE	Australian Academy of Technological Sciences and Engineering
AusAID	Australian Agency for International Development
CAETS	Council of Academies of Engineering and Technological Sciences
CCST	Coordination Committee on Science and Technology
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEETYA	Department of Employment, Education, Training and Youth Affairs
DIST	Department of Industry, Science and Tourism
EU	European Union
EuroCASE	European Council of Applied Science
FAO	Food and Agriculture Organisation
FASAS	Federation of Asian Scientific Academies and Societies
ICSU	International Council of Scientific Unions
IPCC	Intergovernmental Panel on Climate Change
IS&T	International Science and Technology
ISTAC	International Science and Technology Advisory Committee
ISTP	International Science and Technology Program
NGO	Non-Government Organisation
NH&MRC	National Health and Medical Research Council
OECD	Organisation for Economic Cooperation and Development
R&D	Research and Development
S&T	Science and Technology
SET	Science, Engineering and Technology
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WHO	World Health Organisation
WMO	World Meteorological Organisation

Summary

There are powerful benefits to Australia from international collaboration in S&T, mainly due to the international nature of scientific discovery and the role of S&T in Australia's relations with other countries. This position is recognised and acted on by other technology-developed countries.

Science and Technology Links

In the newly emerging knowledge economy, the basis of competitive advantage has shifted from the traditional factors of the economists to knowledge capabilities and networks; the former to provide the basis of learning, and the development of new products and processes; the latter to access in a rapid and effective manner the leading edge of knowledge and innovation.

While Australia is a modest player in international S&T as measured by its output (2% of total publications), the quality of its SET capability, and even more importantly, the strength and richness of its international recognition and alliances, formed out of the necessity of Australians to travel to be part of the international scene, have served to build a strong position at a time when international networks have become so important.

Measured by collaborations in published papers, Australia's scientific links have increased substantially over the past decade and are predominantly with the US and Europe, though collaboration with the Asian region has shown the strongest growth[1].

Research links operate in various ways and involve universities, CSIRO, State research organisations, CRCs and private business. One common feature in effective scientific collaboration is the importance of personal contacts to establish trust and build long term relations. Experience as postdoctoral Fellows, on study leave or at conferences is a well established catalyst for these relations.

Access to major facilities (telescopes, synchrotrons etc.) has been a valuable part of Australia's strategy for scientific collaboration, both overseas and in Australia (e.g. the *Australia Telescope*).

In certain global research programs it is necessary for Australia to cooperate to discharge international obligations or to ensure that the

effect of our position in the Southern Hemisphere is given due attention. In many cases these programs are facilitated by multinational organisations that require an Australian organisation as a member. Tangible benefits of membership of certain climate and global change organisations are provided in Attachment 2.

There are costs associated with international collaboration over and above the costs of research. Effective collaboration needs travel and requires time to be spent on exploring opportunities and setting up arrangements or to adapting to cultural differences. International scientific cooperation in the public sector has been supported by the Government directly through research grant programs such as the ARC, or indirectly through the various public sector research performers.

All major industrialised nations have been devoting considerable attention to strengthening international SET links in recent years. In particular in Europe, the framework of the European Union (EU) has led to a huge growth in multi-nation SET ventures. But, more widely, the recognised importance of international knowledge networking has seen the promotion of international SET linkages move, as a policy matter, from a marginal science policy issue to a major economic policy issue.

Industry Links

The key to providing Australia with a trading position consistent with rapid growth is to increase the export of elaborately transformed manufactures and, characteristically, firms that export are involved in R&D[2].

Companies make their own decisions about the use of technology but, in general, knowledge-dependent industries need access to science and technology inputs both from local sources and from overseas. For small companies in particular appropriate linkages either in Australia or overseas can broaden the base of experience they can draw on in making decisions. The CRC program is a successful means of building such linkages and increasingly these Centres are looking to overseas opportunities for cooperation.

Australian companies find the good perception overseas of Australia's scientific capability helps validate their technological outputs. Countries in our region recognise the importance of S&T in their economic development. They, for the main part see Australia as an inventive nation characterised by very able scientists and

technologists, but it is necessary to maintain this perception and for Australians to understand the growing capability in the region and the outstanding technological capability of major companies, for example in Korea and Taiwan.

Australia's traditional resource-based industries have well-established international links through technology interchange and, particularly in mining, through overseas investment.

Australia and the World: The benefits of collaboration

It is clearly recognised that Australia must become more outward looking and build awareness overseas of its technological capability in order to attract trade and investment both with the technologically mature regions of Europe and America and with countries in the Asia Pacific region. As referred to above the perception of Australia as being technologically advanced is important to Australian companies overseas.

Australia is in a position to provide academic leadership in certain fields that are particularly important to the Asia-Pacific region, and should do so.

The "tyranny of distance" means that Australians do not have the benefit of short journeys to other centres of research as do colleagues in Europe, USA or Asia but on the other hand this has forced Australians to seek international involvement.

International cooperation benefits Australian S&T through:

- access to "state of art" information
- participation in major international competitive research programs
- involvement in setting standards in a range of industries including telecommunications and electronics
- access to facilities or technologies not available in Australia, and
- benchmarking of Australian capabilities.

Australian universities have built substantial enrolments of overseas students, a business that will become increasingly competitive. Postgraduate training, particularly in science, engineering and

technology[a], is one opportunity where Australia can make use of its strengths and at the same time build lasting networks. Additionally, cooperation in research targeting overseas universities is a way of building long term linkages to attract students to Australian universities from overseas.

Australia has participated in international programs to support technology introduction and management in developing countries, for example in the ACIAR and AusAID programs, and can benefit in the long term from networks built this way when countries pass from dependence to self-sufficiency in technology.

Personal networks of scientists, and the experience of students in this country also help build the cultural interactions that this country seeks with other countries, and can in the long term lead to links between people in positions of influence.

The Government's Role

As the main funder of research in the public sector the Government has a substantial responsibility for international cooperation. Further, international cooperation and participation is necessary to discharge global responsibilities (for example in climate, health, biodiversity, or standards).

Government has a role in ensuring that agreements are in place to protect intellectual property in dealings with companies and institutions in other countries and that these arrangements are observed. There has been substantial progress in this issue.

Government also has a particular role in supporting activities that have demonstrable value but would not proceed without intervention and support, i.e. overcoming "market failure". There are three such issues relevant to international cooperation in S&T. The first is the extent that top-performing scientists and technologists are able to generate truly international linkages in their research through the funding mechanisms available. The second is facilitating industry's access to global developments in technology. The third is building awareness overseas of Australian capability and understanding, in Australia, the progress that is taking place in S&T in the region.

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[a] 38% of international students coming to Australia are postgraduate and substantially in S&T.

The Academies' Roles

The Academies have substantial experience in international science and technology programs and can assist in bringing partners together from both the public and private sectors. While for some countries in the region government to government contact is of key importance, Academies can play a useful role in brokering international contacts and joint research activities.[b] As NGO's the Academies can assist Government through their contacts in countries where there may not be a formal link between governments and can support activities which may not be appropriate for Government in the initial stage. Voluntary assistance from senior scientists and technologists makes the Academies' assistance cost-effective.

The National Committees of the Academies provide a useful means of consulting the experts in each field in Australia and reaching major international programs.

The recent report "*Priority Matters*" by the Chief Scientist[3] suggested there was a need for increased coordination of international S&T activities and that much of the support programs could be contracted out. The Academies support his comments and are ideally placed to assist. They can provide the 'bottom-up' support to the 'top-down' policy development by government departments.

[b] The Royal Society Exchange Program and exchanges organised with Korea and Taiwan are examples.

Science and Technology Linkages

Australia has a high-quality base of S&T but it is small in terms of publications and investment relative to the rest of the world. Research links involve universities, CSIRO, State research organisations, CRCs and private business.

Science and technology linkages overseas in the higher education sector have increased substantially in the last 15 years. Bourke and Butler[1] recently made a study of the degree of joint authorship in Australian publications as an indicator of collaboration. The analysis showed marked changes from 1981-1992 with international joint authorship almost doubling from 12 to 22%.

Analyses of cooperation in authorship of papers[1] have also shown that there has been a fall in the *proportion* of Australia's collaborations with 'traditional partners' the United Kingdom, the United States of America, New Zealand and Canada while collaborations with the fast developing nations in the Northeast and Southeast Asian regions have increased. There are opportunities to increase this collaboration further and APEC will also open up other opportunities. Nevertheless, overwhelmingly the target for collaboration remains North America.

The highest rates of growth of collaboration from Australia has occurred in earth and space science, mathematics and physics and the largest decline in clinical medicine. Researchers in the more basic fields of science are oriented more strongly towards the international community. Astronomy, oceanography, atmospheric and space science have historically required a high degree of international co-ordination merely to record and share the basic observations on which the science rests and to share equipment. In the case of mathematics, international links are indispensable. Much of the ARC funding for mathematics is spent on bringing overseas colleagues to Australia and those universities with a realistic presence in mathematics research all have vigorous visitor programs. The relatively small size of the field explains the need for workers to look outside their own countries for collaboration[c].

Major Facilities

Access to major facilities has been a valuable part of Australia's strategy for scientific collaboration. Major facilities can be shared to

[c] see [1] p 17

advantage internationally because their cost is beyond the budgets of many medium sized economies. Australia has participated successfully in overseas facilities in support of the physical sciences for example at CERN and the Rutherford Appleton Laboratory neutron spallation source. Many material science projects depend on this Laboratory as there are no such facilities in Australia.

In the use of synchrotron radiation, Australia has built a beam line at the Photon Factory in Tsukuba, Japan in what has been has been a very successful cooperation between CSIRO, the universities and ANSTO. The success of this international collaboration has led to access to the *Advanced Photon Source* in the USA and could be a step toward an Australian synchrotron.

The new generation of large telescopes need to be sited where the atmosphere can give most advantage to higher resolution technologies; Australia has recently been invited to participate in the *Gemini* project in Chile and Hawaii. In the reverse direction Australia provides access to the *Australia Telescope*.

There will be ongoing opportunities for benefiting from access to facilities to meet scientific needs, but these must be smart partnerships in which Australian scientists contribute to the overall ventures, and with a willingness in Australia to meet the cost of access to facilities that have a specific benefit to Australia. Design of Australia's new reactor will be an opportunity to consider cooperation with other centres of nuclear capability in the Asia-Pacific Region. The issue of access to Major Facilities has been reviewed by ASTEC[4,5]. This has also been a topic of discussion in OECD in the *Mega-Science Forum* over recent years.

Networks and Linkages

The " tyranny of distance" means that Australians do not have the benefit of short journeys to other centres of research as do colleagues in Europe, USA or Asia. However this has forced Australians to seek international involvement and Australian representation and influence on international committees and at international meetings is much greater than the size of the science base would suggest.

Collaboration is essentially a personal activity but it has moved to become part of strategic directions of institutions, groups or companies. The Academy of Science in *The Impact of Australian Science*[6] supported the view that informal networks make a strong

contribution to collaboration and that individuals are the key resource in development of international links.

There are many ways these linkages are established, the most effective being through overseas locations for postgraduate or postdoctoral experience, overseas employment, opportunities to visit laboratories of people in the same field, including major facilities, and specialist conferences or workshops. Many of the existing substantial collaborations with countries such as Japan or Korea have started from short-term exploratory visits from research groups in Australia.

In rapidly developing fields publication is behind the state-of-art knowledge. The most effective exchanges of know-how depend on having something to trade, and the trust that comes from long involvement.

Australia's international access in science would be severely weakened without overseas study programs in some form. In universities the opportunity for a period overseas has been a powerful means of initiating and reinforcing networks in addition to the scholarly outputs produced, but there are signs that a long overseas stay is less practical than it once was since a long period can put strains on colleagues to carry teaching responsibilities and may also not suit families in which both partners have to consider their career development. Young staff, who perhaps can most benefit from periods overseas, are particularly under pressure in this regard. Universities will need to adapt to more frequent short term visits or to integration of the visit with institutional plans to promote links.

Conferences are an important means of network-building since they provide the opportunity to meet people beyond normal networks. A NBEET[d] report found that the ability to attend major international conferences/seminars/meetings in their field at least once every 2 years was considered by most researchers as essential - it helped maintain existing links, was often fundamental in establishing new ones and kept them abreast of new developments in their areas of interest. NBEET found many long-established collaborations that grew out of unplanned, even accidental, encounters at international meetings.

Specialist conferences and workshops are particularly useful in allowing time for members to explore opportunities and developments

[d] See [1] p 64.

in the field. Exchange programs have facilitated network building through support for specialist conferences.[e]

The ARC's Overseas Postgraduate Research Scholarship scheme brings high quality students to Australia from a number of countries, particularly in Asia. Recent evaluation found that this program has contributed to international links.

Traditional collaboration between scientists has been largely driven by key researchers, based on their scientific standing in the major basic fields of research. However, the pattern of collaboration which has emerged under the EU-Australia S&T Cooperation Agreement, and reflected in applications to ISTAC, is one which has a far higher strategic and industrial content - Australian researchers are joining international teams to pursue commercial opportunities arising from leading-edge research.

The Internet

The Internet is an important adjunct to international collaboration and introduces a new flexibility of consultation, access to information and ability to move data and text at speed and in readily useable form from country to country. It has also proved to be a source of new contacts. Despite the obvious advantages, in many fields it cannot replace hands-on experience in research but while face to face contact can create the linkages, the Internet can maintain them and make them productive.

Industry/Science Linkages

Australia is a small economy by world standards, somewhat isolated from the technological and business drivers of the new global knowledge economy. In general, business makes its own decisions about sourcing of technology but there are pervasive factors which contribute to market failure in a small economy. These are, imperfect information and incomplete markets, extensive sunk costs, lack of competition and protected markets.

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[e] Australia has benefited particularly from major conferences held here because they allow students to meet people that they would not normally be able to visit. The cost of facilitating this is perhaps less than expected. For example, in 1994, through the Academy of Science's membership of ICSU, and support from the International Conference Support Scheme over 5000 scientists visited Australia to attend international conferences. A study by the Tourist Commission in that year showed that each tourist spends approximately $2,000 (in addition to their airfares) when visiting Australia, i.e. a total return to the Australian economy of approximately $10 million.

Australia's competitive position is weak in many emerging industries and also in established industries where local capacity has been replaced by imports. The key to providing Australia with a trading position consistent with rapid growth is to continue the growth in exports of elaborately transformed manufactures and in services that have been achieved over the past decade. While Australia's traditional industries of agriculture and mining will continue to play a central role, the need in the future will be integrated goods-services businesses based on clusters of products and service activities.

Those industries will depend on science and technology inputs both from local sources and from overseas. The challenge is to ensure appropriate linkages. Thus CSIRO/industry linkages have been strengthened by the requirement to obtain 30% external funding while the Cooperative Research Centres provide a new approach to linking researchers in universities, government agencies and industry with a view to commercialisation.

A major review of the CRC program in 1995[7] commented on the potential for international links for CRCs as:

"with the globalisation of industry, science and engineering Australia's international connections especially as they pertain to many CRC projects are becoming even more important. The Committee has seen a number of examples of CRCs developing valuable international links."

The CRCs constitute a set of focal points which provide linkages in clearly defined areas of S&T to a network of university, industry and government agency scientists and technologists focussed on those areas. They must be encouraged and supported to use their unique character to establish linkages in the Asia-Pacific region for the benefit of Australia.

Access to international S&T is vital to the development of integrated goods/services industries which are knowledge-dependent. This is particularly true of small industries which do not have the resources to maintain overseas representatives. The Academies can assist in this process by providing opportunities for interaction between Australian researchers both in universities and in industry (and now CRCs) and overseas researchers. While this often occurs between individuals the Academies have moved to a more structured basis using workshops on selected topics of mutual interest and benefit. These can provide the basis for more specific brokerage.

An example of this approach is the series of workshops carried out over the past 4 years under an agreement between the Korean Science and Engineering Foundation and AAS and ATSE together with the Australian Research Council with financial support from DIST. The initial topics selected were light alloys, water quality and treatment, and manufacturing. Groups of experts from each country have met to exchange their latest research findings and to develop joint projects with ultimate commercial benefits. These workshops have been very successful and opportunities have been taken to hold others in related fields such as polymer processing and uses of synchrotron radiation in research. The latter has the prospect of leading to Australian participation in the program at the Pohang Light Source.

Similar workshops have been held with Taiwan through the National Science Council on aquaculture and materials again with flow-on linkages, and with the Czech Republic through the Engineering Academy of the Czech Republic on possible cooperation in photonics, water treatment and materials.

Australian companies find the good perception overseas of Australia's scientific capability helps validate their technological outputs. Countries in our region recognise the importance of S&T in their economic development. They, for the main part see Australia as an innovative nation characterised by very able scientists and technologists, but it is necessary to maintain this perception and for Australians to understand the growing capability in the region and the outstanding technological capability of major companies in Korea and Taiwan.

Australia's traditional resource based industries have well established international links through technology interchange and, particularly in mining through overseas investment.

The Crawford Fund for International Agricultural Research is complementing other international activities through AusAID, ACIAR and university linkages. The Crawford Fund is an initiative of ATSE to publicise the benefits of agricultural research in terms of world food supply. It brings researchers and practising agriculturists to Australia to participate in training courses and visits to Australian institutions, and runs Masterclasses in Biotechnology for professional scientists and policy makers in developing countries. These have an excellent reputation and have opened up new areas for research and teaching in

the participating countries and have developed new linkages with Australia[f].

In certain industries, particularly in information and communication, Australia has benefited from memberships of committees that set technological standards for the industry, and which can have far-reaching consequences for choices of technology and hence investment.

Industry may also be able to strengthen Australian S&T capability through its international business investments, particularly large mining or resource companies through cooperation with overseas centres. In general, the move that is taking place in industry to become more outward looking must include science and technology.

Public Good Linkages

Much of the science and technology carried out in Australia does not have an immediate or foreseeable application for commercial purposes and the benefits cannot be captured by industry as a so-called 'private good'. However, there are benefits to the country and its people - so-called 'public good'. These arise in many areas - health, environment, transport, infrastructure, standards. While many of these are national benefits, there are also benefits to the 'public good' of the world in general. Thus the oceans and the atmosphere know no national boundaries and changes or deterioration on quality affect other countries. Because of its large land mass and responsibility for surrounding oceans, and a large portion of Antarctica, Australia is an important member of the world environmental community and carries out substantial science and technology which is made freely available.

An essential element of these activities is the exchange of information between researchers and the development of cooperative programs to pool scarce resources to tackle problems of common concern. Australia's position as the major S&T country in the Southern Hemisphere has made it a key member of world atmosphere, ocean, astronomical and Antarctic programs.

The Academies have recently made a joint submission on Australia's proposed marine science and technology plan which emphasises that as a small player Australia has more to gain from joining international

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[f] As an example, a very successful *Masterclass on New Technologies for Measurement of Biodiversity* was held in Malaysia under the auspices of the Crawford Fund, AAS, the Federation of Asian Scientific Academies and Societies (FASAS) Environment Australia, with financial support from DIST.

research than going alone. However, this would require increased support for infrastructure such as vessels and for management of research programs if Australia is to play its part effectively.

The diversity and range of Australian participation in international S&T programs with public good implications is difficult to document in this short paper, but examples are activities under the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the World Health Organisation (WHO), the World Meteorological Organisation (WMO), the Food and Agriculture Organisation (FAO) and the United Nations Environment Program (UNEP). While these are supported by Government funds through different Departments, the common theme is that the bureaucrats who run them are dependent on the scientific community for inputs on which they make decisions.

AAS with the support of ATSE and the scientific community, has taken a lead role in drawing together Australian researchers to participate in these programs.

Aid programs are a particular example of public good in other countries. These programs, funded by the Australian Government, have major implications for our image abroad and often have trade outcomes for Australian firms. However, they are only possible if scientists, technologists and engineers with specialised knowledge are available and willing to provide their expertise to support such programs. Again the background provided by international contacts is often a vital feature of a program's success. Australian participation in WHO is extensive and the WHO is working towards enhancing the role of collaborating centres. In the case of the NH&MRC, inter-country collaborative research is encouraged and there are plans in consultation with AusAID to establish mechanisms for NH&MRC to assist research training in the region. Australia has recently initiated company to company cooperation in developing countries as part of its aid program.

Support for linkages

Developing international linkages is a financial commitment over and above the cost of the research and is a cost in time for the people involved. The Academies believe that meeting these costs is vital for the effective future development of Australian S&T and of industry.

Ideally, international cooperation in research should be driven by the outcome of improving the research. For example this may be a need to use facilities, which may be large, or small but with new technology

not available in Australia, or it may be to access state of the art information available at limited or specialist conferences or laboratory visits. There are many examples of major programs involving overseas partners in CSIRO ("gene shears"), universities (e.g. Fujitsu) and increasingly in CRCs. Australian researchers now participate in 26 R&D projects launched under the aegis of the EU Framework program. Support from DIST has been a vital factor in this cooperation.

However "market-failure" can exist for various reasons such as lack of awareness of sources of technology or experience, or of access to networks, or cultural or language barriers, or even a preference to spend resources locally.

Building networks will arise to some extent from research-driven collaboration, but often is outside the accountable responsibility of research grants. It needs the support of other schemes if it is to proceed, particularly for young scientists, or where networks in countries are currently represented below their optimum, say from lack of information on what opportunities are available or cultural or language barriers. Market failure also may occur through isolation of groups in different countries who do not perceive opportunities for cooperation and here there can be value in catalysis of interaction (the recent APEC earthquake study is an excellent example).

As a result of the above processes and outcomes sought for cooperation, there will be a balance of "bottom-up", individual or institutionally promoted activities in a context of self determined funding, and other "top-down", or externally promoted activities.

Within research activities, the main institutions such as CSIRO and the universities have supported international collaboration where necessary for their research and teaching goals, especially through study leave.

The ARC has supported international research through its research grants and through fellowships. It currently has agreements of exchange with a number of countries and the NH&MRC has a number of Memoranda of Understanding on research collaboration.

Outside of the main institutions and the ARC, the *International Science and Technology Program (ISTP)* of the Department of Industry Science and Tourism has provided substantial support for networks and collaboration through a variety of grants aimed at meeting the additional costs of the activity, particularly from travel. Projects have been supported which seek access to facilities not

available in Australia; where Australian researchers gain access to the latest developments in their fields, or where study of particular problems overseas will provide input to similar Australian problems. The program has responded to proposals from scientists on the basis of excellence and benefit to Australia. The Bilateral Program is a grass roots support program for individual scientists. The Major Grants Program targets more strategic activities on a larger scale. The selection procedure aims to avoid duplicating opportunities available from the core research funding routes.[g]

DIST has provided support to the Academies to administer exchange programs e.g. to France, UK, Korea, Taiwan, China, and Japan and for a trial period to a number of other countries.

Many unsolicited comments have been received supporting strongly the ISTP initiatives (Attachment 3). The program evidently has helped build mutual awareness of capability in S&T with other countries and been valuable to scientists through support of cooperation. DEETYA's *Institutional Links* program has supported cooperation at the institutional level in Universities.

DIST has also supported access to APEC collaborations and there is scope for this to increase.[h]

The Department of Foreign Affairs and Trade has provided limited support for scientific exchange as part of cultural interactions (for example with Korea and India) and there would be advantage in co-ordinating these activities, say through CCST[3].

A useful analysis of the issues affecting collaboration is provided in a paper by Stephen Hill[9] and in the paper by Bourke and Butler[1].

It is the Academies view that while there has been substantial progress in the internationalisation of Australian S&T, there remains a degree of 'market-failure' in the establishment of cooperation both with the centres of technological development in Europe, USA and Japan and, to a greater extent, with the emerging countries in the Asia-Pacific that have achieved substantial capability already and will continue to build on this strength. For these reasons support from Government agencies and Government programs will continue to be essential, and the CRCs

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[g] An article in the Australian Educational Researcher analysed the importance of "seed" research funds in science and technology and used the program as a case study[8].

[h] A Senate Committee is currently investigating Australian involvement in APEC. The Academies each have recommended that APEC be recognised as an opportunity for collaboration in S&T.

in particular can provide focus for involvement of industry in this process.

Issues for Government Policy

As the main funder of research in the public sector the Government has a substantial investment in international cooperation. It depends on international cooperation and participation to discharge global responsibilities (for example in climate, health, biodiversity, standards). Australia also can benefit from cooperation through the perception given that Australia is interested in S&T and has very able people working in the field and from links to industry.

Policy statements on foreign relations would be an opportunity to support the role of S&T in addition to the S&T statements. There is now substantial experience of building interactions in S&T that have lead to substantial cooperation and this experience can be used to Australia's advantage in developing links to the centres of technology development in Europe, US and Japan as well as to the fast establishing countries of Asia and the emerging countries elsewhere.

Government has a role in ensuring that agreements are in place to protect intellectual property in dealings with companies and institutions in other countries and that these arrangements are observed. There has been substantial progress in this issue, but satisfactory agreements are as necessary for projects overseas as they would be in Australia.

Government also has a particular role in supporting activities that have demonstrable value but would not proceed without intervention and support, i.e. overcoming "market failure". There are three such issues relevant to international cooperation in S&T. The first is the extent that top-performing scientists and technologists are able to generate truly international linkages in their research through the funding mechanisms available. The second is facilitating industry's access to global developments in technology. The third is building awareness overseas of Australian capability and understanding, in Australia, the progress that is taking place in S&T in the region.

The first issue is better understood and better supported than it was ten years ago particularly in ARC grants and through support for access to major scientific facilities, but this approach must continue and take on new opportunities such as APEC.

The second issue relates to technology-awareness and diffusion of knowledge in Australia. Reorganisation of support for innovation is also an opportunity to recognise the global nature of technology development by industry. Thus the CRCs are ideally suited to link industry and public sector research in overseas cooperation (e.g. water treatment research in Korea).

The third issue depends substantially on the government, not only for financial support but for endorsement of the importance of international S&T for its benefits to industry as well as to science. Policy statements on foreign relations would be an opportunity to support the role of S&T in addition to the S&T statements. There is now substantial experience of building interactions in S&T that have lead to substantial cooperation and this experience can be used to Australia's advantage in developing links to the centres of technology development in Europe, US and Japan as well as to the fast establishing countries of Asia and the emerging countries elsewhere.

Grigg[10] refers to the findings of Blume[11] and comments that

"*...the internationalisation of research training has taken on new significance, with governments in most OECD countries treating the international aspect of the activity as an important and complex policy issue. Where most networks, structures, and resources for international mobility used to be at the post doctoral level, and driven by the scientific community, Blume points out that the impetus now is also coming from the centre, with governments becoming more directive with regard to international exchange and mobility, and research training programs becoming the focus of serious interest and debate."*

All major industrialised nations have been devoting considerable attention to strengthening international SET links in recent years. In particular in Europe, the framework of the EU has led to a huge growth in multi-nation SET ventures. But, more widely, the recognised importance of international knowledge networking has seen the promotion of international SET linkages move, as a policy matter, from a marginal science policy issue to a major economic policy issue.

The Academies' Roles

This paper argues for the importance of international cooperation in science, engineering and technology and for support in areas of market failure. The Academies can contribute through their involvement in international networks, by facilitating exchanges on behalf of government and by catalysing long term interactions.

The AAS has links to the Inter-Academy Panel on International Issues, and also has agreements with individual Academies which promote the exchange of researchers, such as the Royal Society in UK and Academie des Sciences in France, as well as through Fellowship schemes, some of which are funded by the Australian government.

The AAS is the Australian member of over thirty international unions and associations which draws together scientists in specific disciplines across the world to address issues of common interest and to exchange research findings. These operate under the auspices of ICSU. To support its ICSU activities, the AAS has set up a number of national committees which co-ordinate Australian participation and international programs and which serve as foci for bringing forward concerns of scientists in a "bottom-up" process. The ICSU activities have been recognised by successive Governments as a vital role for the AAS to play and have supported these by a special grant. However, the grant has fallen in real terms for over a decade.

ATSE links to the Council of Academies of Engineering and Technological Sciences which has its major support in Europe and North America with Japan and China now Members in our region. There is a loose association with a strong European grouping EuroCASE (European Council of Applied Science) which includes non-CAETS members in Europe. These are links to individual Academies in Europe, e.g. The Royal Academy of Engineering in the United Kingdom, The Netherlands Society of Technological Sciences and Engineering and The Royal Swedish Academy of Engineering Sciences, for group visits and workshops. ATSE has also signed a memorandum of agreement with the Engineering Academy of the Czech Republic to provide a link into Central and Eastern Europe.

These linkages maintain the traditional S&T links to Europe and North America but the Academies have responded to Government policies to stimulate links into our region. Thus a concerted effort has been made by both Academies to link to counterparts where possible in the Asia-Pacific region and to support regional groupings e.g. the Federation of Asian Scientific Academies and Societies (FASAS) and Asia Pacific

Economic Cooperation (APEC) Industry Science and Technology Working Group.[i] ATSE in particular has organised exploratory visits by groups of Australian scientists and engineers.

In some countries, particularly in Asia, the involvement of institutions is necessary before individuals can access funds for international collaboration. In these cases, the kind of bilateral agreements the Academies have with partners in those countries are essential. It is also necessary in those countries to establish relationships of confidence with the partner organisations over time.

In situations where there are formal government-government agreements operated under Joint Commissions e.g. China, Korea, Japan and Indonesia, the Academies have been able to assist with identification of projects, such as workshops and monitoring of progress through the contacts with the S&T community and industry.

The Academies have supported special programs such as the *Intergovernmental Panel on Climate Change* created jointly by WMO and UNEP to examine the global issue of potential warming due to emission of greenhouse gases, its potential impacts and strategies for adaptation and mitigation. In 1994/95, with ATSE in the lead role supported by the AAS and the Academy of Social Sciences in Australia, a major study, funded equally by Government and industry, was carried out on the contentious issue of climate change. The Non-Government Organisation (NGO) character of the Academies enabled them to bring together a very diverse group from industry, academia, government and conservation interests to consider the issue and produce a balanced report which provided the basis for the Government's stand in international debates, based on a community consensus. This was only possible because of the inputs from those scientists in the community who were participants in international programs. They gave freely of their time and experience for a perceived public good.

There is no doubt that these functions and linkages will intensify in the future and that the Academies will need continuing funding from Government to support them. Clearly more could be done with

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[i] In some countries, the two Academies have signed joint agreements and pooled resources to develop exchanges and workshops e.g. in Korea (as noted earlier), Taiwan and Indonesia. In others, separate linkages have been established e.g. in China, the AAS is linked to the Chinese Academy of Sciences and the ATSE to the State Science and Technology Commission (and probably the Chinese Academy of Engineering in the future), in Japan the AAS is linked to Japan Society for Promotion of Science, while in Thailand the ATSE is linked to the National Science and Technology Development Agency.

increased funding but there is a need to set the Academies' role in the larger context of Australian international relations in the region.

Close links have been maintained by the Academies with DIST and other Departments to ensure that activities are complementary from the Academies' 'bottom-up' view and the Departmental 'top-down' view. This has worked extremely well for the national benefit - a clear role for the Academies is program delivery as compared to the Departmental roles of policy formulation for international relations.

The recent review of Advisory and Priority setting mechanisms by the Chief Scientist[3] strongly supported international collaboration.

"Continuing contact with the world's research, science and technology are enormously important for Australia".

but added

"I believe that a more co-ordinated approach to such activities should be taken, without making the processes involved international links excessively complex including rationalisations and amalgamations among the various programs, including the outsourcing of running of some government programs."

This is line with the Academies activities, which could be expanded to take on some of the functions proposed by the Chief Scientist.

The Academies can also promote the cultural will to become involved in cooperation among researchers and encourage them to meet the personal costs involved. It should not be assumed that there is an infinite resource of scientists eager to participate in exchange programs; often the most useful are too busy!

Conclusions

In summary the Academies believe that Government policy must recognise the importance of international collaboration for science, engineering and technology in Australia and for building international cultural links and support activities.

Experience with international exchanges leads to the following conclusions:

- programs should give priority to linkages to the regions strong in technology such as Europe, Japan and the USA, and also to the fast developing countries of Asia

- there is a continuing need to facilitate access to major overseas facilities and to encourage visits to Australian facilities[3]
- research support programs must include development of international cooperation as a valid activity
- university overseas studies programs are of substantial benefit to international collaboration
- In the Asia-Pacific region interaction can be facilitated by building mutual understanding of each others capabilities. Mechanisms could include short visits or workshops as a starting point for ongoing interaction and visits of outstanding scientists - 'ambassadors'- to inform countries about Australia's capability
- Government Departments and IS&T Counsellors at posts overseas have given valuable assistance in gaining access and facilitating cooperations (eg EU Framework program)
- management of programs should be flexible to allow response to opportunities and based on lead organisations that can aid access to overseas networks and also assist with coordination[3]
- international linkages for business R&D should be included as a valid part of the innovation process in the response to the Mortimer report
- there is a continuing need for support for planning of international conferences in order to attract conferences to Australia
- science, engineering and technology, together with assistance in "technology management" should continue to be components of aid programs to developing countries
- it is essential for international S&T programs and activities to be coordinated.

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1 National Board of Employment, Education and Training (1995). *International Links in Higher Education Research*, Commissioned Report No. 37 (P. Bourke and L. Butler), Australian Government Publishing Service, Canberra.

2 Industry Research and Development Board, DIST (1997). *SCOREBOARD 97 - Business Expenditure on Research and Development*, Department of Industry, Science and Tourism, Canberra.

3 Chief Scientist (1997). *Priority Matters*, A report to the Minister for Science and Technology on Arrangements for Commonwealth Science and Technology (Professor John Stocker), Department of Industry Science and Tourism, Canberra.

4 Australian Science and Technology Council (1990). *Small Country, Big Science*, Australian Government Publishing Service, Canberra.

[5] Australian Science and Technology Council (1992). *Major National Research Facilities: A National Program,* Australian Government Publishing Service, Canberra.

[6] Australian Academy of Science (1996). *The Impact of Australian Science,* Discussion Paper, Australian Academy of Science, Canberra.

[7] CRC Program Evaluation Steering Committee, DIST (1995). *Changing Research Culture,* Australian Government Publishing Service, Canberra.

[8] Wood, F.Q., Nicholls, D.C. and Meek, V.L. (1995). *The Importance of "Seed" Research Funds in Science and Technology. An Australian Case Study,* Australian Educational Researcher Vol. 20. No. 3., Australian Association for Research in Education Inc.

[9] Hill, S. (1996). *Researchers across Frontiers.* Commissioned Concept paper for the 1996 Seoul APEC S&T Ministerial Conference, May 1996, Stephen Hill, Director, UNESCO Office Jakarta, Regional Office for Science and Technology for South-East Asia.

[10] Australian Research Council, DEETYA (1996). *The Internationalisation of Australian Higher Education: An Evaluation of the Contribution of the Overseas Postgraduate Research Studentships Scheme,* (L.Grigg), Australian Government Publishing Service, Canberra.

[11] Blume, S. (1995) Problems and Prospects of Research Training in the 1990's. In *Research Training Present and Future,* OECD.